

**EDUCATION REFORM AT THE “EDGE OF CHAOS”: CONSTRUCTING ETCH (AN  
EDUCATION THEORY COMPLEXITY HYBRID) FOR AN OPTIMAL LEARNING  
EDUCATION ENVIRONMENT**

by

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Irene Conrad, Ph. D.

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Currently, the theoretical foundation that inspires educational theory, which in turn shapes the systemic structure of institutions of learning, is based on three key interconnected, interacting underpinnings -mechanism, reductionism, and linearity. My dissertation explores this current theoretical underpinning including its fallacies and inconsistencies, and then frames an alternative educational theoretical base - a hybrid complex adaptive systems theory model for education - that more effectively meets the demands to prepare students for the 21st century. My Education Theory Complexity Hybrid (ETCH) differs by focusing on the systemic, autopoietic nature of schools, the open, fluid processes of school systems as a dissipative structure, and nonlinearity or impossibility of completely predicting the results of any specific intervention within a school system.. In addition, I show how ETCH principles, when applied by educational system leaders, permit them to facilitate an optimal learning environment for a student-centered complex adaptive system.

ETCH is derived from Complexity Theory and is a coherent, valid, and verifiable systems' framework that accurately aligns the education system with its goal as a student-centered complex adaptive system. In contrast to most dissertations in the School Leadership Program, which are empirical studies, mine explores this new theoretical orientation and illustrates the power of that orientation through a series of examples taken from my experiences

in founding and operating the Lancaster Institute for Learning, a private state-licensed alternative high school in eastern Pennsylvania.

## TABLE OF CONTENTS

<b>TABLE OF CONTENTS .....</b>	<b>VI</b>
<b>LIST OF TABLES .....</b>	<b>XIII</b>
<b>LIST OF FIGURES .....</b>	<b>XV</b>
<b>PREFACE.....</b>	<b>XVII</b>
<b>1.0 FACILITATING AN EDUCATION SYSTEM PARADIGM SHIFT .....</b>	<b>1</b>
<b>1.1 PRESSURE FOR A PARADIGM SHIFT.....</b>	<b>1</b>
<b>1.2 SUMMARY: RATIONALIZING A PARADIGM SHIFT .....</b>	<b>9</b>
<b>2.0 DISSERTATION OBJECTIVE .....</b>	<b>11</b>
<b>3.0 THE EDUCATION SYSTEM’S CURRENT TRADITIONAL PARADIGM.....</b>	<b>22</b>
<b>3.1 1<sup>ST</sup> RESEARCH OBJECTIVE.....</b>	<b>22</b>
<b>3.2 THE REDUCTIONISTIC, MECHANISTIC, LINEAR PARADIGM MANIFEST IN THE FIELD OF EDUCATION.....</b>	<b>31</b>
<b>3.2.1 Observable Mechanistic Behavior Operationalized in the Education System</b>	<b>31</b>
<b>3.2.2 Reductionistic Behavior Visible in Education System .....</b>	<b>37</b>
<b>3.2.3 Linear Behavior Visible in the Education System.....</b>	<b>38</b>
<b>3.2.4 The Resultant Effects of Reductionistic, Mechanistic, and Linear Thinking on the Field of Education.....</b>	<b>39</b>

<b>4.0</b>	<b>A COMPREHENSIVE ALTERNATIVE: BUILDING THE EDUCATION THEORY COMPLEXITY HYBRID (ETCH).....</b>	<b>47</b>
<b>4.1</b>	<b>INTRODUCTION: INFORMATION AGE DYNAMICS PRESSURE THE EDUCATION SYSTEM FOR AN EMERGENT PARADIGM SHIFT .....</b>	<b>47</b>
<b>4.1.1</b>	<b>Three Key Processes Operating in Complex Adaptive Systems (CAS): Introduction to Pattern &amp; Structure .....</b>	<b>52</b>
<b>4.2</b>	<b>THE SCIENCE OF THE LIVING AUTOPOIETIC EDUCATION SYSTEM56</b>	
<b>4.2.1</b>	<b>The Complexity Autopoietic Universalities Operationalized in Social Systems .....</b>	<b>64</b>
<b>4.3</b>	<b>SUMMARY .....</b>	<b>76</b>
<b>4.4</b>	<b>AUTOPOIESIS AND THE CURRENT TRADITIONAL PARADIGM.....</b>	<b>78</b>
<b>4.4.1</b>	<b>Readiness of Hierarchical Leadership Structure Operating in the Traditional Paradigm .....</b>	<b>80</b>
<b>4.5</b>	<b>THE AUTOPOIESIS PROCESS IN AN OPTIMAL LEARNING ENVIRONMENT AND ITS FACILITATOR.....</b>	<b>99</b>
<b>4.6</b>	<b>GENESIS OF A COMPLEXITY HYBRID THEORY: A PARADIGM SHIFT 101</b>	
<b>4.7</b>	<b>SUMMARY:.....</b>	<b>117</b>
<b>4.8</b>	<b>THE SCIENCE OF THE LIVING EDUCATION SYSTEM DISSIPATIVE STRUCTURE .....</b>	<b>119</b>
<b>4.8.1</b>	<b>Open Dissipative Structure Systems .....</b>	<b>121</b>
<b>4.8.2</b>	<b>Dissipative structures are living and non-living .....</b>	<b>123</b>

4.8.3	Universalities operational in Dissipative Structures .....	125
4.8.4	Equilibrium vs. Nonequilibrium (Disequilibrium) Systems .....	129
4.8.5	Instability, Perturbations, Bifurcation & the Emergence of New Structures.....	130
4.8.6	Instability, Bifurcations, & Perturbations in Living Systems .....	131
4.8.7	Influence of History at Bifurcation .....	133
4.8.8	Linearity vs. Nonlinearity .....	135
4.8.9	Summary: Key characteristics of Dissipative Structures .....	137
4.9	DISSIPATIVE STRUCTURE AND THE CURRENT TRADITIONAL PARADIGM.....	139
4.9.1	<i>Closed &amp; Open</i> Education Systems.....	141
4.9.2	Education System Interconnectedness.....	141
4.9.3	Traditional leadership in the education system dissipative structure ....	143
4.10	DISSIPATIVE STRUCTURES & ETCH .....	144
4.10.1	The Facilitator as a Dissipative Structure at the Edge of Chaos .....	145
4.10.2	Tools used by the Facilitator .....	159
4.10.3	Summary: The ETCH Education System as a Dissipative Structure ...	160
4.11	THE SCIENCE OF THE LIVING EDUCATION SYSTEMS COGNITIVE PROCESS.....	162
4.11.1	In a nutshell: To understand living systems .....	162
4.11.2	Bateson Maturana and Varela – the Santiago Theory of Cognition .....	168
4.11.3	Reflection and Consciousness.....	175
4.11.4	Emotion .....	177



	<b>TO SUMMARIZE: .....</b>	<b>177</b>
<b>4.12</b>	<b>COGNITION PROCESS .....</b>	<b>178</b>
	<b>4.12.1 Subsequent Effect of the Traditional Paradigm on the Education System</b>	
	<b>184</b>	
<b>4.13</b>	<b>THE COGNITIVE PROCESS AND THE ETCH FACILITATOR ROLE</b>	
	<b>AT THE EDGE OF CHAOS .....</b>	<b>190</b>
	<b>4.13.1 Summary: Cognition Process .....</b>	<b>202</b>
<b>5.0</b>	<b>THE SCIENCE OF EMERGENT STATES OF SYSTEM ORDER.....</b>	<b>203</b>
<b>5.1</b>	<b>PATTERNS OF BEHAVIOR.....</b>	<b>203</b>
	<b>5.1.1 Left on the Continuum: Predictability .....</b>	<b>206</b>
	<b>5.1.2 Cognition at the Edge of Chaos .....</b>	<b>211</b>
<b>6.0</b>	<b>GENESIS OF A COMPLEXITY HYBRID THEORY OPERATIONALIZED</b>	
	<b>FOR EDUCATION SYSTEM REFORM .....</b>	<b>212</b>
<b>6.1</b>	<b>CONCEIVING THE LANCASTER INSTITUTE OF LEARNING: AN</b>	
	<b>OPEN COMPLEX ADAPTIVE LIVING SYSTEM.....</b>	<b>214</b>
	<b>6.1.1 The Role of Facilitator .....</b>	<b>215</b>
	<b>6.1.2 Role of the Empowered LIL Instructor.....</b>	<b>217</b>
	<b>6.1.3 The LIL Think-Tank Processes: Continual Transformation through</b>	
	<b>Cognitive Structural Coupling Feedback Loop Networking (Interaction) .....</b>	<b>220</b>
	<b>6.1.4 The Emergent LIL Vision and Mission: Emergence of an Open Student-</b>	
	<b>Centered Learning School System Described Through the LIL Mission &amp; Vision</b>	
	<b>222</b>	
<b>6.2</b>	<b>THE LIL DESIGN.....</b>	<b>223</b>

6.2.1	<b>The Student Profile: Identifying Behavioral Patterns of Organization through the “Student Profile”</b> .....	223
6.2.2	<b>The Student-Centered Paradigm: Self-Organizing, Autopoietic Design to Transform Student Development in Four Key Areas</b> .....	226
6.3	<b>PSYCHOLOGICAL &amp; SOCIAL ENVIRONMENTAL COMPONENT: FACILITATING THE LIL LEARNING ENVIRONMENT BY SETTING THE ENVIRONMENT FOR SHAPING NEW ATTRACTOR PATTERNS FOR LEARNING BY IDENTIFYING POINTS OF BIFURCATION AND CHANGE IN THE STUDENT’S MENTAL MODEL</b> .....	229
6.3.1	<b>How Behavioral Attractors were Shaped at LIL</b> .....	231
6.3.2	<b>“LEVELS”:</b> Setting a Self-Regulation Environment for New choices of Student Behavior .....	236
6.4	<b>ACADEMIC COMPONENT</b> .....	240
6.4.1	<b>Establishing New Attractor Patterns of Learning: The Student’s Learning Epiphany</b> .....	240
6.4.2	<b>One-on-One Instruction</b> .....	242
6.4.3	<b>Integrate Group Interaction (IGI): THE ROLE OF SKILL AND CONTENT REINFORCEMENT AT LIL: Feedback Loops in the Learning Process</b> .....	246
6.5	<b>“GROUP” INTERCONNECTION AND COLLABORATIVE LEARNING AS PART OF THE DISSIPATIVE STRUCTURE LEARNING SYSTEM</b> .....	247
6.5.1	<b>GROUP - SKILL DEVELOPMENT: How Context Dependent Skill Development Was Shaped at LIL</b> .....	249

6.5.2	<b>GROUP - COOPERATIVE LEARNING: How the Establishment of new Attractors was Shaped at LIL.....</b>	<b>250</b>
6.5.3	<b>GROUP – UPPER-LEVEL THINKING SKILL DEVELOPMENT: How Structural Coupling for a Learning System was Shaped at LIL.....</b>	<b>252</b>
6.6	<b>FIELD TRIPS AS A COMPONENT OF THE LEARNING SYSTEM: HOW STRUCTURAL COUPLING BETWEEN THE STUDENT AND LEARNING ENVIRONMENT WAS SHAPED AT LIL .....</b>	<b>254</b>
6.7	<b>CAREER EXPLORATION---SETTING GOALS: HOW THE EVOLUTION OF CO-EVOLUTION WAS SHAPED AT LIL: .....</b>	<b>255</b>
6.7.1	<b>How the student at phase transition Open and Far-From Equilibrium was shaped at LIL .....</b>	<b>257</b>
7.0	<b>CONCLUSION.....</b>	<b>260</b>
	<b>APPENDIX A: COMPLEX ADAPTIVE SYSTEM TERMS.....</b>	<b>289</b>
	<b>APPENDIX B: TERMINOLOGY.....</b>	<b>296</b>
	<b>APPENDIX C: LIL STUDENT CONTRACT .....</b>	<b>302</b>
	<b>APPENDIX D: COUNTER-CONDITIONING FROM LEVELS .....</b>	<b>304</b>
	<b>APPENDIX E: THE LIL BEHAVIORAL LEVELS .....</b>	<b>307</b>
	<b>APPENDIX F: WEEKLY BEHAVIOR FEEDBACK FORM.....</b>	<b>309</b>
	<b>APPENDIX G: ONE-ON-ONE PROCEDURE .....</b>	<b>311</b>
	<b>APPENDIX H: LIL INTEGRATED GROUP INTERACTION (IGI) PROCEDURE .....</b>	<b>313</b>
	<b>APPENDIX I: LIL GROUP PROCEDURE .....</b>	<b>316</b>
	<b>APPENDIX J: LIL COOPERATIVE LEARNING CURRICULUM .....</b>	<b>318</b>
	<b>APPENDIX K: LIL UPPER LEVEL THINKING SKILLS SCOPE &amp; SEQUENCE.....</b>	<b>321</b>

<b>APPENDIX L: LIL FIELD TRIPS PROCEDURE.....</b>	<b>323</b>
<b>APPENDIX M: LIL PARENT FEEDBACK .....</b>	<b>326</b>
<b>ENDNOTES.....</b>	<b>330</b>

## LIST OF TABLES

Table 1. The nature of change.....	5
Table 2. Types of first order change .....	6
Table 3. A paradigm shift from first order to second order change.....	8
Table 4. First order change .....	12
Table 5. Second order change .....	13
Table 6. System redesign in second order change .....	15
Table 7 Research Framework .....	17
Table 8: Constructive Theorizing Process .....	18
Table 9: Dissertation Framework.....	20
Table 10. Development of Mental Models .....	26
Table 11: Comparison between Traditional Paradigm and Education Theory Complexity Hybrid .....	50
Table 12. Organizing Table for Comparison between the Traditional Paradigm and Educational Theory Complexity Hybrid.....	55
Table 13. Universalities Found in Autopoiesis.....	61
Table 14. Positive and Negative Feedback Loops .....	70
Table 15. Paradigm Contrasts Relating to Autopoiesis .....	79
Table 16: Traditional Leadership Operating in the Traditional Education Paradigm .....	81

Table 17. Paradigm Shift from 1st to 2nd Order Change .....	85
Table 18. Paradigm Shift to Optimal Learning Environment.....	99
Table 19. Leadership Traits that Suggest Readiness or Paradigm Shift .....	106
Table 20. Leadership and 2nd Order Change .....	111
Table 21. Assumptions about Education Practice.....	113
Table 22. System Autopoiesis vs. System Dissipative Structure.....	119
Table 23. Non-living and Living Dissipative Structures .....	124
Table 24. A Living System is a Combination of Autopoiesis and Dissipative Structure .....	125
Table 25. Universalities Found in Dissipative Structures.....	126
Table 26. Role of History in Traditional and Dissipative Structure Paradigms .....	134
Table 27. Description of Dissipative Structure in the Traditional Education System Paradigm and the Educational Theory Complexity Hybrid .....	140
Table 28. Description of Dissipative Structure Found in the Educational Theory Complexity Hybrid .....	145
Table 29. Critical Components to Stretch Adaptation Capacity.....	151
Table 30. The Interconnected, Interdependent Processes of Living Systems.....	162
Table 31. Universalities Found in the Cognitive Process .....	164
Table 32. Cognition and Traditional Education Paradigm .....	179
Table 33. Role of Facilitator in an Optimal Learning Environment.....	192
Table 34. Ten Learning Junctures of an Optimal Learning Environment Facilitator.....	194
Table 35. Comparison between First and Second Order Change .....	196
Table 36: States on the behavior continuum.....	204
Table 37. States of Order as Defined by Various Authors .....	205

## LIST OF FIGURES

Figure 1: Mental Models, Memes, Paradigms, and Fields .....	23
Figure 2: Perception, Mental Models, and Reality .....	25
Figure 3. Emerging Theory of Living Systems .....	53
Figure 4. The Interconnectedness of the Autopoietic, Dissipative Structure, .....	54
Figure 5. Autopoietic Systems Are Living Systems .....	57
Figure 6. Autopoiesis Described in Physical, Mathematical and Social Domains .....	59
Figure 7. Behavior of Autopoietic Systems .....	60
Figure 8. Emergent Pattern of Organization in Living Systems.....	65
Figure 9. Circular Causality of a Feedback Loops .....	67
Figure 10. Circular Feedback Loop .....	68
Figure 11. Self-Balancing and Self-Reinforcing Feedback .....	71
Figure 12. The Process of Emergence .....	72
Figure 13. Traditional System Paradigm .....	87
Figure 14. Morgan's Mental Model 1: Metaphor of Organization as Machine .....	93
Figure 15. Mental Model #2: Organization as Machine in Circular Causation.....	95
Figure 16. Mental Model #3: Herbert Simon's School as Machine.....	96
Figure 17. Mental Model #4: School as Machine plus the "Child Factor" .....	98
Figure 18. Traditional Paradigm System View.....	102

Figure 19. Open Autopoietic Living Education System.....	103
Figure 20. Open Thermodynamic Systems .....	122
Figure 21. Prigogine's Theory of Dissipative Structures .....	123
Figure 22. Bifurcations .....	132
Figure 23 . Dissipative Structure of Living Systems .....	137
Figure 24: Characteristics of Living Systems that Include.....	139
Figure 25. The Do's of On-Going Turbulence (Conner, 1998).....	153
Figure 26. Don'ts of Ongoing Turbulence (Conner, 1998).....	154
Figure 27. The Process of Cognition .....	169
Figure 28. Theory of Cognition as Criteria for Living Systems .....	172
Figure 29. Conner's Organizational Paradigms .....	195
Figure 30. Order continuum from Predictability to Instability (Conner).....	208
Figure 31. Capacity vs. Demand Continuum (Conner) .....	209
Figure 32. The Zone.....	210
Figure 33: LIL Communication Feedback Loops.....	215
Figure 34: The Interconnected LIL Communication System .....	221
Figure 35: The LIL Student-Centered Paradigm .....	228
Figure 36: LIL Interconnected Program Structure.....	230
Figure 37: Structural Coupling Between Education Theory and LIL Practice - As Tools for Student Counterconditioning .....	234
Figure 38: The LIL Think-Tank Process .....	245
Figure 39: The LIL Career & Long-Term Goal Model .....	257
Figure 40: Career Goals Areas of Emphasis.....	258



## PREFACE

The emergence of ETCH was a labor of love inspired by the staff, students, and parents that filled the halls of the Lancaster Institute of Learning. The openness of its teachers to explore uncharted waters in the design of an optimal learning environment for its students is testimony to the altruistic motivation of the teaching profession. Much more than a doctoral committee member, Dr. Michal Jacobson, through his published articles on complex systems and cognition, inspired the initial approach for the constructs of my research. His support, patience, and willingness to debate the validity of supporting theories as I grappled with often difficult science concepts was consistent making the editing journey possible. The patience and support of my doctoral committee, Dr. Michael Jacobson, Dr. Consuella Lewis, and Dr. Maureen Porter is greatly appreciated. Distilling and sharpening the details of the ETCH theory was only possible through many hours of debate and discussion with my Mom, Mary Jastron a viable sounding board to identify observable patterns in the present operating education system. Dr. Alan Lesgold, my research advisor and mentor provided an immeasurable amount of experience, and was indispensable in his input and feedback to build the bridges between the sciences, complexity theory, and education system application. His expertise in both artificial intelligence and psychology provided a sound foundation for dialogue and discourse. Finally, I would like to thank my daughters, Cherie and Robyn, and my son, Chris for their steadfast, uncompromising encouragement, backing, and strength.

## **1.0 INTRODUCTION**

### **1.1 PRESSURE FOR A PARADIGM SHIFT**

Traditionally, education has been a relationship between a teacher teaching and a student learning. Moreover, the traditional view of effective teaching has been atomic. Effective teachers, it was thought, took complex bodies of knowledge, broke them down into simple components, and systematically taught one component after another. The central point of this dissertation is that this simple view of learning and teaching no longer suffices. Today, we know more about learning and know that reductionistic approaches have severe limitations. Educational systems are now much more complex, involving many teachers, many students, complex bodies of rules, and levels of decisions by school boards, superintendents, central staff, principals, teachers, and students.

Fortunately, a substantial science of complex systems has arisen that can be applied to educational systems, just as it has been applied to many other kinds of systems, from living organisms, to global climate, to urban transportation. This science focuses not only on complexity itself but also on the need for most systems to be adaptive. Organisms function to survive and adapt as best they can to threats of extinction. Businesses function to stay solvent and to make profit. In each case, the systems have multiple levels at which different forms of adaptation may be occurring. Nonetheless, there now is a clear body of complex adaptive systems principles that are worth considering as guides to educational learning systems.

This dissertation consists of several chapters. In Chapter 3, I consider the principles that educational leaders seem to be applying to their work today. I suggest that there are three fundamental characteristics of the theories that implicitly or explicitly underpin educational leadership, namely that educational systems can be approached from a linear, mechanistic, reductionistic viewpoint. I show certain inadequacies in this viewpoint. Then, in Chapter 4, I focus on three fundamental principles that apply to complex adaptive systems, namely that they are self-organizing (or autopoietic), dissipative structure (information flows in and out of various components of educational systems and between those components and an outside world) that function cognitively (through mental models that are formed in each system component based upon information that reaches that component, its own goals, and the overall system goals it has assimilated through structural coupling with its environment). In Chapter 5, I explore the behavior continuum from order to chaos of natural complex adaptive systems as they interact with their perspective environments. In Chapter 6, I apply these three central principles to a number of examples taken from my experience leading an alternative high school, the Lancaster Institute of Learning.

The need for this new approach arises partly from the increasing complexity of educational system. We have learned more about how to facilitate learning and how learning happens. Our understanding of the brain as a complex system involving a number of different structures that act in concert has changed our sense of what it means to learn. Where once learning was seen as the storage of facts in someone's head, now we know that learning involves not only knowing what, but also knowing how. Moreover, complex skills such as reading involve multiple brain systems, depending upon exactly what has been practiced and how well.

Further, human interaction often involves a mixture of rational decision making, mental shortcuts, and emotional overrides, making emotion an issue for learning as well.

In addition, we now can see that schools are not closed information systems in which orders flow from on high and are simply executed. Rather pertinent information is openly available (transparent) to and from people inside and outside the system in multiple ways. A teacher responds not only to what a principal says and what she was taught but also to parental inputs, community beliefs, personal needs, magazine articles, and television stories. Where traditionally educators had a significant degree of autonomy from the larger community, and hiring and firing, curriculum decisions, instructional methods, and academic standards used to be set within the system, a growing cultural crisis has emerged (Hoffman, 2002; Senge, 2000). Media investigations, litigation, school board politics, and larger ideological campaigns all mean that system personnel can be exposed to public scrutiny in a way that is fundamentally different from the past. As a result, whether on a fine-grain scale or macro-level, there is no way that an education system or its leader can remain in charge and in control of information with unquestioned authority.

The sources of information creating opportunities to learn have become so vast that they threaten to engulf classrooms and schools. Developments occur so rapidly across many knowledge domains, to the point where information in authoritative journals is out of date before it is published; products are obsolete before they hit the market; and many current events change on a minute-by-minute basis. Consequently, at a finer-grain scale, traditional student information sources are affected by technology. Many textbooks are fundamentally inappropriate. Few textbooks are the primary source of current information. Similarly, even teachers who are constantly updating their own professional expertise can only keep pace with a

small fragment of what is becoming available. Teachers are often second-guessed when genuinely contradictory information is available to students from multiple sources, ranging from television's Discovery Channel to the Internet. Students repeat the opinions of talk show hosts as unquestioned authorities. Messages in media and the arts challenge some taken-for-granted value systems. And many adults who advocate strong views are seen as not practicing what they preach.

Whether on a coarse or fine grain scale, Technology has transported *interconnectedness* to the forefront through the World Wide Web, virtual reality, unlimited international access to television viewing, encyclopedic information of all types, and instant access to the world's greatest minds, mark only a few of the possibilities. As a result time constraints have crumbled as digital signals replaced mechanical action, computers have become faster, and people have opportunities to work together even when separated by thousands of miles.

Pressures for Change---To What? Education system critics suggest that discoveries in science and technology pressure both societal changes for living successfully in the information-rich world, as well as a shift in perception in the education system. They suggest that "The new times need new languages, theories and methods .....provide a platform for facilitating effective governance"(White, 2001). To really restructure anything, they believe, requires a restructured thinking that includes a shift deep in the connections of the human psyche. However, as Table 1 and Table 2 below further define, "PIECEMEAL," "INCREMENTAL," or "SYSTEMATIC" FIRST ORDER CHANGE are insufficient for improving education systems (Brown, 1991); Weil; (Ison, 1999). Weil, drawing on the work of Donald Schön, argues that the 1<sup>ST</sup> ORDER CHANGE attempts at management are not the stable states perceived by the education system.

2<sup>ND</sup> ORDER change is a necessary requirement for the education system's evolvement (Ison, 1999; Laurillard, 1999).

**Table 1. The nature of change**

<p><b>Chapter 2 of Dissertation</b></p> <p><b>The Traditional Paradigm</b></p> <p><b>Change is Thrust on Schools</b></p>			<p><b>Chapter 3 &amp; 4 of Dissertation</b></p> <p><b>A Comprehensive Alternative: Building the Education Theory Complexity Hybrid</b></p> <p><b>Requires Change of System Not Within System</b></p>	<p><b>Chapter 5 of Dissertation</b></p> <p><b>PARADIGM SHIFT TO OPTIMAL LEARNING ENVIRONMENT</b></p> <p><b>Requires System Redesign</b></p>
<p><u><b>1<sup>ST</sup> ORDER CHANGE</b></u></p> <p>Form: <b>Reaction to symptoms and focus on surface change.</b></p>			<p><u><b>2<sup>ND</sup> ORDER CHANGE</b></u></p> <p>Form: <b>Engage system holistically and focus on Fundamental change</b></p>	
<p><b>Piecemeal Change</b></p>	<p><b>Incremental Change</b></p>	<p><b>Systematic Change</b></p>	<p><b>Systemic Change</b> Is holistic not reductionist, dynamic not linear, a critical process not mechanical, and individually and locally relevant not generalizable</p>	
<p><b>“Once and done”</b></p>	<p><b>Make what exists more efficient and effective without disrupting the basic features</b></p>	<p><b>Make results generalized to a larger context</b></p>		

1

**Table 2. Types of first order change**

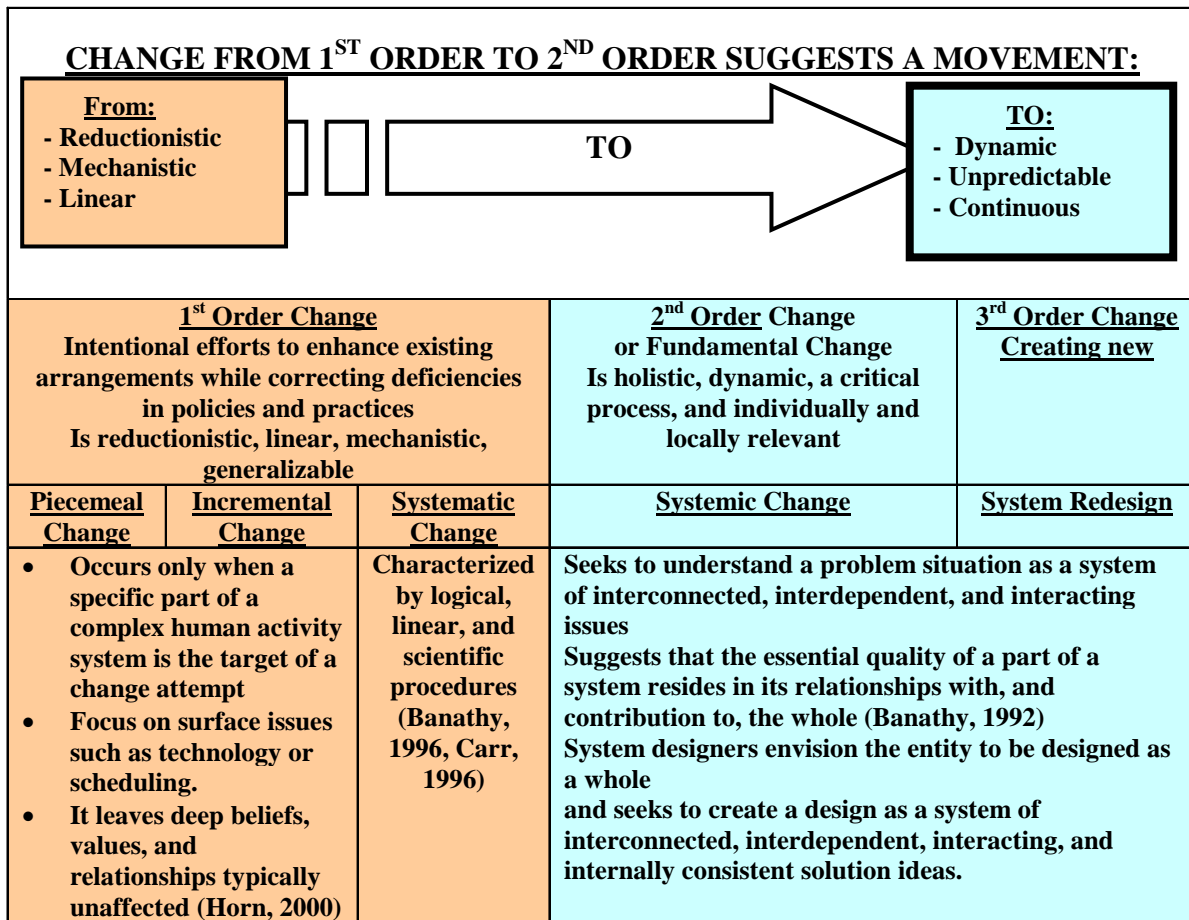
TYPES OF 1 <sup>ST</sup> ORDER CHANGE	CHARACTERISTICS	EXAMPLE
<p><b><u>PIECEMEAL CHANGE</u></b>            “Once and Done” occurrences divorced from other parts of the learning system</p>	<ul style="list-style-type: none"> <li>• Seemingly random uncoordinated, disjointed tinkering useful in ‘fixing’ certain types of hard systems</li> <li>• Outmoded for changing soft and social systems</li> <li>• Does not encourage the development of an overall vision</li> <li>• Without vision, the resultant chain of effects rippling throughout the whole educational environment cannot be anticipated and understood. Banathy 1991 suggests that this is why many changes are short-lived.</li> </ul>	<p><b>Focus on surface issues such as:</b></p> <ul style="list-style-type: none"> <li>• <b>Technology</b></li> <li>• <b>Scheduling.</b></li> </ul>
<p><b><u>INCREMENTAL CHANGE</u></b>            Since mid-19<sup>th</sup> century schools have changed in incremental ways</p>	<ul style="list-style-type: none"> <li>• Attempts to make what exists more efficient and effective without disrupting the basic organizational features of the classroom, school, or district (Cuban 1991)</li> <li>• Tightly focused changes can be attempted in specifically identified parts of the system encouraging micro-management of the change process.</li> <li>• Promotes limited rather than broad-based commitment to change</li> <li>• An assumption that the current goals and structures of schooling are both adequate and desirable (Cuban 1991 p 197)</li> <li>• It has not substantially changed teaching because it does not challenge educational cultures that are balkanized or individualized (Cuban 1991)</li> </ul>	<p><b>Focus on surface issues such as:</b></p> <ul style="list-style-type: none"> <li>• <b>Discipline</b></li> <li>• <b>Scheduling.</b></li> </ul>
<p><b><u>SYSTEMATIC CHANGE</u></b>            Typically found in engineering, military, and computer science contexts</p>	<ul style="list-style-type: none"> <li>• Is based on problem solving where a problem is identified, a plan of action is developed, and then the plan is implemented to solve the problem</li> <li>• Typically assumes the ability to resolve a problem by identifying and controlling significant variables linking it to traditional forms of scientific method</li> <li>• Often supported by scientific procedures such as employing experts, quantifying the problem, and devaluing experiential data and indigenous knowledge</li> <li>• Is top-down and typically does not disrupt existing power dynamics</li> <li>• ‘One size fits all’ strategy---Produces results that can be generalized to a larger environment or context ---the need to translate a “solution” to a diverse set of school communities (ie: the exact duplication and subsequent implementation of a standardized direct instruction model in numerous school districts</li> <li>• The linear nature of systematic processes prevents holistic orientations that would view the situation as dynamic and continuous—this is an end point</li> <li>• Although many systematic change models do encourage feedback in a cybernetic sense, there is rarely a critical concern for the whole environment</li> <li>• Called “input’ or ‘buy-in’---systemic change effort affords students, parents, and teachers a limited controlled voice</li> <li>• Reform not design is a typical outcome, which works within existing educational systems (design would involve creating something new)</li> </ul>	<ul style="list-style-type: none"> <li>• Implementing portfolios due to an external mandate</li> <li>• ***Asking and answering questions about the effects of assessment on children</li> <li>• ***Asking and answering questions about the purpose of assessment in relation to their performance</li> <li>• ****Asking and answering questions about the purpose of assessment as a sorting tool in terms of expected school functions</li> </ul> <p>*** These different conversations open the system to power disruptions, causing power brokers to generally avoid conversation as a method for change. Can lead to systemic change because they call communities to dialogue about deep values and beliefs</p>

School systems tend to be rather turbulent, because of the many agendas their participants are pursuing, and a turbulent system requires a different set of beliefs – a different perceptual orientation, to collectively conceive in fundamentally different ways (Caine & Caine, 1997).<sup>2</sup> In such systems, simple rearrangements of existing structures will not produce much improvement (Caine & Caine, 1997). Nor can simple high-level budgetary control produce optimal results (Ison, 1999). A new approach is needed for what is possible for people to be and become.<sup>3</sup>

CHANGE FROM 1<sup>ST</sup> ORDER TO 2<sup>ND</sup> ORDER, shown in the diagram below, is a change from the mechanistic, reductionistic, linear paradigm to a systemic viewpoint. The differences between a mechanistic (traditional) and a systemic or ecological (holistic) vision are striking. The traditional notion of students has implied individuals who must ingest some form of basic information to survive, consume, and produce. To adopt the notion of learning as the acquisition of meaningful knowledge instead of the delivery of information developed by experts suggests changing the core relationships – the deep beliefs that express the nature of the “connectedness” between the people and elements of the system. It signifies a simultaneous change in power relationships within the system. The systemic or ecological viewpoint implies that individuals are intrinsically motivated, the environment is spontaneously self-organizing environment, where emphasis on control is structurally unsound for growth, and where the future is not an extrapolation of the present (Goerner, 1995). Through adequate self-reflection and self-reference, the system could reorganize itself in ways that actually assist education. Shown in Table 3 below, a “new paradigm” change from 1<sup>ST</sup> ORDER TO 2<sup>ND</sup> ORDER offers a theory of learning that can guide new approaches to teaching and education.



Table 3. A paradigm shift from first order to second order change



To grasp the nature of this fluid and dynamic “*interconnectedness*” of 2<sup>ND</sup> ORDER CHANGE, which is less predictable and far more interconnected than what was previously understood, a new set of tools for thinking about the nature of relationships within and beyond a system is needed. It is necessary in order to reframe the issues and the description of the situation itself. If, as complexity scientists believe, complex adaptive systems of all kinds – those in nature and those in human society---share fundamental properties and processes, then the complexity approach offers a way to understand and work with the fundamentals of all organizations.<sup>4</sup> Already, across many different disciplines in business management, there is increased interest in an alternative frame of reference, for envisioning the organizational world.

Some have labeled it a constructivist epistemology, while others have called it the self-reference paradigm. Whatever the label, there seems to be some common threads, (White, 2001) one of which is the emergence of a leader that understands the underlying influences of this new paradigm (Senge, 2000). Consequently, perhaps the conduit for effective change or school reform is not bounded in programs, initiatives, or directives, but enclosed in this fundamental set of complexity universalities, (sometimes referred to as laws, and sometimes theory) that anchor societal structure and affect every dimension of human interaction with their environment.

## **1.2 SUMMARY: RATIONALIZING A PARADIGM SHIFT**

I argue that the dominant paradigm for educational leadership must be replaced by an emergent style of thinking, (2<sup>nd</sup> order change) that allows the possibility of a fluid relationship to be formed among different actions/actors (between problem, problem owner, and would-be problem structurer) (White & Taket, 1993). Chapter 3 (Traditional Paradigm) of this dissertation identifies and describes the system behavior from the dominant traditional paradigm as observed through its mechanistic, reductionistic, linear characteristics. Chapter 4 and Chapter 5 (A Comprehensive Alternative) build on Chapter 3 by comparing and contrasting the traditional paradigm, described in Chapter 3, with an alternative paradigm (a complexity theory complex adaptive system (CAS) model which will serve as a foundation for the ETCH design and implementation of the education system). The alternative approach to the mechanistic, linear, reductionistic paradigm, ETCH (Education Theory Complexity Hybrid) embraces a self-organizing paradigm that encounters problems that may not yet be manifest; a methodology that will emerge; and an environment where it may not be possible to deduce outcomes from stated

objectives, or even where the structurer and owner of the problem may be one and the same (White, 2001). From the scaffolding within Chapter 4 and Chapter 5 emerges a comprehensive theory – a complexity theory hybrid – that replaces the current paradigm and explains and enables an optimal learning environment for the 21<sup>st</sup> century student-centered education system. Chapter 6 demonstrates evidence of the complexity universalities found in ETCH by using an education system example---The Lancaster Institute of Learning. As a result, ETCH is established as a coherent, valid and verifiable alternative, more comprehensive theory for the education system.

## 2.0 DISSERTATION OBJECTIVE

“Faulty notions” operating in a “system that is outdated”---these words from Ginsberg (1992, p. 2) and similar words from other educational critics, describe the present educational system. They suggest status quo---a quality of education reinforced by an operationalized theoretic model. Educators have found it difficult to move forward to a more effective education system, even though the current system fails to provide many children with the education they now need. Perhaps this inability to change can be explained by the theory and practice that traditionally have been pursued by disciplines within and closely related to the field of education (Bloch 1992). In contrast to most dissertations in the School Leadership Program at Pitt, which are empirical studies, in this dissertation, I question the theoretic and operationalized underpinning of the education field - the current linear, reductionistic, and mechanistic conception of education and educational practices. I explore the underlying factors of what Ginsberg refers to as 1<sup>ST</sup> ORDER CHANGE as shown below, on the left of Table 4. Ginsberg, (1997) and others point to a traditional thinking about 1<sup>ST</sup> ORDER CHANGE where all is very efficient, consistent with prevalent worldviews, and serves the development of a free, universal, compulsory public school system quite nicely. Little has changed in how education functions for these roots planted nearly a hundred years ago.

Table 4. First order change <sup>5</sup>

<b>CHAPTER 2 OF DISSERTATION THE TRADITIONAL PARADIGM</b>  <b>Change is Thrust on Schools</b>			<b>CHAPTER 3 &amp; 4 OF DISSERTATION</b>  <b>A COMPREHENSIVE ALTERNATIVE: BUILDING THE EDUCATION THEORY COMPLEXITY HYBRID</b>  <b>Requires Change of System Not Within System</b>	<b>CHAPTER 5 OF DISSERTATION PARADIGM SHIFT TO OPTIMAL LEARNING ENVIRONMENT</b>  <b>Requires System Redesign</b>
<u><b>1<sup>ST</sup> ORDER CHANGE</b></u>  <b>Form: Reaction to symptoms and focus on surface change.</b>			<u><b>2<sup>ND</sup> ORDER CHANGE</b></u>  <b>Form: Engage system holistically and focus on fundamental change</b>	
<b>Piecemeal Change</b>	<b>Incremental Change</b>	<b>Systematic Change</b>	<b>Systemic Change</b> Is holistic not reductionist, dynamic not linear, a critical process not mechanical, and individually and locally relevant not generalizable	
“Once and done”	Make what exists more efficient and effective without disrupting the basic features	Make results generalized to a larger context		

I argue for an alternative---a more encompassing theoretical paradigm that will inspire educational policy and practice. Within my 2<sup>nd</sup> research objective I explore the type of change that addresses education in its entirety –as a system, specifically a complex adaptive system.

Table 5. Second order change <sup>6</sup>

<p><b>Chapter 2 of Dissertation</b> (1<sup>st</sup> Research Question)</p> <p><b>THE TRADITIONAL PARADIGM</b></p> <p><b>Change is Thrust on Schools</b></p>			<p><b>Chapter 3 &amp; 4 of Dissertation</b> (2<sup>nd</sup> Research Question)</p> <p><b>A COMPREHENSIVE ALTERNATIVE: BUILDING THE EDUCATION THEORY COMPLEXITY HYBRID</b></p> <p><b>Requires Change of System Not Within System</b></p>	<p><b>Chapter 5 of Dissertation</b> (3<sup>rd</sup> Research Question)</p> <p><b>PARADIGM SHIFT TO OPTIMAL LEARNING ENVIRONMENT</b></p> <p><b>Requires System Redesign</b></p>
<p><b><u>1<sup>ST</sup> ORDER CHANGE</u></b></p> <p><b>Form: Reaction to symptoms and focus on surface change.</b></p>			<p><b><u>2<sup>ND</sup> ORDER CHANGE</u></b></p> <p><b>Form: Engage system holistically and focus on fundamental change</b></p>	
<p><b>Piecemeal Change</b></p>	<p><b>Incremental Change</b></p>	<p><b>Systematic Change</b></p>	<p>Systemic Change Is holistic not reductionist, dynamic not linear, a critical process not mechanical, and individually and locally relevant not generalizable</p>	
<p>“Once and done”</p>	<p>Make what exists more efficient and effective without disrupting the basic features</p>	<p>Make results generalized to a larger context</p>		

This type of 2<sup>ND</sup> ORDER CHANGE, framed in the middle of above, is opposite on a continuum from 1<sup>ST</sup> ORDER CHANGE. 2<sup>ND</sup> ORDER CHANGE is holistic not reductionist, nonlinear not linear. It is a critical emergent process requiring evaluative thought, not a mechanical intervention. Discoveries about CAS in the natural sciences suggest that social systems also obey the complexity universalities (laws of complexity) and offer intriguing speculations to the education field. To argue effectively that the education system is a complex adaptive system (CAS) several key assumptions must be made. These assumptions create challenging hurdles which are addressed in Chapter 4. The first assumption is that the natural

systems, studied in such natural sciences as biology, botany, zoology, marine biology, astronomy, etc. are all complex adaptive systems. The second assumption is that the universalities described for complex adaptive systems can all be observed in all of those natural systems. The third assumption is that educational systems are natural systems, and hence describable as complex adaptive systems subject to the same set of universalities.

Chapter 5 explores the behavior continuum from order to chaos of natural complex adaptive systems as they interact with their perspective environments. Fluctuations on the continuum are changes in the system's capacity to adapt to changing environments (Lewin, 1999). The *process of adaptation* (cognition) to change in systems on the behavior continuum at the edge of chaos is at “optimal”---the point where order and chaos most closely resemble one another without jeopardizing the integrity of the system. At the edge of chaos exists the greatest possibility for broadening the human capacity to adapt to instability and uncertainty.

Chapter 6 of my dissertation, through the use of complexity universalities as a lens for viewing the specifics of the Lancaster Institute of Learning, explores systemic redesign, as framed in the right section of below, and urges examination in two areas: identifying optimal learning environments through the CAS lens, and exploring educational leaders' roles in these environments.

**Table 6. System redesign in second order change**

<p><b>Chapter 2 of Dissertation The Traditional Paradigm</b></p> <p><b>Change is Thrust on Schools</b></p>			<p><b>Chapter 3 &amp; 4 of Dissertation</b> A COMPREHENSIVE ALTERNATIVE: BUILDING THE EDUCATION THEORY COMPLEXITY HYBRID</p> <p><b>Requires Change of System Not Within System</b></p>	<p><b>Chapter 5 of Dissertation</b> PARADIGM SHIFT TO OPTIMAL LEARNING ENVIRONMENT</p> <p><b>Requires System Redesign</b></p>	
<p><b><u>1<sup>ST</sup> ORDER CHANGE</u></b></p> <p><b>Form: Reaction to symptoms and focus on surface change.</b></p>			<p><b><u>2<sup>ND</sup> ORDER CHANGE</u></b></p> <p><b>Form: Engage system holistically and focus on fundamental change</b></p>		
<p><b>Piecemeal Change</b></p>	<p><b>Incremental Change</b></p>	<p><b>Systematic Change</b></p>	<p>Systemic Change Is holistic not reductionist, dynamic not linear, a critical process not mechanical, and individually and locally relevant not generalizable</p>		
<p>“Once and done”</p>	<p>Make what exists more efficient and effective without disrupting the basic features</p>	<p>Make results generalized to a larger context</p>			

Why should complexity theory be of interest to leadership in the field of education? On a daily basis, key stakeholders in the field of education encounter complexity theory phenomena, unaware of how their lack of knowledge about complexity and complex adaptive systems (CAS) impedes their ability to enhance student learning. Development of a hybrid complexity theory applicable to education can provide alternative frames of reference to explain the education system in ways that lead to more effective educational leadership. It can offer a constructive lens for educators to diagnose, intervene, and overcome challenges to student achievement. To embrace complexity theory as a viable heuristic requires a systems-level perspective where a leader interacts with the educational system as a catalyst, facilitating (not directing) his/her school district, through a transition phase. The goal here is for the behavior of the system to



emerge operating at optimal level (not maintenance level) within a regime of behavior, referred to as the Edge of Chaos.<sup>7</sup>

The rationale for constructing an educational theory complexity hybrid is to inspire a paradigm shift from a “traditional” to “complexity” model of education, thereby prompting an alternative theoretical frame of reference which in-turn could provide the potential to enhance the effectiveness of education in preparing our students for 21st century demands. In addition the educational theory complexity hybrid can provide a roadmap for future preparation and practices of educational leaders, a variety of educational programs, interventions, and diagnostic tools.

**OBJECTIVE:** The primary objective of my dissertation as shown in Table 7 below, is to construct an Educational Theory Complexity Hybrid (ETCH) targeted for the educational system, for leadership to facilitate optimal learning environment in a student-centered educational system.

Table 7 Research Framework

PRIMARY RESEARCH OBJECTIVE:	To Construct an Education Theory Complexity Hybrid (ETCH) targeted for the educational system, for leadership to facilitate optimal learning environment in a student-centered educational system
RESEARCH FRAMEWORK TO DESIGN A COMPLEXITY HYBRID THEORY	<ol style="list-style-type: none"> <li>1. Systematically review and describe the current educational system with emphasis on those linear, reductionistic, and mechanistic mental models and approaches that may be contributing to the current problems and lacks in the effectiveness of education</li> <li>2. Present a detailed description of the major tenets of modern complexity theory</li> <li>3. Using the universalities of complexity theory for viewing the educational system, construct a hybrid theory of complexity for the educational system that provides a comprehensive alternative to present educational theories in facilitating an optimal learning environment for a student-centered education system.</li> </ol>
Method	Constructive Theorizing Process
Research Strategy	Retroductive and Abductive Research Strategies

Within my primary objective are *three specific supporting research objectives* (as shown in Table 7, above) that emerge from application of a constructive theorizing process and retroductive and abductive research strategies. More specifically my dissertation:

- Systematically review and describe the current educational system with emphasis on those linear, reductionistic, and mechanistic mental models and approaches that may be contributing to the current problems and lacks in the effectiveness of education
- Presents a detailed description of the major tenets of modern complexity theory

- Using the universalities of complexity theory for viewing the educational system, constructs a hybrid theory of complexity for the educational system that provides a comprehensive alternative to present educational theories in facilitating an optimal learning environment for a student-centered education system.

The Constructive Theorizing Process in Table 8 below, will be used to build this theory, and to describe how it will be confirmed and tested. It incorporates a four step process that always produces a theory.

**Table 8: Constructive Theorizing Process**

<u>Steps</u>	<u>Constructive Theorizing Format and Description</u>
<b>Step #1</b>	<b>Define the problem as a discrepancy between knowing and not knowing the facts, values, or actions associated with a circumstance</b>
<b>Step #2</b>	<b>Find reasons to explain these discrepancies between knowing and not knowing</b>
<b>Step #3</b>	<b>Evaluate the credibility and worth of the reasons and explanation</b>
<b>Step #4</b>	<b>Adjust existing beliefs by repeating Steps 1-3</b>

Through the CONSTRUCTIVE THEORIZING PROCESS (from Table 8 above), I first (Chapter 3) challenge the present theoretical educational assumptions that have dominated both theory and practice, and compare and replace those assumptions (Chapter 4 & 5) with a broader 21<sup>st</sup> century alternative - complexity theory hybrid that will serve as a foundation for design and implementation for the education system in (Chapter 6).

As I explored the current educational paradigm and noted how traditional behavior (current educational paradigm) was captured through indicators, I began to question whether key educational stakeholders had even a superficial awareness that a mental model, whose structure is traceable to the influences of 18<sup>th</sup> century scientific philosophical beliefs and technological discoveries, continues to

influence educational beliefs, practices, structure, design, and execution of administrative educational policy. Would a traditional practitioner recognize the value of replacing traditional educational practice with a view reflecting a new scientific worldview like complexity theory and complex adaptive systems theory? Probably not without being convinced at length. It is with these considerations, therefore, that the Constructive Theorizing Process in Table 8 above, was chosen to underpin my efforts at theory construction and to shape the structure of this dissertation.

The Constructive Theorizing process, by definition, implies a learning process that absorbs information from the existing environment and that subsequently challenges and prompts evolutionary changes in existing mental models of actors in that environment, thus changing their behaviors. In other words, the approach embodies the CAS principles and logically can carry the leadership practitioner from the current linear perspective to that of nonlinear complexity and mental modeling grounded in principles of adaptive complex systems. Finally, and most importantly, with retroductive and abductive research strategies interwoven through the Constructive Theorizing Process, the traditional educational practitioner is challenged to design an optimal learning environment. As seen through the complexity hybrid lens, a comprehensive educational theory will emerge as a coherent, valid and verifiable systems framework that accurately aligns the education system with its goal to facilitate an optimal learning environment. A student-centered complex adaptive system, for education, replaces the current paradigm, and enables learning in the 21<sup>st</sup> century, as shown in Table 9. Previous research has not examined the possible implications for future school systems design based upon the adaptive complex systems model.

It is this approach that dictates the subsequent outline for my dissertation, as shown in the column on the right of Table 9 below, and ultimately crafts a comprehensive alternative to present educational theories in facilitating an optimal learning environment.

Table 9: Dissertation Framework

<u>CONSTRUCTIVE THEORIZING PROCESS</u>		<u>SUPPORT RESEARCH OBJECTIVES</u>	<u>CONTENTS OF DISSERTATION PAPER</u>
<u>Steps</u>	<u>Constructive Theorizing Format and Description</u>		<u>Dissertation Parts Created to Frame a Complexity Hybrid Theory</u>
Step #1	Define the problem as a discrepancy <u>between existing educational beliefs and practice formulation</u>	To compare/contrast the “traditional” structural, organizational paradigm vs. a broader framed alternative -- -a complex adaptive system model which will serve as a foundation for the design and implementation of the education system.	<u>Chapter 3 – Traditional Paradigm</u>
Step #2	<u>Identify reasons to explain the discrepancies and construction of a hybrid theoretical framework that both address those discrepancies and their subsequent impact on the education system</u>		<u>Progressive Vertical Scaffolding of: Chapter 3 – Traditional Paradigm Chapters 4-5 - The New Science of Complexity: Building the Education Theory Complexity Hybrid</u>
Step #3	<u>Evaluate the credibility and worth of the reasons and explanation constructed in #2.</u>	2. To frame a comprehensive theory ---a complexity theory hybrid --- that replaces the current paradigm and explains and enables learning for the 21st century  3. To frame an “optimal learning environment” for the education system, within the complexity theory hybrid	<u>Feedback Loop comprised of: Chapter 3 – Traditional Paradigm Chapters 4-5 –The New Science of Complexity: Building the Education Theory Complexity Hybrid Chapters 4-5 – Paradigm Shift to Optimal Learning Environment Demonstrated through Organizational Structure and Leadership Chapter 6 – Application of ETCH to LIL</u>
Step #4	<u>Adjust existing beliefs about the circumstance by repeating the four-step strategy to eliminate other inconsistencies between the new theory and existing beliefs (Newell and Simon 1972)</u>		<u>Feedback Loop comprised of: Chapters 1-2 – Objective &amp; Approach Chapter 3 – Traditional Paradigm Chapters 4-5 –Building the Education theory Complexity Hybrid Chapters 4-5 – Paradigm Shift to Optimal Learning Environment Demonstrated through Organizational Structure and Leadership Chapter 6 - Application of ETCH to LIL</u>

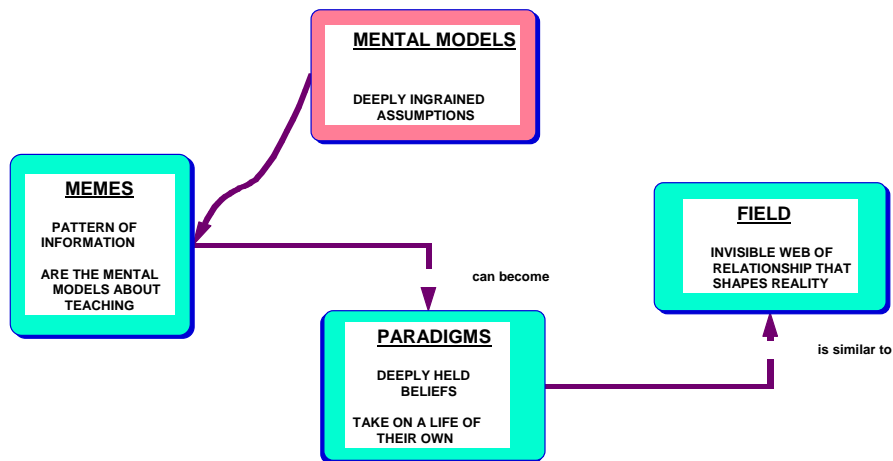
In order to establish CAS as a natural aspect of education system development, this paper will cross reference some of the original conclusions from CAS (Found in Chapters 4 & 5) to the views (mental models) incorporated in education theory (Chapter 6). However, the status-quo operationalized in the education system is well entrenched, as is described in Chapter 3. To expect that the education system would willingly and openly embrace an alternative, in lieu of this traditional practiced framework, outlined in Chapter 3 of Table 9 above, is foolhardy. The science of complexity theory, or the resultant hybrid explored in Chapter 6 of this dissertation, is not the traditional mechanistic, reductionist, linear approach that presently dissects and identifies “faulty” individual components, and as a result, assumes repair to the system at large (like a watch or machine). At the core of Complexity Theory is an appropriate workable scaffold of some fairly simple scientific concepts (described as Complexity Universalities and listed in Appendix A), that many claim fundamentally alters their view of the world and their reaction and interaction with it (Capra, 1996; Kauffman, 1995).

### **3.0 THE EDUCATION SYSTEM'S CURRENT TRADITIONAL PARADIGM**

#### **3.1 1<sup>ST</sup> RESEARCH OBJECTIVE**

- Systematically review and describe the current educational system with emphasis on those linear, reductionistic, and mechanistic mental models and approaches that may be contributing to the current problems and lack of effectiveness in education.

I suggest that the quality and success of education is hampered by the current traditional educational theoretical model. This chapter of my dissertation first explores three dominant mental models (linearity, reductionism, and mechanism) that underlie current educational system structure (educational beliefs, structure, design, and practice for the last hundred years (Fullan, 1991)).<sup>8</sup> I suggest visible identifying indicators of these three dominant paradigms in the education system, and consider the effects of these features on education.<sup>9</sup> Key is how the reductionistic, mechanistic, linear mental models of the present education paradigm influence and manifest in the conduct, habits, customs, behavior, and traditions of the education system. To make progress, it is imperative to understand how these powerful forces drive human decision making, and in school systems, keep traditional classroom teaching in place. Therefore, in the last section of the this chapter a lens is opened into the psychology underlying the “process of resistance” which critics of traditional practice suggest are innate to these central paradigms.



**Figure 1: Mental Models, Memes, Paradigms, and Fields<sup>10</sup>**

As mentioned above, the present central PARADIGM, (defined in Figure 1 above) of deeply held beliefs in the field of Education includes three dominant characteristics:

Linear Thinking which carries with it a strong sense that outcomes can be predicted and controlled. This way of thinking has penetrated all Education especially in terms of “cause and effect relationships.” For teachers the underlying assumption is that the greater the input the student invests through hard work, practice, and rehearsal, the greater the result in the form of test scores and grades. Based on linear cause-effect relationships, for example, clearly identified rewards are offered for things done right. In turn, poor results are caused by poor teaching...or poor textbooks...or an inadequate curriculum. The focus, therefore, rests on fixing or altering the structure instead of a better understanding of what keeps the structure in place (Caine & Caine, 1997).



Mechanistic thinking has led to a perception and subsequent behavior that encourages the forces that prevent change. Statements such as “if instruction is provided then the child would emerge ready to join the work force of society” (Stacey 1995) exemplify this mechanistic thinking. The paradox, and the frustration, is that most of the effort that has been put into changing education has actually reinforced the basic dynamics that make change exceedingly difficult (Caine & Caine, 1997).

Reductionistic thinking (or reducing into parts or categories) when coupled with “mechanistic” thinking make uncertainty and ambiguity appear to be constrained (at least in perception) (Caine & Caine, 1997). However the resultant effect appears to be a “mechanistic” paradigm that has robbed individuals of an understanding of personal meaning, of trust in our own strengths, and power to change conditions or behavior.

In a self-reinforcing feedback cycle, these traditional mechanistic, reductionistic, linear characteristics form the MENTAL MODELS described by Senge or the MEMES,<sup>11</sup> PARADIGMS,<sup>12</sup> and FIELDS<sup>13</sup> described by Richard Dawkins (Dawkins. 1976), shown in Figure 1, above. Senge (1990) describes MENTAL MODELS, as shown in Figure 1, above, as “deeply ingrained assumptions, generalizations, or even pictures or images that influence how the world is understood and how action is taken” (Senge, 1990). An individual’s MENTAL MODELS largely determine how the individual views and interprets his or her world. Moreover, through interactions with one another, people in an organization jointly shape each other’s mental models. The culture of education, and more generally the broader culture, thus develops fundamental beliefs and assumptions that exert a powerful influence on education theory. Senge (1990) states that often the individual is not consciously aware of the impact of mental models, or the effects they have on individual behavior (Senge, 1990). Like a MEME, shown in Figure

1, above, these powerful forces have become a “permanent pattern of matter or information produced by an act of human intentionality,” and like memes, these forces have “affected actions and thoughts in ways that are at best ambiguous and at worst, definitely not in our interest” (Csikszentmihalyi, 1993).

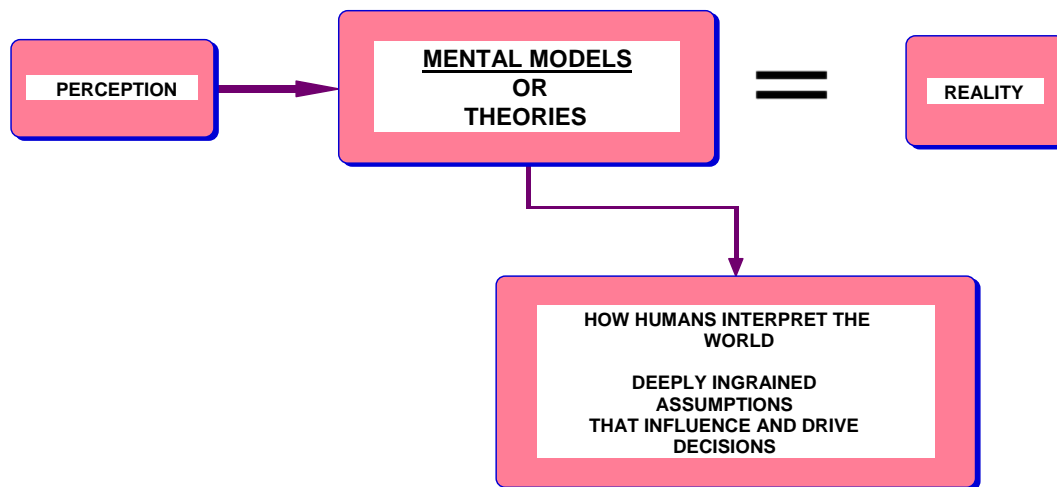


DIAGRAM FORMULATION:

**Figure 2: Perception, Mental Models, and Reality<sup>14</sup>**

Marion (1999) states that models or theories that humans create from what they perceive, are then used to explain reality, and overtime, to adapt the original models or theories to new situations. In other words, human perception = reality + models or theories = best shot to explain reality (Marion, 1999). Moreover, models are revised continually to adapt them to newly acquired information (Marion, 1999). Table 10, below depicts the components of model development, from mechanical perspectives that emerged into MACHINE THEORY through COMPLEXITY THEORY that describes systemic models (Marion, 1999).

**Table 10. Development of Mental Models**

DEVELOPMENT OF MENTAL MODELS	
Machine theory	Mechanical perspectives
Human Relations Models	Rescued human psychology from Machine theory's mechanical perspectives
Systems theory	Added the environment to previously closed theories
Complexity Theory	Complexity provides a mental model of how (complex) systems work, which explains the behavior of stock markets, ecosystems, large firms, than the traditional approach.

Marion (1999); however, cautions about perceiving models through a bias lens---with degrees of generalizable “good-ness.” Although endorsed, a model may not always reflect practice (Marion, 1999). Elmore (1995) appears to agree. As exemplified in teaching practice, Elmore states that changes in teaching practice would not necessarily follow from changes in structure (Elmore, 1995). And Caine & Caine (1997) further confirm Elmore’s assertion by stating that change in a mental model about how learning works would not inevitably emerge into a change in practice (Caine & Caine, 1997). Their research expected to find that a new perceived method of learning for the learner would then empower the teacher to naturally create, modify, expand, and adapt his/her own teaching to reflect the learner’s new understandings. But, this didn’t happen. Teachers assimilated the new ideas but this did not change school practice! Therefore, it cannot be taken for granted that all mental models that stand the time test are useful and applicable. This is really an important point that needs to be stated very clearly, iterates, Dr. Lesgold. Without an effective conduit to introduce ideas into the education system, those ideas will not matriculate. First-order change approaches are insufficient to accomplish the task (Lesgold, 2005).

Ackoff (2001) and Pourdehdnad (2001) appear to agree with Marion (1999) when they assert that every system has one or more functions in one or more larger systems of which it is a part, and that what many systems preach is not what is actually practiced. The US health care system and criminal justice system are examples of systems whose basic models differ from common practice (Ackoff, 2001). From universities to instruction in primary school, the education system is no exception. Universities provide an example of this distinction between theory and actual practice, states Ackoff (2001) since the dominant concern of the faculty is the faculty, not necessarily the students, despite its declared function. The function universities actually carry out is to provide their faculties with the quality of work life and standard of living they desire (Ackoff, 2001). Theoretically, from the university level to the elementary level, learning by students is the objective in the education system; however, the education system clearly has a more dominant objective, teaching by faculty members (Ackoff, 2001).

In other words, states Dr. Lesgold, “is it student learning versus teaching, or student learning versus having a pleasant life as a teacher?” (Lesgold, 2005) The incorrect assumption suggests that to be taught is an effective way to learn a subject. On the other hand, to anyone who has ever taught a class, it is more than apparent that the teacher learns the most. The school process is upside down. Students should be teaching because this is an effective method of learning, and teachers should act as resources available to students to use as they see fit in their efforts to learn (Pourdehdnad, 2001).<sup>15</sup> However, teachers still stand and talk while students sit and listen. Teachers work too hard during class time and students are too passive. Teachers should let the technical devices do the easy work (Smalley, 1989).

The central point here, is that good, bad, or indifferent, “beliefs or MENTAL MODELS, as described in Figure 1, above, held by the general public will shape the behavior of educational

leaders, who must remain accountable to the public on terms the public understands (Lesgold, 2005). What is missing often is the realization that public beliefs prompt public influences on education that shape the behavior of educational systems even when the public is not considered to be part of that system. Successful educational leaders often assimilate public understanding which then constrains their behavior, whether they realize it or not” (Lesgold, 2005).

FIRST ORDER TO SECOND ORDER PARADIGM SHIFT: Understanding *how* educators and administrators have learned this underlying traditional philosophy, which undergirds policy execution, as shown in FIGURE #3 below, is the first step toward a paradigm shift in thought and practice from 1<sup>ST</sup> ORDER TO 2<sup>ND</sup> ORDER CHANGE (Senge, 1990).

We can characterize approaches to change in school systems as being either first order or second order. In this section, I discuss the models of change prevalent in education today, which are primarily FIRST ORDER CHANGE MODELS. Table 4, below, outlines some of the differences between this current state of affairs and what I believe is needed, namely second order change. Ginsberg, (1997) and others point to a traditional thinking about 1<sup>ST</sup> ORDER CHANGE where all is very efficient, consistent with prevalent worldviews, and serves the development of a free, universal, compulsory public school system quite nicely. Little has changed from nearly a hundred years ago in how education views leadership and change. The system seems internally designed to function in a traditional way irrespective of how meaningless or ineffective that approach may be.

Table 4. First order change <sup>16</sup>

<b>Chapter 3 of Dissertation</b> <b>The Traditional Paradigm</b>  <b>Change is Thrust on Schools</b>			<b>Chapter 4 &amp; 5 of Dissertation</b>  <b>A Comprehensive Alternative: Building the Education theory Complexity Hybrid</b>  <b>Requires Change of System Not Within System</b>	<b>Chapter 6 of Dissertation</b> <b>Paradigm Shift to Optimal Learning Environment</b>  <b>Requires System Redesign</b>
<u>1st order change</u> <b>Form: Reaction to symptoms and focus on surface change.</b>			<u>2nd order change</u> <b>Form: Engage system holistically and focus on fundamental change</b>	
<b>Piecemeal Change</b>	<b>Incremental Change</b>	<b>Systematic Change</b>	<u>Systemic Change</u> <b>Is holistic not reductionist, dynamic not linear, a critical process not mechanical, and individually and locally relevant not generalizable</b>	
<b>“Once and done”</b>	<b>Make what exists more efficient and effective without disrupting the basic features</b>	<b>Make results generalized to a larger context</b>		

Critics who describe the education system suggest that traditional educational practice is simply outdated<sup>17</sup> (Bimber, 1994; Cawelti, 1994; M. Fullan, 1997; Ginsberg, 1997). As a result, it comes as no surprise that education reform initiatives are missing both a clear, coherent sense of purpose and a how-to-proceed action plan (cf., Fullan and Stiegelbauer, 1991). Consequently, states Fullan, these reforms are often characterized by faddism, superficiality, confusion, unwarranted and misdirected resistance, and consequent failure.

Complicating educational reform initiatives are confrontations with deeply entrenched mindsets at the level of individual schools, school systems, and the society within which those systems are embedded – the current paradigm is reinforced through present educational policy

execution. This is a paradigm that can be easily traced to the Classical Science Era where the mechanistic, reductionistic, and linear characteristics of the paradigm emerged (Caine & Caine, 1997) (Lewin, 1999) and continue to thrive. Accordingly, present practice, with its emphasis on this traditional machine-like micro-level efficiency, often ignoring macro-level effectiveness (Callahan, 1962; Capra, 1982), is the result of this unchanging set of underlying beliefs --- mechanism, reductionism, and linearity---that culminates to form its educational theoretical foundation, and in turn strongly infiltrates present policy formation and execution.

An alternate, more comprehensive viewpoint is 2<sup>ND</sup> ORDER CHANGE, which views the education system as a complex adaptive system (CAS). To transform education theory to align with 21<sup>st</sup> century technology and vision, where students thrive in a global, knowledge-based economy involves change. Unfortunately, those who are comfortable with the fundamentals of a more traditional mechanistic, reductionistic, linear model that maintains status quo, are at odds with those who embrace a CAS viewpoint. These groups speak different languages and have different assumptions and meanings. To bridge the chasm between these two groups, and create an environment conducive for a paradigm shift from 1<sup>ST</sup> TO 2<sup>ND</sup> ORDER CHANGE in thought and practice, Senge (1990) suggests that it is important to understand “how educators and administrators learn the underlying philosophy.”

## **3.2 THE REDUCTIONISTIC, MECHANISTIC, LINEAR PARADIGM MANIFEST IN THE FIELD OF EDUCATION**

### **3.2.1 Observable Mechanistic Behavior Operationalized in the Education System**

It is important to acknowledge that in many respects, the mechanistic paradigm implemented in daily agendas had served its purpose, particularly in the industrial era, when factories served as the social models for schools. Both government and industry have capitalized on bureaucratic modes of organization. Science and technology had thrived by using mechanistic modes of thinking. Schools and universities had both adopted the mechanistic paradigm and prepared the people needed to function in and operate these systems. With genuine pride, the knowledge and understanding provided by the Newtonian mechanistic paradigm had influenced the structure, institutions, and processes of society.<sup>18</sup> The central paradigm and the dominant view of reality for several hundred years---The Newtonian Paradigm---views systems as separate elements connected by lawful relationships to produce well-defined, controllable outcomes (Goerner, 1994). This reliance on objectivity was worthwhile. It could be touched, analyzed, taken apart, and fixed. And what was nonlinear and elusive was undervalued and often ignored.

Observable indicators in the education system reflect the mechanistic influence that educators have created, maintained, and controlled. Its basic set of thinking tools perceives education to be mechanistically well-ordered, organized with a self-reinforcing influence on teaching and learning. It is visible in a belief of external control; in “top-down” leadership that supports maintenance of status quo that supports equilibrium, non-growth. It depends on stakeholders or “agents” that ignore the capabilities of individuals. The assumption being that



leader-generated or mandated information was the only information in the system and leader-taught mental models the only models in the system. Problems are to be solved by “fixing” them. This notion of “fixing” is applied to human beings and every aspect of educational instruction.

### **3.2.1.1 Observable Mechanistic Behavior Manifested in External Control**

Mechanism constrains the larger system. It is present in sources of funding (state, local communities, and others). Policy decisions on curriculum are made at state and district levels and, in some cases, at federal levels. Mechanistic behavior also manifests externally through the fierce battles for positions on school boards; how community participation in school materializes; how boards exercise local controls over such items as school architecture, times of operation, teacher credentials, textbooks, and curriculum; political and religious issues.

One of the most powerful and successful expressions of mechanistic behavior has been the development of and reliance on bureaucratic modes of organization. The development of bureaucracy to structure human interaction (the social machine) includes hierarchy and compartmentalization. Bureaucratic modes of organization are the perfect answer to organizing a society on the model of a machine. In fact, a bureaucracy is defined as a social machine.

Hierarchical organization and some forms of bureaucracy date back to biblical times,<sup>19</sup> to the Romans, and to the Chinese. In "Restructuring Our Schools", W. Patrick Dolan (1994) recalled the original Roman military model, which paralleled a pyramid: "Power and authority for the direction of the enterprise are centered at the top of the pyramid. The military command orientation has powerful ramifications on decision making and information flow" (pg 12) what Dolan called the "middle tier" then has at least some say in the interpretation of authority and hence some degree of power. At the bottom, however, are the grunt workers who "live, work and die.., their job is to do what they're told and not to ask questions" (pg 13). Dolan summarizes:

“Thus, it is very important where you find yourself in the pyramid. In this top-down, command-demand structure you are reminded every day where you belong in the hierarchy. Your rank tells the world how much you need to know, and how much say you have about it” (Dolan, 1994). He goes on to document how this model was adopted by the Church at the time of the Holy Roman Empire and later more widely by institutions and companies during the industrial revolution.

In a bureaucracy, everything is compartmentalized. People have roles that entitle them to make specific decisions, and they are given only the information that those at the top believe is appropriate for those decisions. Hierarchies were and are used to maintain an orderly division of labor and responsibility and are evident in almost any type of administrative organization, including schools, district offices, and state and federal organizations.

To function, bureaucracies in general needed almost total control of their lifeblood -- both the nature of the information and the direction and method in which it flowed. Traditional education was built on this similar machine-like model which required a type of leadership to maintain and control this bureaucratic structure. Administrators were taught that facts and skills were conceived of as owned by the educators in the system and warehoused in schools to be distributed much like a conveyor-belt, or a packaging-and-delivery system, where products that conform to design specifications are identified and selected, and where much that does not conform is discarded or rerouted as an inferior product (Caine & Caine, 1997).

The mechanistic influence also becomes visible in instructional institutions around the notion that only its experts can create knowledge, exemplified in information about people, grades, assessments, or reports. Schools survive and thrive for as long as central players are in the control and flow of this information. Caine and Caine (1997) referred to "system-speak" as

an underlying thinking base present in all the people interviewed in the Caine & Caine's research. In "system-speak" most people still thought that learning meant memorization. Traditional approaches in the neurosciences, and approaches that educators had adopted in interpreting the neurosciences, still persisted in viewing the learner in fragmented and limited ways consistent with a mechanistic thinking (Caine & Caine, 1997). Moreover, once one believes that a system in which everyone follows directions is working efficiently, then failures of children to learn must be interpreted as being due to deficiencies in the failing students, not in teachers or the overall system.

Caine and Caine (1997) further observed that an intricately designed system of administration was used, where administrators supervised teachers, to make certain that the appropriate information was dispersed in classrooms. The structure and information was linked through a timetable so that places (classrooms), teachers, and subject matter were connected and managed (Caine & Caine, 1997).<sup>20</sup>

Caine and Caine (1997) also observed that, what they call the "distribution-and-delivery system," is maintained and controlled by many mutually reinforcing methods and ideas, and emerges in the system's organizational structure. For example, the schools they observed operated for five days a week on nine month cycles. Content was broken apart and usually taught in fifty to fifty-five minute sections in clearly delineated subjects, and was based on the assumptions that school and learning are linear and predictable processes. The mechanistic thinking was present in a curriculum that was separated by subject. There tended to be a set of core subjects, at the core of which are "the basics", such as reading, writing, and math, with others as secondary. Each subject was assumed to have a logical developmental sequence, with

one segment sequenced in each year of a student's education. The Scope and Sequence Chart was the primary representation of the plan for a class's schooling

Even the students were organized into groups by reference to age, grades, and academic year. They were then age-batched into independent and minimally coupled classrooms, each with separate but related functions. They were funneled into separate parts of the building throughout the day to make efficient use of teaching resources and the physical plant. Children were graded on how much of the information they had stored.

The teachers were no exception in that they also reflected a mechanistic behavior, (Caine & Caine, 1997), by delivering knowledge, in the form of information, to the ready student. From elementary schools, where one group of children often far too large, tended to be the responsibility of one teacher, to the later grades, where teachers are allocated groups of children for small chunks or blocks of time, the purpose was to deliver prescribed curriculum content.

The actual day-to-day distribution of information was ultimately a task for the teacher. The teacher had a significant degree of freedom in how to "teach" the material, usually with the use of texts, film, and videos. However, teachers were isolated within classrooms and subject-specific departments, with little time or opportunity to connect knowledge to other subjects or to the real world - or to students. Teachers, observed Caine and Caine (1997), acted in a didactic-relationship with mostly passive clients who are forced to attend.

Increasingly, "states require us to teach teachers to 'teach to the standards,' moreover, the testing process puts emphasis on this, since it tests for the individual little tidbits of knowledge identified in a reductionist process. Much of the reductionistic approach is frozen into law. Further, for the worst schools, such an approach does produce improvement, just as Taylor found for the least efficient machine shops" (Lesgold, 2005).

Continuous emphasis on grade-based evaluation acted as feedback to control the system and stemmed from the community at large (Caine & Caine, 1997). The modes of assessment were used to ensure that information flowed in the right manner and that people, both students and adults, performed in the right ways. Standardized testing was the gatekeeper used to promote students from one reading level to the next and in some cases one grade level to the next (Ginsberg, 1997).<sup>21</sup>

Psychology and the social sciences had responded with similar types of beliefs. Mechanistic thinking in psychology insisted that mind was an artifact or epiphenomenon of nature. In Social Sciences freedom was really an illusion. Purpose and meaning were not intrinsically real. Behaviorism and the applications of rewards and punishments, that were externally controlled and relatively immediate, were compatible with a mechanistic thinking in fixing and controlling behavior one bit at a time. Smiley stickers, grades, training, detention, promotion, awards, incentive schemes, penalties, and so on, were packaged with a pre-specified correct outcome established by an external agent. These continue to be the tools or implements with which the parts could be “fixed.” These are the tools that schools continue to implement to urge students to do what is necessary to take their place in society.

The "Fix-me" or "Fix-it" philosophy has played itself out best in pharmaceutical intervention, particularly in fixing unpleasant, frightening, emotional, or dysfunctional states (Freeman, 1995). The argument is not against the use of medication; however, the issue is that an inappropriate set of beliefs may lead to an inappropriate use of medication. With children, this kind of thinking has led to misdiagnosis or to even more insidious consequences, that in some cases culminates in a lifetime of dependence and sense of helplessness (Freeman, 1995). All

these examples, provided through these fix-me or fix-it attitudes and approaches dramatize the effects of mechanistic thinking.

### **3.2.2 Reductionistic Behavior Visible in Education System**

The power and achievements of the traditional reductionist thinking were and are visible in many scientific disciplines. Scientists discovered that the same type of particles form all matter, living and nonliving, therefore any system could be divided into separate parts and dealt with in isolation.<sup>22</sup> Parts have clear and distinct functions and purposes. Simply identifying the parts and taking them apart means comprehension of the whole (Caine & Caine, 1997). The reductionist thinking and its accompanying beliefs are a good match. Reductionistic thinking is also applicable in breaking complex systems apart and studying the components in order to figure out how the system works as a whole. The influence has created a basis for the education system to operate as highly mechanistic. It was built on the idea that the world could be controlled like a big machine. In schools, the practical implication of this view is that schools could be changed and restructured by working out what each part does and then changing the parts so that they worked better. Like machines, the parts could be redesigned, but change was controlled by human prerogative. The school model and the car model shared similarities - the car has distinct and identifiable parts that make it run; and its performance can be quantifiably assessed. When parts broke they were fixed. Low performance could be enhanced with the use of higher grade fuel or higher-quality oil. School restructuring or reform was the equivalent of pushing harder on the accelerator.<sup>23</sup> This notion has been translated into all types of educational structures. Schools as subsystems are constrained by larger systems, where every school is a part of a larger education and social system that influences it.

Much of how humans interact with their environment has been the product of this approach (Lewin, 1999).<sup>24</sup> Since the function of the parts was described with an eye on control, our feelings, including love, empathy, awe, and spiritual longings, are also seen as artifacts of how the physical machine interacts (Caine & Caine, 1997). Such a view is linked to seeing teaching as a job that has more to do with assembly-line production, rather than with creating experiences linking learning to genuine shifts in understanding. Specific responsibilities and job descriptions---each function is treated as separate and out-of-context, and only connected in a specific and limited way (Caine & Caine, 1997).

Brian Goodwin summarizes effectively by arguing that the shortfalls in reductionism are increasingly apparent (Goodwin, 1994), and that Complexity Science offers a path that leads beyond the limits of reductionism. It is a path where the world is understandable as much more than a set of linear causations. It is not comprehensible through a cataloguing of its parts, but consists instead mostly of organic and holistic systems that are difficult to comprehend by traditional scientific analysis (Lewin, 1999).

### **3.2.3 Linear Behavior Visible in the Education System**

There are plenty of straight-forward examples where linearity has worked and where some things lead directly to other things. In schools these include examples where hard work that led to better results or where clear management policies could be implemented. Linearity carries with it a strong sense that outcomes can be predicted and controlled. An example is the legal system that tries to make the punishment fit the crime, or in the scientific system that tries to identify and then measure the individual impact of independent variables. In both bases, much of the context is ignored.

This way of thinking, though, has penetrated all of education and our other institutions especially in terms of "cause and effect relationships." The education system has required accountability (control). Based on linear cause-effect relationships, clearly identified rewards are offered for "things done right" and "poor results are caused by poor teaching..., or poor textbooks..., or an inadequate curriculum" (Caine & Caine, 1997), or poor students.

If students are not learning enough, the solution is a need for even more on task behavior. The assumption being that more such behavior translates into better results. The assumed solution then is to improve by repairing or fixing these defects. Thus, in teaching, the contention is that the greater the input through hard work, practice, and rehearsal, the greater the result in the form of test scores and grades. The focus is on fixing or altering the structure instead of a better understanding of what keeps the structure in place (Caine & Caine, 1997).

### **3.2.4 The Resultant Effects of Reductionistic, Mechanistic, and Linear Thinking on the Field of Education**

The subsequent effects of the reductionistic, mechanistic, linear thinking have led to the design of the education system as a social machine that is both stuck and resistant to evolution and change. "Stuck" is the system's thinking and its resultant bureaucratic procedures---the essence of which has been to remain stable and unchanging over long periods of time, (even when perturbed) as evidenced by core beliefs about the nature of learning and teaching that have not changed for over a hundred years (Caine & Caine, 1997). And the education system is part of a larger system grounded in thinking- a paradigm- and that also is deeply entrenched (Caine & Caine, 1997).



On a micro-level, “stuck” are the memes/mental models of the individuals who make decisions about education---stuck decisions that continue to prepare students for a “predictable,” “controllable” world, in the wake of a reality of life that is both uncertain and ambiguous (Caine & Caine, 1997). Consequently, universities, parents, and businesses resist change and embrace the predicable, and the controllable. They love A's and “objective” measurements (assessment). However, all the traditional reasons for testing are misconstrued, and true effects are ignored, such as the use of assessments as learning tools with timely feedback for the child, or whether the teacher has done an adequate job. Traditionally, assessment in relation to performance, and assessment as a sorting tool in terms of expected school functions, have been used to “shame and blame” the child. “Johnny is not learning because he is not focused on the teacher, so he needs Ritalin to help him focus,” on what many times is a boring presentation. The degree, to which a child is active in his own learning process, is the degree to which that child will learn. If he is passive, learning is not taking place. Reevaluating the purpose of assessment, medications, and methods of teaching---all could lead to dynamic systemic changes, but they require transparent dialogue about deep values and beliefs (Horn & Carr, 2000). Consequently, it is no surprise that “almost none of the widely advocated reforms of the mid-60s to the mid 70s period – open space, individualization, community-based education – survived” (Pogrow, 1996, pg 657). Arthur Combs (1991) concurs.

“It isn’t because we haven’t tried. We’ve tried a hundred things. Here are a few: the Palmer method, phonics, teaching machines, psychological testing, audio-visual...techniques, open schools, open classrooms, team teaching, teacher aids, social promotion, the New Math, the New Sciences, languages in the early grades, tracking, homogeneous grouping, inquiry learning, behavior modification, rewards and punishment, systems analysis, grades, competition, and ...behavior objectives, competency based instruction, “back to basics,” computer technology, and voucher systems. Each of these, in its time, was enthusiastically advanced as a solution to education’s major ills. As it became evident that it, too, was as disappointing as its processors it was soon laid aside. Changing public education is like punching a pillow or, as someone has suggested, “Like moving a cemetery; after you’ve done all the work, you still have a cemetery (A. W. Combs, 1991).

Indeed, the paradox - and the frustration - is that most of the effort that has been put into changing education has actually reinforced the basic dynamics that make change exceedingly difficult. Mechanistic thinking has led to a perception and subsequent behavior that encourages the forces that prevent change. It provides an illusion of safety. So education struggles.

All the reports, state Caine and Caine (1997) of how difficult it has been to change education, support this logic. The system has “tried to adapt” in that it makes some responses to its perceived environment,” states Caine and Caine. “There may be some innovations and some good results, particularly when a teacher or school is given a moderate degrees of autonomy” (Caine &Caine, 1997); however, when those highly innovative people leave, “the norm has been for the school to revert back to the pattern of the basic traditional system” (Caine & Caine, 1997).

A number of researchers have traced possible causes for this resistance to change in the education system.<sup>25</sup> Their explanations cover a continuum, from one extreme where there is no possible more room for improvement of the current system, to self-fulfilling pessimistic teacher beliefs, to agenda bias, to power games. I believe all these are contributing factors, but firmly believe that cause of a resistance to change in the education system is much more fundamental. On an individual level, Caine and Caine (1997) argue that human brains are designed to make sense of their experiences. Consequently, the source of resistance to change within the individual can be linked to the basic instincts of fight/flight innate in all living systems. Each has basic instincts for security, safety, for example, and each responds to perceived threat with varying degrees of fear. Our instincts then emerge into deep beliefs about the nature of our environment. Those deep beliefs for many people translate and justify stability, power, mechanism----a perception that enables protection of safety and security, and avoids the

perception of threat and subsequent fear. As a result an accompanying paradigm emerges to those deep beliefs, with influence on behavior that feeds back to reinforce basic needs for security and safety, and an avoidance of threats that cause fear.

Embedded in changing the traditional education paradigm is a perception that a paradigm shift means uncertainty. If the perception is that a well-ordered universe is like a well-oiled machine, then disorder, uncertainty, sudden change, unpredictability, and turbulence must be signs of a machine that is malfunctioning (Caine and Caine, 1997). Our traditional thinking perceives---something is wrong! In short, Western society in particular, has bought deeply into the notion that stability, predictability, and planned change are the real signs of health, and fears their opposites. For many people, stability, power, mechanism, and reductionism, or the reducing into parts or categories, means uncertainty is constrained (at least in perception) and represents security and safety (Caine & Caine, 1997). However, the resultant effect appears to be a mechanistic thought pattern that has robbed individuals of personal meaning; of trust in our own strengths; and power to change conditions or behavior. These thought patterns are dehumanizing.

However, changing a resistant system has a perceived personal cost that is too high. Too "fearful" is a life perceived as complex, emergent, and organized at ever-higher levels of complexity. Too "uncontrollable" is the perception of the child or adult who self-actualizes; is creative; lives in dynamic balance; and grows in spirit. Although this description is an oversimplification, it is essentially accurate. It is no wonder, share Caine and Caine (1997) that attempts at change are inordinately difficult (Caine & Caine, 1997). Coupled with uncertainty is confusion of what is expected on the job and elsewhere, and a fearful apprehension that change could happen unpredictably, leaving the individual suddenly vulnerable.<sup>26</sup>

Psychophysiological responses to a perceived threat (Threat = any stimulus that triggers fear) as described above, fall under the umbrella known as "downshifting" (Caine & Caine, 1997). It is often accompanied by a sense of helplessness or fatigue or both. Over time, it is associated with a lack of self-efficacy. Understanding "downshifting" is pivotal. When people downshift, they revert to more primitive instinctual responses or to early programmed behaviors. Underlying all of these conditions is a belief structure that denies the learner's own purposes and meanings, even though they are a critical part of the learning process. When these conditions exist, the learners' ability to solve problems is impeded. As they encounter feelings of helplessness, they tend to revert to early-programmed behaviors indicative of conformity to the status quo. Additional reactions include becoming territorial, using and yielding to hierarchical command-and-control behaviors, and having little tolerance for thinking appropriate for complex issues like diversity and individuality.

When stressed, individuals are less able to access their entire knowledge base or see what is really there. Our ability to consider subtle environmental and internal cues is reduced. The individual is also less able to engage in complex intellectual tasks, those requiring creativity, and the ability to engage in open-ended thinking and questioning (Caine, Caine, & Crowell, 1994). Thus downshifting inhibits many of the basic capacities that education seeks to develop (R. Caine et al., 1994). In "Making Connections" (Caine & Caine, 1994; Caine et al., 1994) argue that the design of the educational system induces downshifting in administrators, teachers, and students. The combined effect is to reduce the capacity of participants at all levels to think and act "out of the box."

## Summary and Transition

Bjork (1995) and Ginsberg (1997) argue that education is what may be considered a “hybrid pre-paradigm field,” certainly not as well established as the more mature sciences, and “made up of a compilation of ideas drawn from a variety of disciplines” (Bjork, 1995). Although Gell-Mann (1995) states that theory in the field of education is grounded (Gell-Mann, 1995), Glaser and Strauss (1965) counter that a good deal of the organization, structure, and practice in schools has no theoretical base (Glaser, 1965). In practice, states Ginsberg (1997), “there may be no theoretically sound reason why a particular method is followed. Often, and Gell-Mann would concur, folklore is as powerful as theory, as the basis for operation. Put another way, “school board members generally don’t let theories or facts get in the way of a good opinion” (Ginsberg, 1997 p 11).

The sources and influences of the central paradigm in the present education system inspire education theory, and in turn form the system structure of institutions of learning (educational beliefs, structure, and design). Exploring the nature of this central paradigm both horizontally (across time from classical science to the information age) and vertically (through the science, social science, and business domains), illuminates the magnitude and depth of influence and entrenchment of these three central paradigms (reductionistic, mechanistic, and linear) into the field of education. On an individual level, these beliefs flourish in mental models held by education leadership---a leadership that creates the policy design and execution which in turn limits optimal learning potential for the student. Acting on this set of beliefs suggests that the system is internally designed to function in a particular way irrespective of how meaningless or ineffective it is.

In terms of the research for this paper, the suggestion being made here is the need to change this “central paradigm” of thinking (especially evident in Management Science (White, 2001) from a style of thinking that implements a methodology that is prescriptive and indicative of 1<sup>st</sup> order change ---seen as a recipe for ensuring that certain outcomes will prevail, and that solutions can be stated from objectives, (White, 2001)--- to an alternative style of thinking (explored in the next section). The change in paradigm moves the system from 1<sup>st</sup> order change, as described by Ginsberg (1997) and Horn (2000) to 2<sup>nd</sup> order change as previously referred to in Table 4. <sup>27</sup>

If mental models, memes, fields, and paradigms, described in Figure 1, drive decision-making and policy execution, the implication is that to successfully improve education, a change of the mental models that the leadership and educators have about learning and teaching is required. However, the type of change in fundamental beliefs required here affects a deeper type of learning which has the capability to change the individual (Senge, 1990) or said more succinctly in Piagetian terms----assimilation and accommodation are not limited to acquiring new information, but are actually transformative. People do change. Described by Maslow’s (1968) theory of self-actualization, human beings are CAS, living on the edge of the continuous ability to self-actualize. They are not machines.

In Chapter 4, I argue for that change in the fundamental beliefs of the present mental model. Using an organizing table, constructed for clarity, the observable discrepancies and fallacy behaviors for the traditional paradigm (through leadership and organizational structure) are described using the three primary complex systems processes ---autopoiesis, dissipative structure, cognition. The “complex universal patterns of behavior,” (traced through all living systems) are described in detail and introduced for each of those three complex systems

processes. Then, I compare the discrepancies and fallacies of the traditional paradigm, through the lens of the three interconnecting, interacting ETCH processes (Autopoiesis, Dissipative Structure, Cognitive Process) and their major tenets (complexity universalities) and contrast to the alternative ETCH paradigm. The concepts introduced in Chapter 4 and Chapter 5 become the foundation for design and implementation of Chapter 6. Chapter 6 evaluates the credibility and worth of ETCH through the practical experience and application at the Lancaster Institute of Learning, a state-licensed, (grades seven through twelve) high school in eastern Pennsylvania.

#### **4.0 A COMPREHENSIVE ALTERNATIVE: BUILDING THE EDUCATION THEORY COMPLEXITY HYBRID (ETCH)**

#### **4.1 INTRODUCTION: INFORMATION AGE DYNAMICS PRESSURE THE EDUCATION SYSTEM FOR AN EMERGENT PARADIGM SHIFT**

The reductionist, mechanistic, linear paradigm is no longer the only option. Developments in the science of complexity, including specific applications to social systems, economics; technology; and business management now permit an alternative view that may be more productive. As the quotations below indicate, business leaders and consultants are beginning to embrace this alternative.

“We must abandon the formal, static, linear planning process...In the new nonlinear world, no predictions remain valid for too long.” Colin Crook, former senior executive with Citicorp. (Lewin, 1999)

“The bigger picture is the physical understanding of how order evolves naturally, why change is inevitable, and what factors underlie transformations.” (Goerner, 1995)

For business enterprises, the Information Age is very different in comparison to the Industrial Age (Conner, 1998), so it is not surprising that the paradigm is changing there before it changes in the education world. Sophisticated, and high-performance oriented---successful business enterprises must be able to operate in situations where market speed and response time are many times faster than the old manual system would allow. Many business organization functions are performed by a computer, not guided directly by the leader (Conner, 1998). The



speed and accuracy of the feedback mechanism in a computer allow the organization to increase its production dramatically compared to manual leadership control. Organizations that, for decades, depended on luck and unconscious competence; on “change management approaches” used when infrequent “incremental” first order change was predominant; or on deeply ingrained procedures, traditions, attitudes, and cultural biases about managing change, now face a framework with a new array of options much different in scope.<sup>28</sup>

Recent discoveries in Relativity Theory, Quantum Mechanics, Biology, and Chemistry have led to a science of complexity<sup>29</sup> that has affected everything from the way scientific data are being interpreted and business and economic trends are assessed, to how brain research is approached for clues to better understand teaching and learning. The Science of Complexity permits deeper insight into human systems through use of discoveries from other complex systems in the world, both “natural,” such as ecosystems, or “artificial,” such as computer simulations (Lewin, 1999). Complexologists believe human society and human social systems are complex adaptive system (CAS) that exhibit the same behavior characteristics as other ecosystems that are nonequilibrium, open, thermodynamic systems. Viewed through the lens of complexity theory, the parallels between ecosystems and social communities are intriguing --- both are complex adaptive systems (Lewin, 1999), and the patterns in physical, biological, and computational systems also are manifest in social systems. In Biology, the genetic message encoded and compressed in DNA reflects the experiences of the past. In the case of human societies, the equivalent of this experiential record is institutions, customs, traditions, and myths---in effect, cultural DNA (Gell-Mann, 1995).

Some social scientists now are applying Complexity Theory concepts to explain organizational structures and processes (White, 2001)<sup>30</sup> and are providing new ways of

visualizing the complex “*relationships*” in an organizational world (White, 2001). Complex adaptive systems, such as businesses, the economy, education, and social systems in general are both “open” and “living.” As such, their component agents (as contrasted by nonadaptive complex systems such as snowflakes or galaxies) take in data from their environments, find regularities in the data, and compress these perceived regularities into internal models that are used to describe and predict other agents’ future behavior (Gell-Mann, 1995).

Complex adaptive systems may be characterized by the “interactions” of numerous individual elements or agents that “self-organize” to show “emergent” and complex properties not exhibited by the individual elements/agents. The term *autopoiesis* has been introduced to capture this self-organizing capability. The internal autopoietic processes of these systems are subjected to natural selection pressures from specific environmental conditions and exhibit evolutionary changes in the internal models of their component agents over time.<sup>31</sup> The “emergent” properties comprising a particular complex system frequently can be identified as one of many elementary parts of a still- larger complex system.

My hybrid complexity theory builds upon the theory and ideas connected with complex adaptive systems (Appendix B) to provide a comprehensive alternative to present educational theories, one that can help leaders to facilitate an optimal learning environment. Through comparisons and examples, this Chapter of my dissertation connects the universalities of complex adaptive systems to the behavioral indicators present in the education system. Although most of the vocabulary of complexity theory originates from mathematics, computer science, and the natural sciences, this new thinking has great implications for every aspect of education, including learning, instruction, and specifically educational administration. The science of complexity<sup>32</sup> provides an encompassing theoretical skeleton or a new design for education--- one

that is primarily based on evolution and adaptation in which the activity of system participants is facilitated rather than directed. My proposed theory differs from the old paradigm that assumed a direct connection from the leader’s hands to the end result.<sup>33</sup> In my view, a facilitator is a catalyst for “growing an environment ripe for visible self-organization, open communication, and personal discipline among agents”--- where “agents learn to assess their own performance accurately, understand their capabilities, and negotiate real commitments based on what’s doable” (Kelly and Allison, 1999 p 120). “The function of leadership (the facilitator) in my proposed theory is not to push for change but to remove the shackles that are imprisoning the organization’s natural inherent capability to renew itself through self-organization” (Merry).

In Table 11, below, I provide a summary that compares and contrasts how two paradigms - the present traditional and the complexity hybrid - lead to different operating education system (with different objectives/ mission/goals).

**Table 11: Comparison between Traditional Paradigm and Education Theory Complexity Hybrid**

<b>Chapter III</b>			
<b>Paradigm Shift to Optimal Learning Environment</b>			
<b><u>Current Traditional Paradigm</u></b> <i>How present educational theory with its organizational structure and leadership is too linear, mechanistic, and reductionist</i>		<b><u>Educational Theory Complexity Hybrid</u></b> <i>How implementation of the theory can produce a considerably improved organizational system and leadership</i>	
<b><u>Mechanistic organizational structure</u></b>	<b><u>Hierarchical leadership structure</u></b>	<b><u>Optimal Learning Environment</u></b>	<b><u>Facilitator</u></b>

The purpose of this section is to explore “how” the universalities of complexity theory operationalize in social systems in order to bridge between the universalities of complexity theory as explored in the hard sciences and their manifestation in social systems. This enables the final section of this paper in which I illustrate and describe a complexity theory hybrid for the education system that can support a more optimal learning environment.

On a daily basis, key stakeholders in education encounter phenomena described by complexity theory, unaware of how lack of knowledge about complexity theory and complex adaptive systems (CAS), limits their ability to achieve an optimal learning environment and also stifles student learning (M. J. Jacobson, 2001; M. Jacobson & Wilensky, 2006). Through the emergence of my complexity theory hybrid for education, the education system can be redefined by its dynamics or how the system interacts (J Lemke, 2002).

Each of the interconnected, interacting processes of a living system like education reflects observable behaviors within each level of the system, as well as between levels. The education system is an Autopoietic, Cognitive, Dissipative Structure (these terms are defined below). As such it is a self-organizing, emergent, open, nonlinear, structurally coupled, complex adaptive system. The education system exists in dynamic states *far from equilibrium*<sup>34</sup> (Laszlo, 1998). Like any biological system, it differs from Physical Systems in that it *adapts* and *carries information about its environment and its past*. Like biological systems, *the education system learns from its experiences and adjusts its behaviors accordingly*. The education system has *the ability to anticipate its future and to attempt to manipulate that future* (Marion, 1999 #9). Therefore, the same underlying complexity universalities found in Autopoietic, Cognitive, Dissipative Structures that thread through Biology (living systems), Physics (physical systems), Mathematics, and Chemistry (chemical systems) are universally present in the education system (part of the social system).

The central thesis of this dissertation is that explicit characterization of education systems as complex adaptive systems and tailored explication of the complexity universalities in terms of educational systems can have powerful implications for the improvement of those systems. It can offer a constructive lens for education stakeholders to diagnose, analyze, document, and

understand the complexities of change/reform and execution issues. It could also help the administrative practitioner learn to make better decisions and the school district to make better policies. It could encourage the emergence of a leadership that would interact as a catalyst, to facilitate (not direct) his/her school district, through a transition phase, to emerge operating at more optimal level (not maintenance level) within a regime of behavior, referred to as the Edge of Chaos<sup>35</sup> and not merely at or below average level. Or juxtaposed on a broader level, complexity theory + systems analysis of the education system = the emergence of a hybrid theory applicable for the field of education.

#### **4.1.1 Three Key Processes Operating in Complex Adaptive Systems (CAS): Introduction to Pattern & Structure**

The key to building a comprehensive theory of any living complex adaptive system, including educational systems, is the study and synthesis of three multi-dimensional processes (Capra, 1996); as shown in Figure 3, below: “self-organization” or autopoiesis, “dissipative structures,” and, “cognition.”

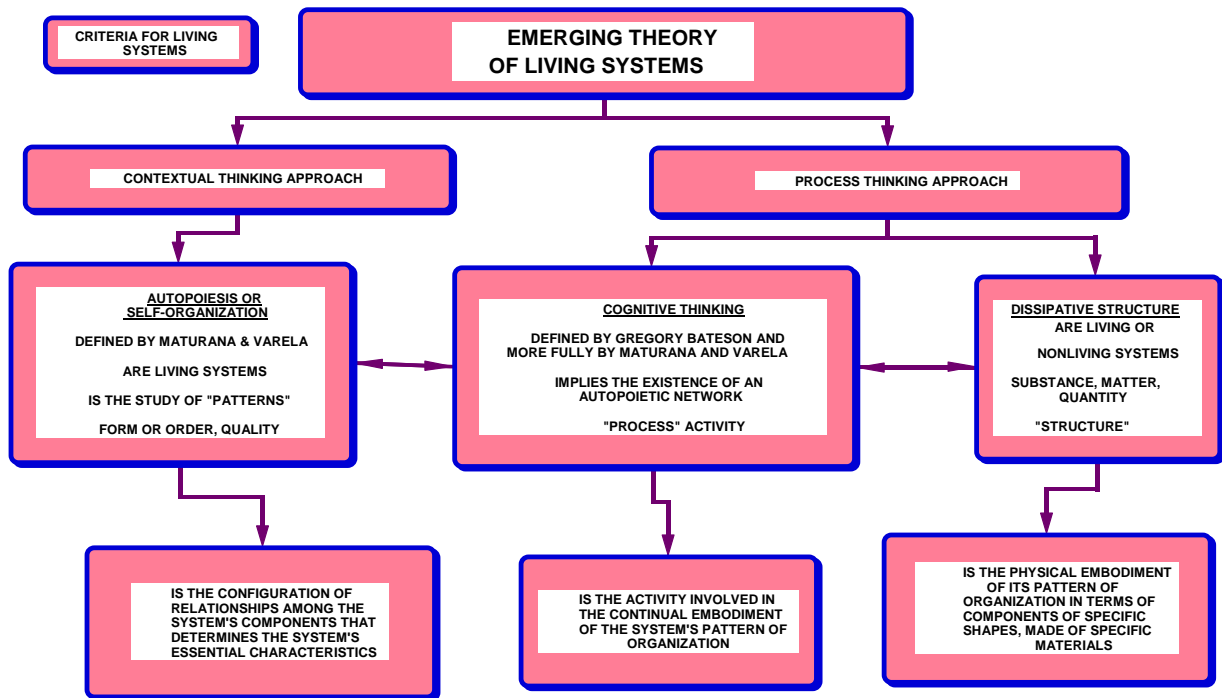
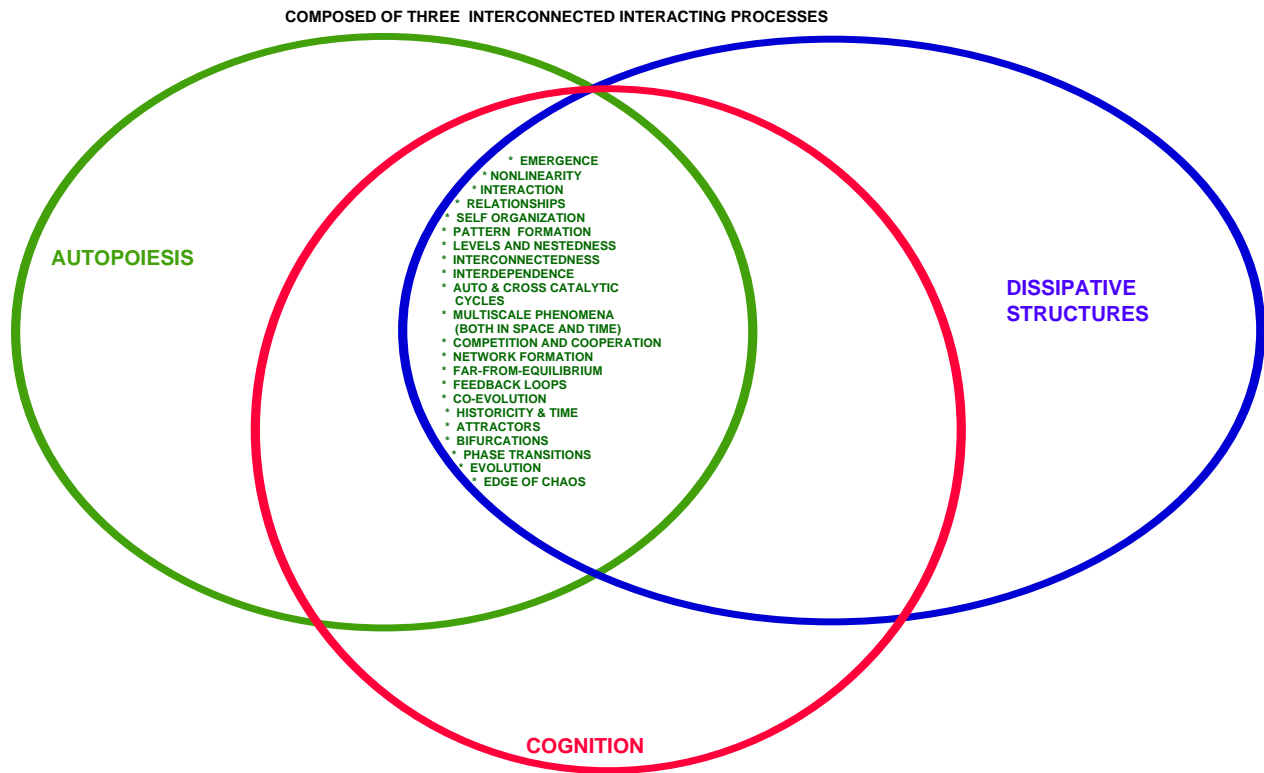


Figure 3. Emerging Theory of Living Systems <sup>36</sup>

The criteria of the three are totally different, yet interdependent. They are so closely intertwined that it is difficult to discuss them separately, as shown in Figure 4, below. All three incorporate the laws of complexity (universalities) in coarse and fine graining.<sup>37</sup>

## EDUCATION SYSTEMS OPEN NON-EQUILIBRIUM THERMODYNAMIC SYSTEMS



**Figure 4. The Interconnectedness of the Autopoietic, Dissipative Structure, and Cognitive Processes** <sup>38</sup>

The following three sections of this chapter extend the concepts of autopoiesis, dissipative structures, and cognition in the form needed to undergird an educational theory complexity hybrid.

- Part 4.2 describes the emergent Autopoiesis process behavior of an education system
- Part 4.8 describes the Dissipative Structure of an education system
- Part 4.11 describes the Cognitive process of an education system

As shown in Table 12, below, the observable discrepancies and fallacy behaviors for the traditional paradigm (through leadership and organizational structure) can be described using the three primary complex systems processes ---autopoiesis, dissipative structure, and cognition. The complexity universalities patterns of behavior, (traced through all living systems) are described in detail and introduced in the three main sections below.

**Table 12. Organizing Table for Comparison between the Traditional Paradigm and Educational Theory Complexity Hybrid**

<b>Part III Paradigm Shift to Optimal Learning Environment</b>				
	<b><u>Current Traditional Paradigm</u></b> <i>How present educational theory with its organizational structure and leadership is too linear, mechanistic, and reductionist</i>		<b><u>Educational Theory Complexity Hybrid</u></b> <i>How implementation of the theory can produce a considerably improved organizational system and leadership</i>	
	<b><u>Mechanistic organizational structure</u></b>	<b><u>Hierarchical leadership structure</u></b>	<b><u>Optimal Learning Environment</u></b>	<b><u>Facilitator</u></b>
<b><u>Autopoiesis - Processes operating within the system</u></b>				
<b><u>Dissipative Structure – Processes of system interacting with its environment</u></b>				
<b><u>Cognition – processes of system adapting to change</u></b>				

Then I compare the discrepancies and fallacies of the traditional paradigm, through the lens of the three interconnecting, interacting ETCH processes (Autopoiesis, Dissipative Structure, Cognitive Process) and their major tenets (complexity universalities) and contrast to the alternative ETCH paradigm. The distillation from Chapter 4 becomes the foundation for design and implementation of Chapter 6---The Genesis of an Education Theory Complexity Hybrid.



## 4.2 THE SCIENCE OF THE LIVING AUTOPOIETIC EDUCATION SYSTEM

Biologists recognize the ability of an organism to adapt to its environment, and yet to retain its identity as separate from that environment. This dual ability is referred to as Autopoiesis. School organizations are autopoietic since the school as a whole retains its identity, even though, over time, employees come and go (Eoyang, 1993). Complexity theory defines the autopoietic process of living systems as an internal network pattern---a circular configuration of nonlinear relationships or intertwined webs that can regulate themselves and can generate feedback loops --resulting in collective behavior within the system.

*Autopoiesis – the Pattern of Life – Self-Making – is a network pattern in which the function of each component within the system is to participate in the production or transformation of other components within that network.*

Therefore, the autopoietic process of the education system describes the interconnection of its system's internal operations. Autopoiesis includes the relationships between the use of people, energy, matter, and information needed to maintain the school system's boundaries, vitality, and fitness. It is through the autopoietic processes that social system vision, mission, culture, structure, product, service, and communication emerges.

The subtle but important point in the definition of autopoiesis is that an autopoietic network is not a set of relations among "static" components (like the autopoiesis of a crystal), but rather a set of relations among evolving processes that emerge from the interconnected relationships of its components.<sup>39</sup> Should these processes stop, so does the entire system. In other words autopoietic networks must continuously regenerate themselves to maintain their

organization. The autopoietic process of living systems (its order and behavior) is not imposed by the environment<sup>40</sup> but established within the system itself.

Most of the research to date on complex adaptive systems has focused on “minimal” autopoietic systems such as simple cells, computer simulations as shown in Figure 5, below, and the recently discovered autopoietic chemical structures.<sup>41</sup> Considerably less work has been carried out on the study of autopoiesis of “multicellular organisms,” ecosystems, and social systems of which the Education System is part<sup>42</sup> as shown in Figure 5.

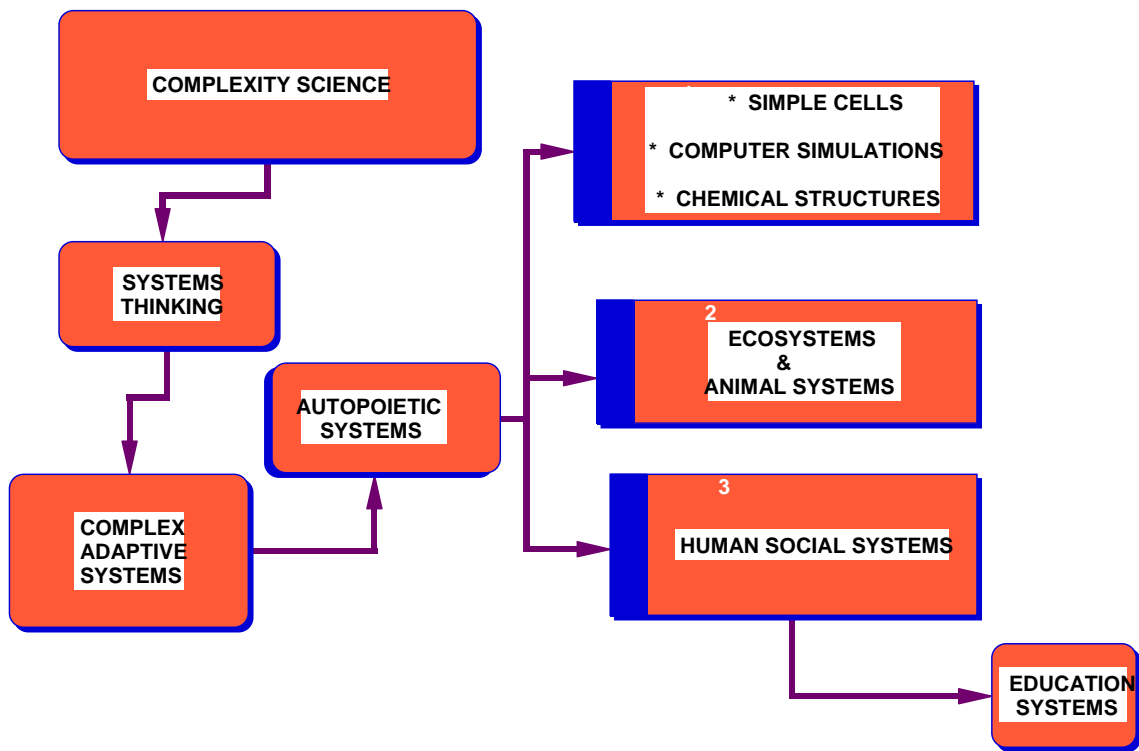


Figure 5. Autopoietic Systems Are Living Systems<sup>43</sup>

The question of whether human social systems can be described as *autopoietic* has been discussed quite extensively. Different authors have proposed various perspectives<sup>44</sup> (Fleischaker, 1992; Mingers, 1995). The central problem, as framed in Figure 6, below, is that *autopoiesis* has been defined precisely only for systems in physical space and for computer simulations in mathematical spaces. It is not unusual for simple physical models to be used initially to explore new scientific constructs. Moreover, since Autopoiesis is a property of living systems, it is inevitable that all real systems that exhibit Autopoiesis will be more complex than the initial mathematical models. Nonetheless, social systems will have slightly different properties than individual organisms. For example, while different parts of a human may have local variations – scars, freckles, etc, - the variations in different local communities of a larger social system may be more complex. Still, though, the basic universalities will be found, regardless of the additional complexity.<sup>45</sup>

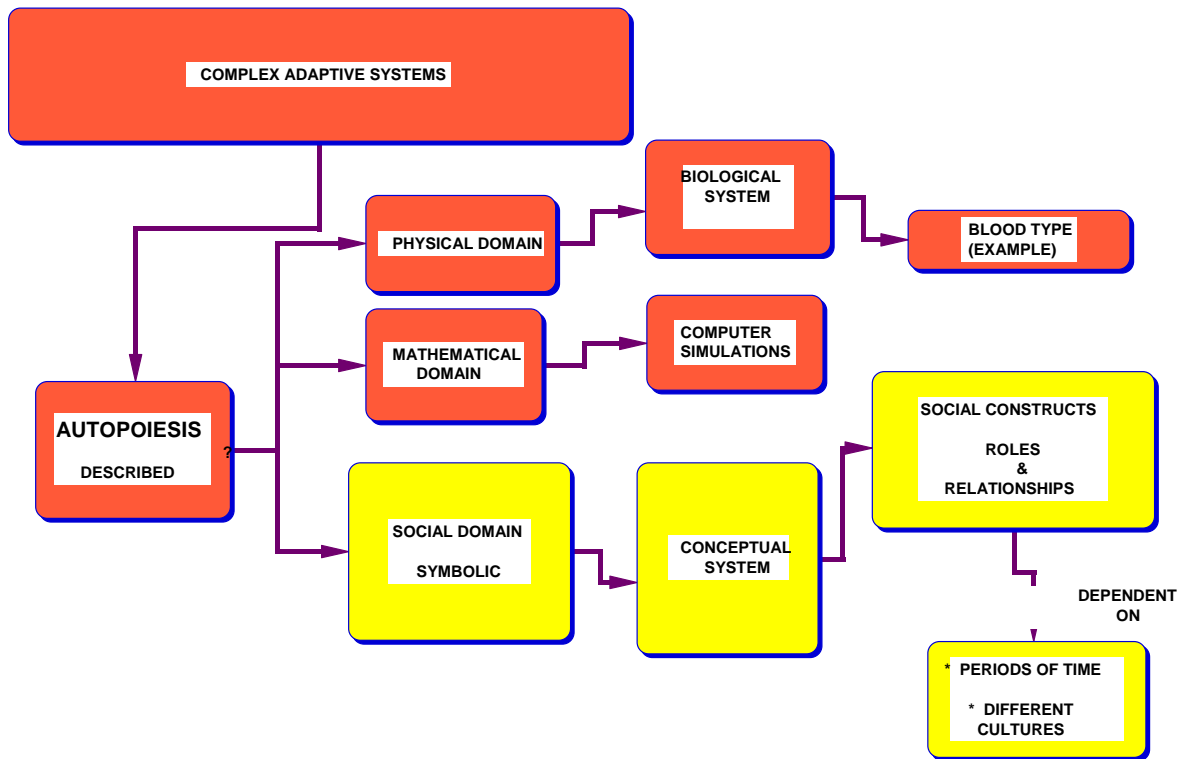


Figure 6. Autopoiesis Described in Physical, Mathematical and Social Domains <sup>46</sup>

Concepts, ideas and symbols that arise with human thought, consciousness, and language, enable human social systems to exist not only in the physical domain but also in the symbolic social domain. Thus a human family can be described as a biological system, defined by certain blood relations, but also as a “conceptual system” defined by certain roles and relationships that may or may not coincide with any blood relationships among its members (Capra, 1996).

While behavior in the physical domain is governed by the “laws of nature,” behavior in the social domain is governed by rules generated by the social system and often codified into law. The crucial difference, as shown in Figure 7, below, is that social rules can be broken, but natural laws or the complexity theory universalities cannot. Human beings can choose whether

and how to obey a social rule; molecules cannot choose whether or not they should interact (Fleischaker, 1992; Mingers, 1995). Choice is a key aspect of social system development and is instrumental in understanding how education system has evolved to its present autopoietic social network state

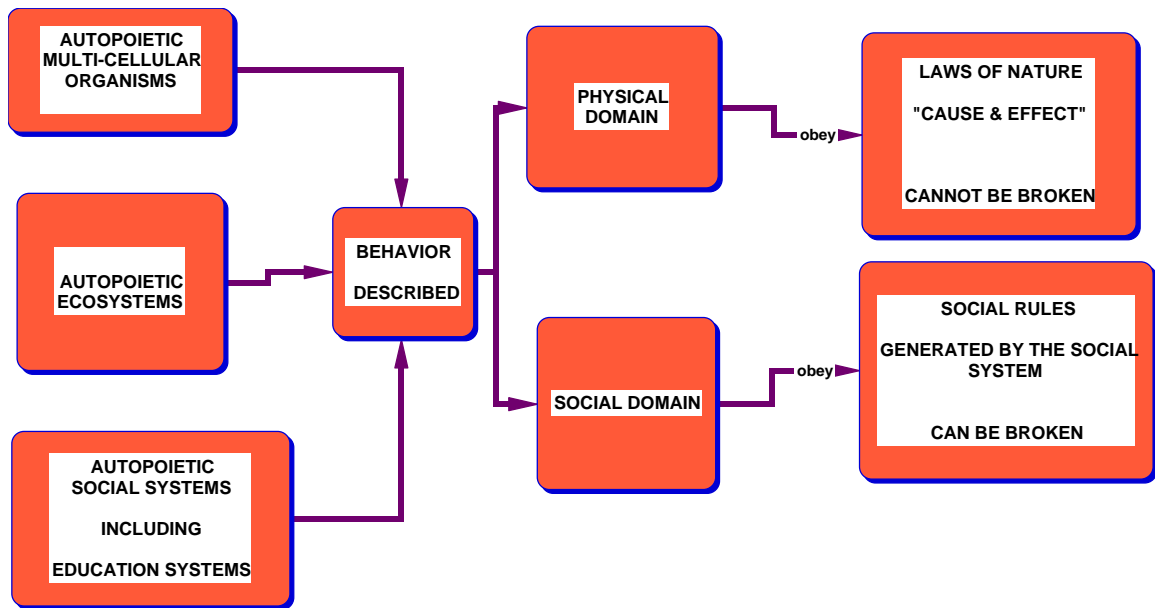


Figure 7. Behavior of Autopoietic Systems <sup>47</sup>

Since all these processes take place in the symbolic social domain, the boundary cannot be a physical boundary as shown in Figure 7. It is a boundary of expectations, confidentiality, loyalty, and so on. For example, both the family roles and boundaries are continually maintained and renegotiated by the autopoietic network of conversations (Capra, 1996). The stance of this dissertation aligns human society systems as living systems that contain multi-level, interdependent autopoietic processes in the physical and social (process of communication) domains. On a micro-level this concept includes human actors who interact in several systems at once and whose mental models for one system may contain information from another system of

which they are a part. I believe that the Autopoietic process contains the following Complexity Theory Universalities that operate within every living system very much like the laws of nature:

- Self-Organization
- Auto and Cross Catalytic Cycles
- Interactiveness
- Emergent Pattern Formation and Pattern of Organization
- Feedback Loops
- Emergence
- Self-Regulation & Self-Perpetuation

These universalities are amplified in. It is these universalities that provide a basis for an educationally relevant theory of leadership.

**Table 13. Universalities Found in Autopoiesis**

Components of Autopoiesis	Universalities or Laws of Complexity Description
Self-Organizing	<p>“the spontaneous emergence of order (not directed or controlled by a conscious entity) that results from the interrelationships of the system’s parts (Kelly &amp; Allison, 1999) as well as a delicate interplay between the combined processes of far-from-equilibrium, irreversibility, feedback loops(increased interactions trigger feedback loops among the components giving rise to collective behavior), instability,”</p> <p>It takes place only under conditions of disequilibrium</p> <p>A constant flow of energy and matter through the system is necessary for self-organization to take place.</p> <p>Many believe that organization will self-organize when they are pushed far enough from equilibrium. Spontaneous group activity, dissenting factions, cliques, and groups of close-knot personal relationships may be examples of self-organization in human systems</p>

Components of Autopoiesis	Universalities or Laws of Complexity Description
Autopoiesis, Self-Organization, and <u>Emergence</u>	<ul style="list-style-type: none"> <li>• is a process where collective new properties arise from the change in the relationship of existing properties of parts within the system</li> <li>• how behavior at a larger scale of the system arises from the detailed structure, behavior and relationships on a finer scale</li> <li>• New Patterns are generated by the interaction of the agents. New structures are established, and old ones disappear. These structural changes are not designed and imposed by some force outside of the system, but self-organize as the internal dynamics of the system play out over time.</li> <li>• The interdependent activities of the parts that emerge into the systemic behavior of the whole, where the whole system behavior is not just the summation of the behavior of the parts (Eoyang, 1993)</li> <li>• In the extreme, it is about how macroscopic behavior arises from microscopic behavior. (Bar-Yam)</li> </ul>
Auto and cross catalytic cycles	<ul style="list-style-type: none"> <li>• At the core of self-organization, catalytic cycles interlock to form closed loops where one cycle acts as catalyst in subsequent cycle. They have the ability to self-balance and self-organize.</li> </ul>
Interactiveness	<ul style="list-style-type: none"> <li>• Complex interactions generate a system that is always changing.</li> <li>• From the interaction of the teachers, students, administrators, and stakeholders emerge patterns of behavior. Learning how those patterns of behavior arise is key to understanding the system as a whole</li> <li>• Interactions among interdependent agents of a CAS transform and are transforming. Transformation occurs across the system's external boundaries because CAS &amp; its agents are open systems</li> </ul>
Emergent Pattern Formation / Pattern of Organization	<ul style="list-style-type: none"> <li>• How the relationships configure determines the system's essential characteristics/identity or patterns of organization. Over time systems exhibit certain classical patterns of behavior, which some describe as attractors</li> <li>• If the pattern is destroyed, then the organism will die</li> <li>• If the pattern is an autopoietic network the system is alive</li> <li>• If the pattern is not autopoietic the system is nonliving</li> </ul>

Components of Autopoiesis	<p style="text-align: center;">Universalities or Laws of Complexity</p> <p style="text-align: center;">Description</p>
Feedback Loops	<ul style="list-style-type: none"> <li>• Most complex systems include some form of feedback which describes the tendency of a system to use its own output to make adjustments in its inputs and/or processes.</li> <li>• In the absence of a rigid external boundary, agents in a CAS are connected to each other by a complex network of transforming feedback loops (Eoyang, 1997). These loops carry resources (material, information and energy) from one agent to another. When an agent receives a resource, it adapts and sends out responding messages to other agents in the system. These transforming feedback loops serve to give both stability and changeability to the CAS. They fuel the interdependence of the system by keeping the parts synchronized. They support evolution of the system by providing impetus and resources for adaptation (Eoyang &amp; Berkas, 1998)</li> <li>• Embedded in physical structures or in the activities of living organisms, where they generate both change and stability in the system</li> <li>• Circular arrangement of causally connected elements, in which an initial cause propagates around the links of the loop so that each element has an effect on the next until the last “feed back” effects into the first element of the cycle.</li> <li>• Classical homeostatic feedback – occurs in situations where a sequence of several chemical steps produces some modification of the input chemical (Segel 2000), which explains individual pathways in isolation but does little to explain the various pathways of the metabolic systems that are extensively coupled.</li> <li>• Diffuse feedback - feedback of environmental information that modifies a systems response so that it moves to a more favorable environment (Segel 2000). Diffuse feedback appears in a complex system composed of a number of interacting agents.</li> <li>• Positive feedback (magnifies the trend) amplifies system outputs; negative feedback (since the mechanism works counter to the trend that would continue without any interference) opposes the system.</li> <li>• The system sensed by sensors influences not only its own state but also the state of its immediate surroundings</li> <li>• Takes the form of attempting simultaneously to increase a number of “good” properties and to decrease other “bad” ones (the goals generally overlap and even conflict with one another)</li> <li>• All this information is fed back into the multiple systems in a way that improves the collective achievement of the goals</li> <li>• the feedback loop is self-balancing (negative) if it contains an odd number of negative links and self-reinforcing (positive) if it contains an even number of negative links</li> <li>• Feedback is the primary means of “control” in a CAS, so the design of feedback systems within an organization are critical to adaptation and effective functioning.</li> </ul>

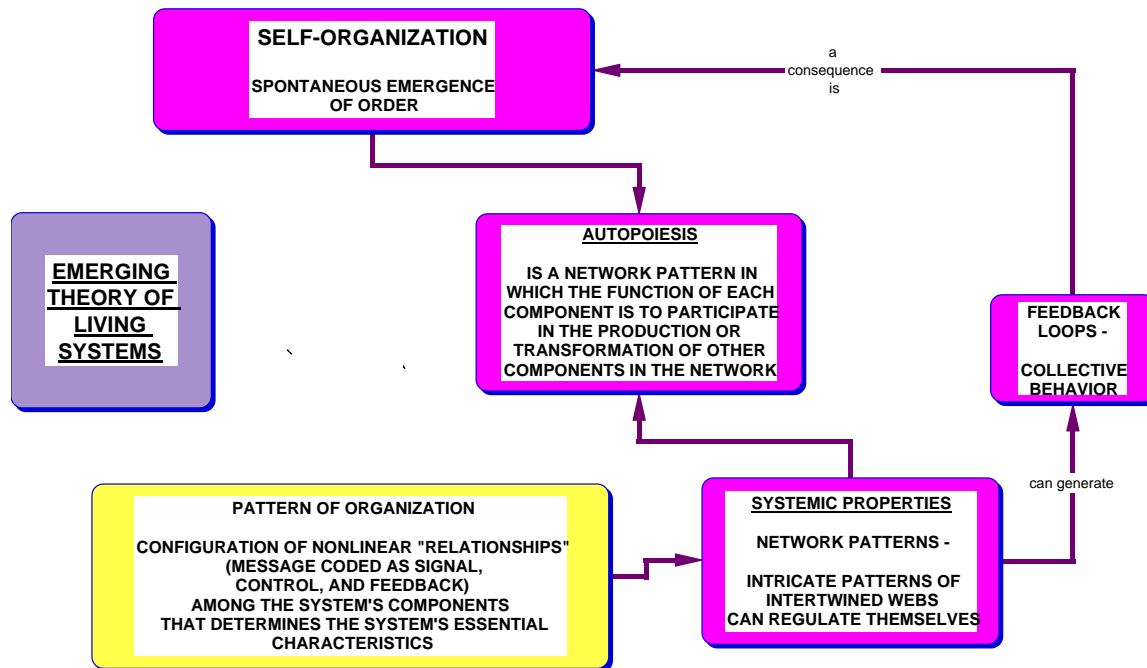


Components of Autopoiesis	Universalities or Laws of Complexity Description
Autopoiesis & <u>Self-regulation</u> & <u>Self-perpetuation</u>	<ul style="list-style-type: none"> <li>• Self-regulation of the entire system is a consequence of the feedback loop (the first link (input) is affected by the last (output) – the initial effect is modified each time it travels around the cycle</li> </ul>

#### 4.2.1 The Complexity Autopoietic Universalities Operationalized in Social Systems

**Self-organization**, the first universality listed in the table, is a common thread in all living systems. It refers to the system’s ability to form new structures, new patterns of behavior, to determine its essential characteristics, and to create its own boundaries<sup>48</sup> to maintain its organization. Self-organization is dependent on the “interaction”<sup>49</sup> of a system’s components (agents). It is through the process of self-organization that the interactions between the system’s components continually regenerate, produce, reproduce, and/or transform the system and themselves, while maintaining the overall circularity of the network. One example is the process of reproducing and shedding of skin cells.<sup>50</sup>

Patterns of Behavior: Self-organization is the underlying phenomenon creating a system’s Autopoietic pattern of behavior. The system’s pattern of behavior is nonmaterial and irreducible, and emerges self-organized from the “interaction” between the components in a system’s autopoietic process<sup>51</sup> as shown in Figure 8, below (**Bar-Yam, 2001**).



**Figure 8. Emergent Pattern of Organization in Living Systems**

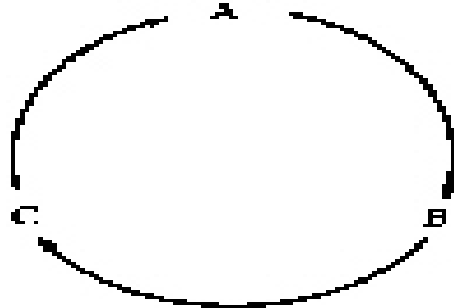
The system components can still be there, but if the configuration of relationship among them – the pattern – was destroyed, then the organism will die. Its pattern of organization,<sup>52</sup> is the configuration of relationships among the system’s components that determine the system’s essential characteristics. To identify whether the state of a system (crystal, a virus, a cell, or a planet earth) is living, merely determine whether its pattern of behavior or organization exhibits autopoietic network characteristics. If so, then the system is a living system, if not, the system is nonliving. Therefore, living or not, understanding begins with identifying the *pattern* (Capra, 1996). Without understanding how *patterns* arise from the *interactions* inside a system, understanding the system’s behaviors is difficult.

From Pattern of Organization to Network Patterns - Since the early part of the century it was known that the “pattern of organization” of a living system was really a “network pattern”<sup>53</sup> (McCulloch, 1943) as depicted in Figure 8, above. Living systems are really network patterns

capable of *self-organization*.<sup>54</sup> Network patterns are made up of *nonlinear relationships* that influence or pass information along a cyclical path.<sup>55</sup> Whether organisms, parts of organisms, or communities of organisms – they are all arranged in network fashion, often with intricate patterns of intertwined webs. Since *networks nest within larger networks* (Capra, 1996), network patterns are present on all systems levels.

From “network patterns” to “patterns of circular causality” to “feedback loops” As shown in Figure 8, above, network patterns and the concept of feedback are intimately connected (Capra, 1996). *Feedback loops*---the basic organization universality of all living systems and the key driver of autopoiesis.<sup>56</sup> A feedback loop is a circular pattern of relationships (patterns of communication and control and in particular patterns of circular causality)<sup>57</sup> embedded in physical structures or in the activities of living organisms,<sup>58</sup> and arranged of causally connected elements, as shown in Figure 9, below, in which an initial cause propagates around the links of the loop, so that each element has an effect on the next, until the last “feeds back” the effect into the first element of the cycle. As the number of interactions (or the emphasis of certain interactions over others (breaking symmetry) is increased, *feedback loops* are triggered among the components, giving rise to a collective and self-organized behavior. This distinction is crucial in the contemporary Theory of Living Systems<sup>59</sup> (Margulis, 1995) which is the first time systems thinking distinguished the pattern of organization of a system from its physical structure.

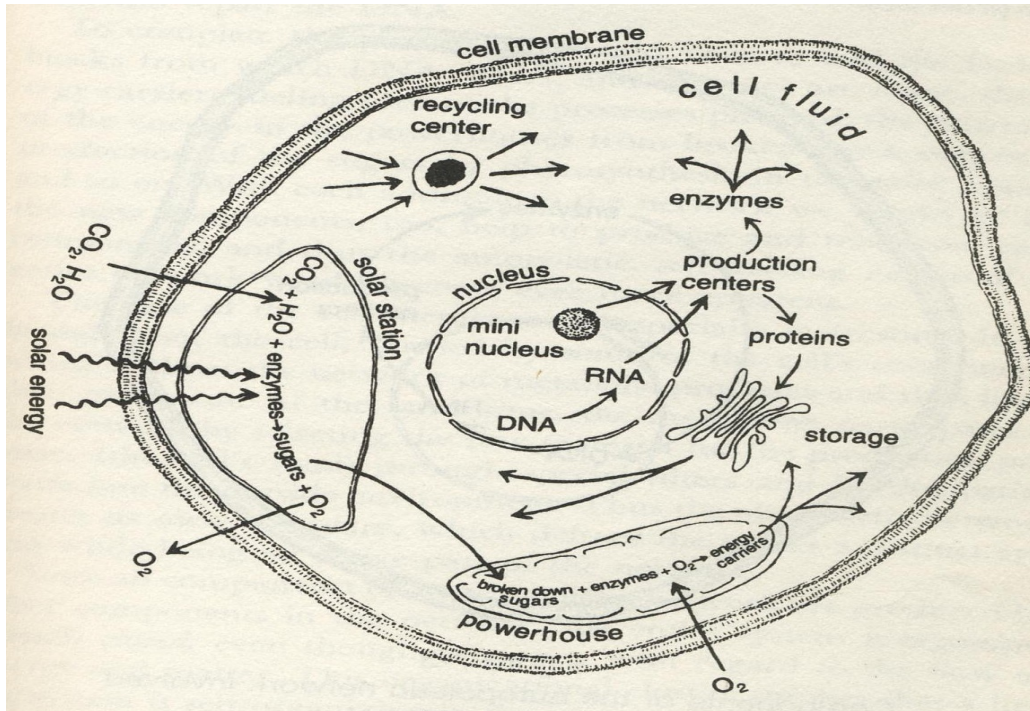
## Circular Causality



**Figure 4-1**  
**Circular causality of a feedback loop.**

**Figure 9. Circular Causality of a Feedback Loops**

The circular causality in the feedback loop does not imply that the elements in the corresponding physical system were arranged in a circle. Looking at the various arrows showing relationships in Figure 10, below, even a simplified plant cell contains circular feedback loops that indicate how cell components are interlinked into a network of metabolic processes.<sup>60</sup>



**Figure 10. Circular Feedback Loop**

**Present in the Basic Autopoietic Components of a Plant Cell**

When Cyberneticists introduced the concept of the “feedback loop,” it led to new perceptions of the many self-regulatory processes characteristic of life. *Self-regulation of the entire system was the consequence of the feedback loop*--- the first link (input) was affected by the last (output) ---the initial effect was modified each time it traveled around cycle. Feedback could now be identified with “sensor-based control of basic tasks” (Segel, 2000). In a broader sense feedback means the conveying of information about the outcome of any process or activity to its source. Elements in an interacting system would be a sensor for some aspect of the state of the system (temperature), and if information from this sensor influenced the basic tasks of the element in questions, then there was a presence of feedback. Feedback means that a machine or process is controlled on the basis of its actual performance, rather than only by its expected performance Weiner, 1950 #305}. Because networks of communication generate feedback

loops, they acquire the ability to regulate themselves. Similar circular feedback loops are present in human social systems. For instance a community that maintains an active network of communication will learn from its mistakes, because the consequences of a mistake will spread through the network and return to the source along feedback loops.

As shown in Table 14, below, feedback loops are frequently composed of both positive (self-reinforcing) and negative (self-balancing) causal links. A family system can be defined as a network of conversations exhibiting inherent *circularities*,<sup>61</sup> where the father, for instance, reads in the paper about new and different expectations, re-invents his role, and thereby alters his family's behavior in addition to his own. The results of conversations give rise to further conversations, so that *self-amplifying feedback loops* are formed, as in an abusive partnership of two people who themselves had abusive parents. As in all autopoietic systems, it is information crossing boundaries that produces change in the system as well as self-replication. That information can be carried by chemicals, but it can also be carried through language, etc. The communicative acts of the network of conversations include the *self-production* of both the roles by which various family members are defined and the family system's boundary.

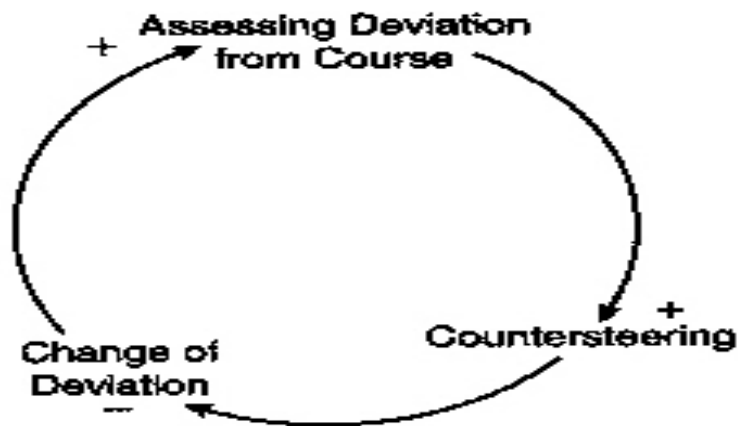
**Table 14. Positive and Negative Feedback Loops**

<p><b>SELF-BALANCING FEEDBACK</b></p> <p><b>(NEGATIVE)</b></p>	<p><b>SELF-REINFORCING FEEDBACK</b></p> <p><b>(POSITIVE)</b></p>
<p><b>Self-regulatory homeostatic process</b> in living organisms Every species has the potential of undergoing an exponential population growth, but these tendencies are kept in check by various balancing interactions within the system</p>	<p>Effect is much more dramatic than the self-balancing of the negative feedback loops. Exponential runaways will appear only when the ecosystem is severely disturbed. For instance, some plants will turn into “weeds” some animals become “pests” and other species will be exterminated, and thus the balance of the whole system will be threatened. Purely self-reinforcing feedback phenomena are rare in nature, as they are usually balanced by negative feedback loops constraining their runaway tendencies</p> <p>I.e.: “Vicious circle” – a bad situation leading to its own worsening through a circular sequence of events</p> <p>I.e.: “runaway” feedback loops – are commonly known runaway effects, or vicious circles, in which the initial effect continues to be amplified as it travels repeatedly around the loop</p> <p>I.e. “self-fulfilling prophecy” – originally unfounded fears lead to actions that make the fears come true</p> <p>I.e.: bandwagon effect” – the tendency of a cause to gain support simply because of its growing number of adherents</p>
<p>A causal link is defined as negative if B changes in the opposite direction, decreasing if A increases and increasing if A decreases</p>	<p>A causal influence from A to B is defined as positive if a change in A produces a change in B in the same direction (i.e.: an increase of B if A increases)</p>

The overall character of a feedback loop is easily determined simply by counting the number of negative links around the loop, as shown the example in Figure 11, below, where a boat that steers off course has only one negative causal link, so the entire loop is negative, or self-balancing. The reason why these labels are so convenient is that they lead to a very simple rule for determining the overall character of the feedback loop. The “Feedback Loop” will be self-balancing (negative) if it contains an odd number of negative links and self-reinforcing (Positive) if it contains an even number of positive links.

The key point expressed in Table 14, above, and Figure 11, below, is to remember that the labels “+” and “-“ do not refer to an increase or decrease of value, but rather refers to the relative direction of change of the elements being linked – equal direction for “+” and opposite for “-“. Exponential runaways will appear only when the ecosystem is severely disturbed. I.e.: some plants will turn into “weeds” some animals become “pests” and other species will be exterminated, and thus the balance of the whole system will be threatened. Purely self-reinforcing feedback phenomena are rare in nature, as they are usually balanced by negative feedback loops constraining their runaway tendencies.

**Self-Balancing & Self-Reinforcing**



**Figure 4-3  
Positive and negative causal links.**

Figure 11. Self-Balancing and Self-Reinforcing Feedback <sup>62</sup>

**Emergence & Catalytic Closure.** How does this self-organizing process take place?<sup>63</sup>

*Self-organization* is often referred to as *emergence* from the change that takes place between the



relationships (interactions) of its components within the system (U. Merry), as shown in Figure 12, below.

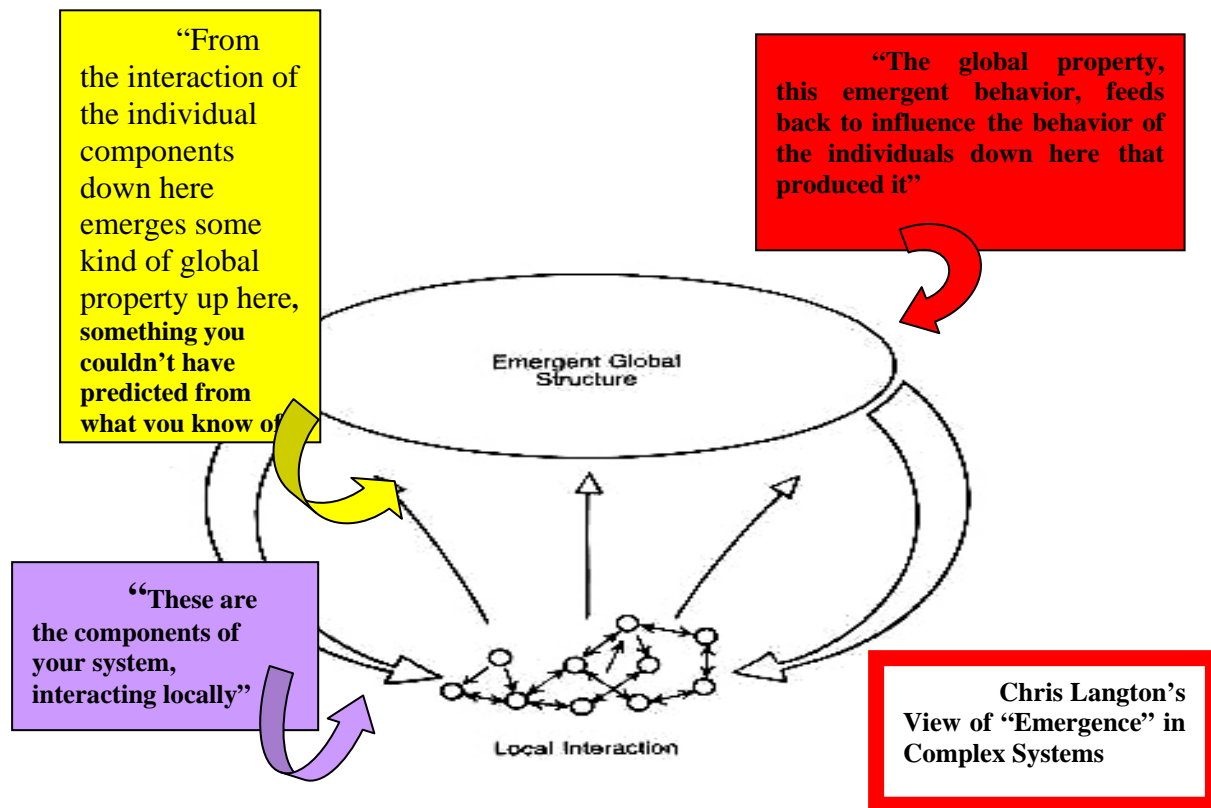


Figure 12. The Process of Emergence <sup>64</sup>

*Emergence* is a process that materializes through the self-organizing interactions of the agents within a system. The emergence process spontaneously materializes a whole, in the form of collective properties such as life, thought, or purpose, that the agents might never have possessed individually. As is visible in, Figure 12 above, within the circular production processes, *parts interact* with sufficient intricacy that their emergent aspects and even their overall behaviors cannot be predicted by standard linear equations. There are so many variables at work in the system that its overall behavior can only be understood as an emergent consequence of the holistic sum of all the myriad behaviors embedded within it (Marion, 1999).

New properties will dominate the system's behavior as degrees of freedom increase or the system's parameters are tuned to break symmetry. Either way, explaining the emergent system independently of the details from which they were composed explains the emergent system's order. The order of an organism or an individual cell arises almost without regard for how the networks of interacting genes are strung together. It is not a property of any single molecule; it is a property of a system of molecules. It means that every molecule in the system either is supplied from the outside as food or is itself synthesized by reactions and catalyzed by molecular species within the autocatalytic system. It means that the system lifts itself from a former way of functioning and creates something new and entirely different in a more complex way of functioning.<sup>65</sup> Although its composition remains the same, the new internal boundaries that suggest how to parse a system into parts have been redrawn from within. This forces a change in how the system is described, and how it is referenced. An example would be that the air over the U.S. is not referred to merely as a flowing gas, but rather in terms of cold and warm fronts or huge vortices such as hurricanes (Fontana, 1999). In other words, living systems are autonomous. This process is known as *emergence* (Fontana, 1999) is one of the complexity theory universalities.

*Emergence can be summarized as follows:*

- *The parts exist for and by means of the whole;*
- *The whole exists for and by means of the parts;*
- *The whole is greater than the sum of its parts.*

Catalytic Closure. A set of molecules either does or does not have the property of catalytic closure. Catalytic closure implies that living systems are self-organizing. Self-organization implies *catalytic closure, meaning that living systems are in part, closed networks of interactions,*<sup>66</sup> which ensure that the whole exists by means of the parts, and they are present

both because of and in order to sustain the whole. The *closure* of the network makes possible a shared system of beliefs, explanations, and values – a context of meaning – that is continually sustained by further interaction. Jointly, once catalytic closure among them is achieved, the collective system of molecules is alive (Kauffman, 1995). Although catalytic cycles, point out Maturana and Varela, by themselves do not constitute living systems, because their boundary is determined by factors (such as physical container) that are independent of the catalytic processes. Catalytic closure is an emergent property of the Boolean networks “autocatalytic sets”, and will begin to appear as a deep feature of the laws of complexity, reemerging in our understanding of ecosystems, economic systems, and cultural systems (Kauffman, 1995).

In Figure 12, The Process of Emergence explains *emergence as* occurring bottom-up, whenever a collection of chemicals contains enough different kinds of molecules to experience catalytic closure and spontaneously crystallize (emerge) into a collective structure.<sup>67</sup> How does this catalysis happen? When the number of different kinds of molecules (components) in a “chemical soup” passes a certain threshold, a self-sustaining system of reactions – an “autocatalytic” metabolism or “self-organization” – will suddenly appear that is a functional whole. Normally a chemical “A” would combine with chemical “B” to make “C” with great difficulty. A catalyst can speed up both the forward and the reverse reaction by the same amount. *Catalysts* such as protein enzymes and ribosome hasten the rate at which this state of balance is reached. However the equilibrium between A and B is not altered.

There is an intermediate state between A & B called the *transition state*. The transition state passing from A to B is exactly the same as the transition state passing from B back to A. In this transition state, one or more bonds among the atoms of the molecule are severely strained and distorted. The transition-state molecules are therefore unhappy. The measure of this

unhappiness is given by the energy of the molecule. Low energy corresponds to unstrained molecules. High energy corresponds to strained molecules.

Catalysts (Enzymes) are thought to work by *binding to the transition state and stabilizing it*. This makes it easier for both A & B molecules to jump to the transition state, increasing the rate at which the equilibrium ratio of A and B concentrations is approached. In the presence of a catalyst, “D” the reaction catches fire and proceeds much faster. “A” & “B” fit into slots on “D”, in just such a way that they are far more likely to combine to form C. If the number of kinds of antibody molecules is held at some low number, say 1,000, and the number of kind of organic reactions is increased, eventually there will be so many possible reactions among these organic molecules that the 1,000 antibody molecules will catalyze reactions.

It becomes important to recognize which molecules catalyze which reactions, because once the system is ignited, it will keep exploding in diversity of new kinds of molecules that in turn catalyze the formation of still further new kinds of molecules that in turn beget still new kinds of molecules. Diversity begets diversity, driving the growth of complexity.

While D is the catalyst that joins A & B to make C, the molecules A, B and C might themselves act as catalyst for other reactions and play a dual role within a system. This dual role is very important because it can serve as an ingredient or a product of reactions, but it can also serve as a catalyst for another reaction. Proteins and RNA molecules play such a dual role.

### 4.3 SUMMARY

As part of the Theory of Living Systems, Autopoiesis contains key interconnected, transdisciplinary concepts that will be used to frame a comprehensive complexity theory hybrid for the education system.

*Autopoiesis – the Pattern of Life – Self-Making collective behavior in a system – is a circular (feedback loop) network pattern in which the function of each component is to participate in the production or transformation of other components in the network. In education, the autopoietic process operates at each level of the system (learning process/teaching/professional development process/financial process/policy development, etc., as well as the collective behavior pattern that provides *organizational closure* for the system as a whole.*

*Self-Organization*, a universality operating in the autopoietic process, is dependent on the “interaction” of a system’s components/agents, and implies “organization closure” meaning that living systems are “*closed networks*” of interactions. In closed networks, order and behavior are not imposed by the environment but established within the system itself. Therefore, *Organization Closure*” implies that living systems are “self-organizing.” Examples of self-organizing patterns of behavior are observable on all levels of the education system. A specific example on the level of individual agents emerges as they interact and interconnect to discuss curriculum, plan projects, and negotiate a contract.

Within the self-organizing process, as the number of interactions between the components in a system increase “*feedback loops*” are triggered among the components, giving rise to collective self-organizing “patterns of behavior.” Using the previous example, as individuals continue to engage around an understood mission/vision/goals, the process of

interaction triggers feedback loops that enable adjustments/adaptations and emerge in collective patterns of behavior. By identifying these patterns of behavior in autopoietic processes, a facilitator does not require every detail of what had transpired between the individual agents in order to facilitate a student-centered optimal learning environment.

*Self-Organizing Emergence* is the term for the process in living systems that produces new properties from the change in the relationships of its components within that system. Emergence in the education system, occurs in a self-organizing bottom-up processes, again on all levels, where for example, the interactions between individuals and their individual ideas and goals, emerges into a larger whole---as when interactions/discussions between department members emerge a scope and sequence curriculum alignment K-12.

This section has explored the dynamics of the Autopoietic processes found in all living systems. The fact that these processes appear in all living systems (including education) implies that they are grounded (much like the laws of nature) in the same scientific understandings that apply to basic physics, chemistry, and biology. An education facilitator equipped to identify these forces/laws that undergird patterns of system behavior in his/her school/district, can more accurately align his/her decision-making process to provide an optimal learning environment for a student-based learning system. Truly understanding Autopoiesis permits a more comprehensive approach to facilitating school systems.

The next two sections identify and describe these autopoietic concepts in a living education system---first within the current traditional education system, and then within an ETCH education system. The three key concepts identified in Chapter 4 - Autopoiesis, Dissipative Structure, and the Cognitive Processes re the cornerstones of ETCH, a new education theory complexity hybrid. Chapter 5 builds on the foundation established in Chapter 4 with

application to optimal learning environments at the edge of chaos. In Chapter 6 the principles are applied to a state-licensed private high school. With this new ETCH theory, the practitioner/facilitator is equipped with a more comprehensive paradigm for leadership to facilitate a student-centered optimal learning environment for schools of the 21<sup>st</sup> century.

#### **4.4 AUTOPOIESIS AND THE CURRENT TRADITIONAL PARADIGM**

In this section, as reflected in Table 15, below, I expand on the concept of autopoiesis discussed above and establish its language and principles through the LEADERSHIP role, and the education system's ORGANIZATION STRUCTURE. I then compare and contrast the CURRENT TRADITIONAL PARADIGM, with its EDUCATION THEORY COMPLEXITY HYBRID alternative in the next section. Table 15, below, is a description of the continuum of the shift from the present traditional paradigm of “where we are” (described in Chapter 3), to the alternative ETCH paradigm of “where we need to be” within the education system.

**Table 15. Paradigm Contrasts Relating to Autopoiesis**

<b>PARADIGM CONTRASTS BETWEEN TRADITIONAL APPROACHES VS. THE EDUCATIONAL THEORY COMPLEXITY HYBRID</b>				
	<u>Current Traditional Paradigm</u> <i>How present educational theory with its organizational structure and leadership is too linear, mechanistic, and reductionist</i>		<u>Educational Theory Complexity Hybrid</u> <i>How implementation of the theory can produce a considerably improved organizational system and leadership</i>	
	<u>Hierarchical leadership structure</u>	<u>Mechanistic organizational structure</u>	<u>Facilitator</u>	<u>Optimal Learning Environment</u>
<u>Autopoiesis - Processes operating within the system</u>	Impact on the Resultant patterns of observable leadership behavior described as the complexity universalities operate within the <u>hierarchical leadership structure and organizational structure</u>	Impact on the Resultant observable patterns of organizational structure behavior described as the complexity universalities operate within the <u>traditional organizational educational structure</u>	Impact of resultant observable patterns of educational leadership behavior as <u>facilitator</u>	Impact of resultant observable patterns of organizational structure behavior as the educational system operates within an <u>optimal learning environment</u>
<u>Dissipative Structure – Processes of system interacting with its environment</u>				
<u>Cognition – processes of system adapting to change</u>				

This table, which will be developed further throughout Chapter 4, demonstrates how ETCH can provide additional support for educational practitioners, once they are ready for a mental model paradigm shift. Without this readiness, any education reform initiative is ill-fated.



#### **4.4.1 Readiness of Hierarchical Leadership Structure Operating in the Traditional Paradigm**

Most of today's leaders and decision makers continue to administer within the traditionalist paradigm,<sup>68</sup> as described in Table 16, below. Since the days of Darwin and Smith, today's leaders (including business theorists and practitioners Lewin, 1999) continue in their predecessor's footsteps (Russell & Peters, 1998). Evolutionary Theory still dominates with ideas of "competition" and "survival of the fittest," and in turn, systems based on competition and survival of the fittest are trapped, operating within the outdated traditional or *stable equilibrium paradigm* that illustrates notions of efficiency, effectiveness, and control (Stacey, 1996). All of these examples are based on a fear of change.

**Table 16: Traditional Leadership Operating in the Traditional Education Paradigm**

	Education System Operating on the Traditional Paradigm	Leadership Operating in Education System Reflected by the Traditional Paradigm
Patterns of Behavior in Educational Practice	Educational practice is the result of an <u>unchanging set of underlying beliefs</u> . Acting on those beliefs means that the system is internally designed to function in a particular way, irrespective of how much additional activity there is, and irrespective of how meaningless or ineffective it might be	Believes that the organization is entirely predictable, and good management should be able to get similarly reliable performance from the organization  Believes that factors, targets, organizational structures need to be nailed down  Is intolerant of ambiguity
	To “Provide instruction and the child will emerge ready to join the work force of society” (Stacey 1995)  A place where students are told what to think.	Seeks stability as the ultimate bulwark against anxiety, which might otherwise become overwhelming
	<u>Increased public concern</u> about whether the U.S. educational system as presently constituted, has the sufficient institutional flexibility and resilience to adequately prepare citizens for the rapidly changing and increasingly complex world of the 21 <sup>st</sup> century.(J. Lemke)	Fail to recognize when an old viewpoint or operating procedure has completed itself and a new one requiring a fresh paradigm should be started  Believes that re-examination of cherished assumptions is unnecessary  Do not have a clue as to what factors go into determining “adaptation limitations” and lack an understanding of the ramification of extending beyond the future shock borders or what can be done to heighten the organization’s absorption level.  <u>Waits for certainty before acting</u>

	Education System Operating on the Traditional Paradigm	Leadership Operating in Education System Reflected by the Traditional Paradigm
	<p>The <u>role of high-stakes standardized testing and assessment schemes</u> pull the system toward behaviors that maximize test results rather than deep conceptual understanding (unless, of course, these are the same)</p>	<p>Does not recognize various trends and events, inside and outside their organization, that are likely to influence its future</p>
	<p><u>Faulty notions about how children learn:</u> The way schools, classrooms, and learning are structured and operated are based on faulty notions about how our world and the individuals that inhabit it actually work</p>	<p>Believes that uncertainty is to be ignored or denied</p> <p>Believes that organizational transitions should unfold in an incremental fashion, where innovation is relatively sequential in nature</p>
	<p><u>Present policy formation and execution infiltrated by the traditional paradigm:</u> Mechanism, Reductionism, and Linearity culminate to form the educational theoretical foundation, which has strongly infiltrated present policy formation and execution</p>	<p>Become intrigued with tactical change and fail to provide the organization with adequate “navigation” for the more strategic transition, or they err the other way around and leave a tactical guidance void. As a result, they are vulnerable to either providing too little specific guidance about the changes that are necessary or imposing too much direction and not enough latitude</p>
	<p><u>Channels for Interaction:</u> In complex systems of many kinds that system behavior is limited because some elements are decoupled from others; interactions that might otherwise be expected to occur are blocked or strongly buffered.</p>	<p>Believes that the dynamics of “group think” and the possible effect of divergence on promotion or even survival within the organization are potent pressures for conformity</p> <p>Believes in long-term planning, strategic management that includes tasks of goal formation, environmental analysis, strategy formulation, evaluation and implementation and strategic control</p>

	Education System Operating on the Traditional Paradigm	Leadership Operating in Education System Reflected by the Traditional Paradigm
<u>Patterns of Behavior in Learning Structure:</u>	<u>Teachers tend to be isolated</u> by the structure of schooling from significant professional contact with other teachers in their field. This applies not only within the school, but more widely, with teachers in other fields and even with colleagues in the same school who teach the same students on the same day.	<u>Leaders who flounder</u> , during the formalization, because either they won't act without a general consensus, or they go to the other extreme, and fail to adequately involve others in making sound judgments, that can be embraced by enough people within the organization Do not act decisively leading to their downfall. Sometimes decisions appear to be made in a way that confuses people or leaves some doubt about priorities
	<u>Limited community interaction:</u> Schools today have very <i>limited and controlled forms of interaction with the surrounding community and even with students' families</i> . Even young adult students in our society are not encouraged or given significant opportunity to take on real responsibility or experience the satisfactions of making real contributions to the wider community	When faced with new and significant challenges, they do not identify which factors are affected or they cannot determine how to alter them in order to maintain alignment with the new requirements for success
	<u>Internal barriers:</u> Within the school, two classic forms of segregation barriers contribute: those between disciplines and those between grades.	<u>Fails to see and create patterns that can guide actions</u>
<u>Patterns of Behavior in Educational Reform Initiatives:</u>	<u>Initiatives without purpose:</u> Educational reform initiatives are missing a clear, coherent sense of purpose, including a how-to-proceed action plan, and are often characterized by faddism, superficiality, confusion, unwarranted and misdirected resistance, and consequent failure	<u>Closes itself off from new information and innovative possibilities</u>  Tend to under perform when attempting change, and they fail to successfully orchestrate their broader transitions

	Education System Operating on the Traditional Paradigm	Leadership Operating in Education System Reflected by the Traditional Paradigm
	Educational reform initiatives are confronted with deeply entrenched mindsets in the schools	<p>Believes that the management task is the enunciation of mission, the determination of strategy, and the elimination of deviation</p> <p>Believes that the board should preside over a cohesive management team with a vision or strategic intent supported by a common culture</p>
	Schools are part of the education system which in turn is part of a larger system that is grounded in similar ways of thinking –a paradigm that is reinforced through present educational policy execution.	Does not appreciate the struggle between the accelerating “transition demands” taking place and the diminishing “resources” (capacity available to help organization adapt to these disruptions
	This <u>unchanging set of underlying beliefs</u> has also seeped into the individual (agent) level, and flourishes in the development of the mental models held by education leadership – a leadership that cycles to create the policy design and execution that in turn limits optimal learning potential for the student	<p><u>Is pessimistic about resolving problems and exploiting opportunities</u></p> <p>Do not stretch beyond their school or district’s transition limits. Even though some new variable is tested</p>
	Changing those fundamental beliefs is at the heart of a deeper type of learning which has the capability to change the individual	<p><u>Scatters efforts in unrelated directions</u></p> <p>Often thinks 1<sup>st</sup> order change will accomplish what only a 2<sup>nd</sup> order transformational, transitional passage can achieve. (Display a tendency to drive toward transition outcomes under the mistaken assumption that the destination they seek is a terminal objective. The transformational nature of a transition is missing. Often what occurs is insignificant movement within existing confines)</p> <p>Do not better prepare people for change. Rather, these leaders are camouflaged with plenty of macho posturing and solid dose of “I-know-we-can-do-it” motivational hype. The hope is that, through all this, employees will somehow come up with the heroic effort needed to make it all work.</p>

If the attributes of leaders reflect these criteria,<sup>69 70</sup> it is impossible to create a work environment that fosters change (an ETCH culture and structure) throughout the rest of the school/district (the autopoietic component of the human system) (Conner, 1998). The skills and talents required to operate in an optimal learning ETCH environment cannot be attained by leaders trapped in the old, 1<sup>ST</sup> ORDER INCREMENTAL MENTAL MODEL PARADIGM,<sup>71</sup> as shown in Table 17, below.

**Table 17. Paradigm Shift from 1st to 2nd Order Change**

<b>Chapter 3 of Dissertation The Traditional Paradigm</b>			<b>Chapters 4-5 of Dissertation A Comprehensive Alternative: Building the Education Theory Complexity Hybrid</b>	<b>Chapter 6 of Dissertation PARADIGM SHIFT TO OPTIMAL LEARNING ENVIRONMENT</b>
<b>Change is Thrust on Schools</b>			<b>Requires Change of System Not Within System</b>	<b>Requires System Redesign</b>
<b><u>1<sup>st</sup> Order Change</u></b>			<b><u>2<sup>ND</sup> ORDER CHANGE</u></b>	
<b>Form: Reaction to symptoms and focus on surface change.</b>			<b>Form: Engage system holistically and focus on fundamental change</b>	
<b>Piecemeal Change</b>	<b><u>Incremental Change</u></b>	<b>Systematic Change</b>	<b>Systemic Change</b>	
<b>“Once and done”</b>	<b>Make what exists more efficient and effective without disrupting the basic features</b>	<b>Make results generalized to a larger context</b>	<b>Is holistic not reductionist, dynamic not linear, a critical process not mechanical, and individually and locally relevant not generalizable</b>	

This linear style of leadership is based on decades of training to be systematically linear, where infrequent incremental change was predominant; and deeply ingrained procedures, traditions, attitudes, and cultural biases about how to manage change. Complexity theory suggests that such traditional leaders need to develop a new framework with a new array of options much different in scope<sup>72</sup> ( Stacey, 1996; Axelrod, 1999).

#### **4.4.1.1 What Transpires When a Traditional Hierarchical Leadership Structure, Operating Within a Mechanistic Organizational Structure, Is Observed Through the Autopoiesis Processes That Operate Within the System?**

The complexity universalities are inherent properties of complex adaptive systems such as school systems. They are present whether or not leaders choose to use linear or more adaptive strategies. They operate in all living systems and show no partiality. When leaders align decision-making processes to the complexity universalities (laws of complexity), the system as a whole increases its ability to sustain and adapt to a changing environment. Through the complexity universalities many patterns of behavior of the education system can be explained. Over time complexity universalities exhibit, then operationalize, into patterns of behavior or attractors (indicators) in schools, school districts, and the system at large. As shown in Figure 13, below, their interconnected relationship within the system determines the system's essential characteristics/identity or patterns of organization.

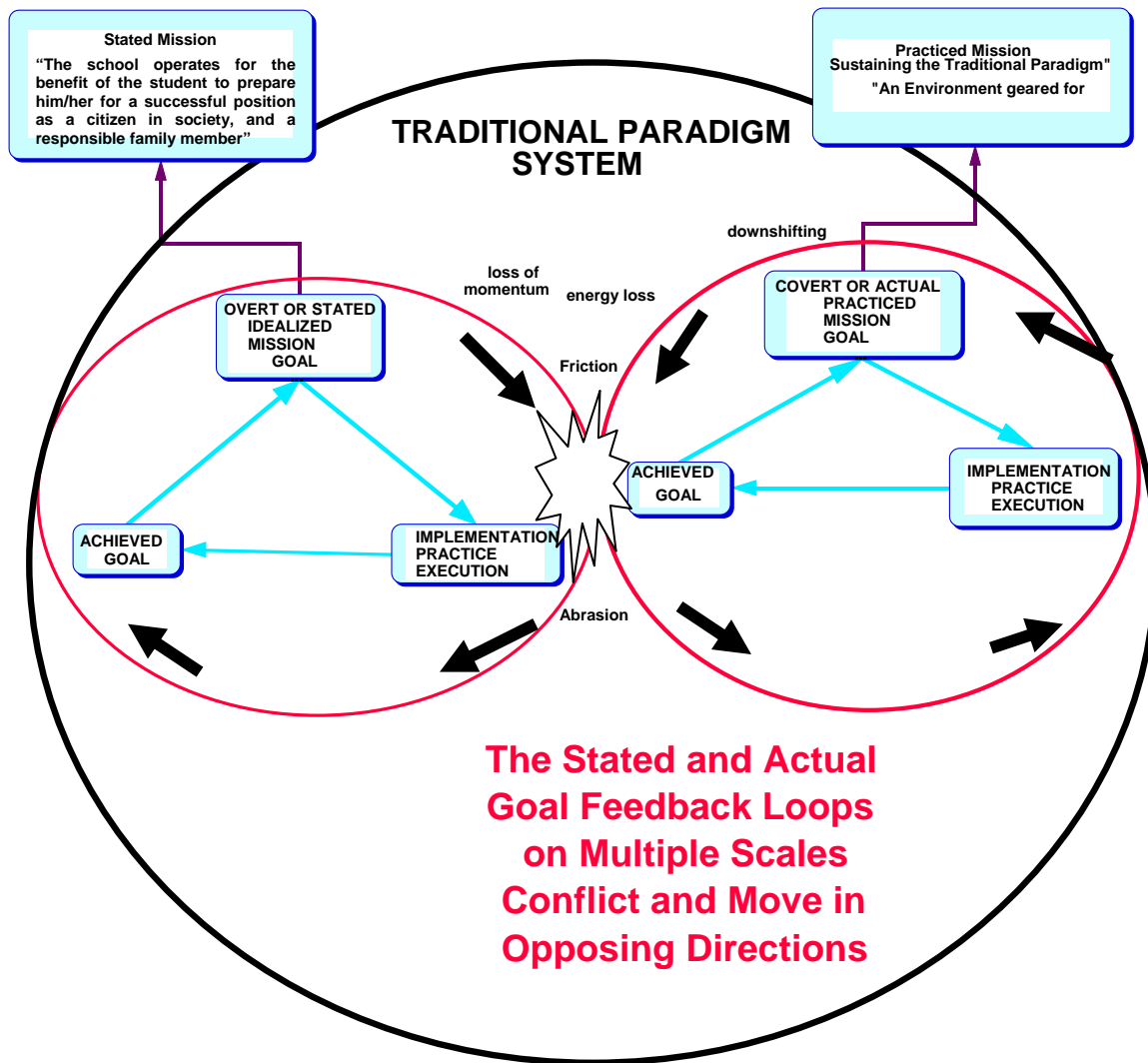


Figure 13. Traditional System Paradigm

In the present education system an operational traditional paradigm coupled with an autopoietic process that is influenced by this traditional paradigm leads to internal conflict. In the education system, when the traditional paradigm and the complexity hybrid are compared using the universalities, it becomes evident that the present traditional paradigm is in autopoietic conflict (a system in internal conflict with itself).<sup>73</sup> In the traditional paradigm, two key feedback processes---the stated and actual---are in conflict and spinning in opposite, opposing directions.



The stated or idealized mission or goal of the traditional education system is to create a teacher-centered environment where the teacher is the main resource and the student is a passive recipient. In opposition, counter to the stated mission yet within the same system, the actual or practiced mission or goal of the traditional paradigm operates to create an environment geared for sustaining the traditional paradigm. These *feedback loops* are embedded in the physical structures or in the activities of the system.

This delicate interplay between the combined processes of these *feedback loops self-organizes*, and gives rise to collective behavior that creates forces of friction and abrasiveness. Through this conflicting self-organizing process, a constant flow of energy and matter circulates through this system and manifests in an emergent paradigm. Collectively new properties arise and change the relationship of existing properties of parts within the feedback loops of the system. What *emerges on the larger scale from the behavior and relationships on the finer scale, in the education system, is energy waste and loss of momentum, causing downshifting and stagnation for the system as a whole.*<sup>74</sup> Nothing gets done.

When a new agent (in this case a new employee) enters the system, he/she will move toward the established *pattern of behavior*, the predominant *attractor regime* (Eoyand & Berkas, 1998). *Attractors* explain why dissenting factions, cliques, and closed relationship groups materialize and reinforce the behavior of the education system at large. As a result, these self-opposing loops feed on each other and put the brakes on any reform initiative, any creativity, or any exploration of possibilities for growth. Not only are these *feedback loops* multi-variable, multi-scale (occurring in course and fine graining of the system) but are also time-scale sensitive. Eventually this will lead to a grinding halt mid sparks of friction.

#### 4.4.1.2 Example of Autopoietic Process Operationalized in the Traditional Paradigm:

I have chosen Alternative Education, an enigma in the education system, as an example where the need to embrace the paradigm shift is greatest. Alternative Education includes those children (individual or agent level) whom society labels as having “fallen through the cracks.”

Although alternative education is a microcosm of the education system, the challenges of today's youth in general have expanded beyond Maslow's hierarchy of basic needs in food, clothing, and shelter to include issues of family drug addiction, incest, abuse, neglect, etc.<sup>75</sup> Today's child, whether disabled, gifted, or average, faces issues on a day-to-day basis that the children of years past have not encountered.

- 258,000 children or 8.3% of Pennsylvania's children do not have health insurance (Children, 2000).
- "One child in twelve is uninsured in Pennsylvania (Children, 2000)
- “The State of Youth Employment” report shows that one in 11 Pennsylvania youth 16-21 is idle, defined as not working and not enrolled in school. One in seven Pennsylvanians 19-21 is not working and not enrolled in school (Children, 2000).
- 900 substantiated cases of child abuse in children 0-4 in Pa according to 2004 PA Dept of Welfare (Children, 2000)
- 22,799 births in PA by mothers without HS diploma between 1996-2004 (Children, 2000)
- 16.8% of Pre-K-3<sup>rd</sup> grade classrooms have 17 or fewer students according to 2004-2005 PA Dept. of Education report (Children, 2000)
- "An estimated 12 %, or 7.5 million, of the nation's children suffer from mental disorders severe enough to warrant treatment." (Goldsmith, 1992)
- "3/4 of adolescent deaths are due to social causes, many of which could have been prevented" (Goldsmith, 1992)

"Schools," adds the Pathways article, "are increasingly recognizing that the educational performance of at-risk children will not improve unless `effectors' are made to remove the barriers to learning created by problems that begin outside the classroom walls." To restate and clarify, I will apply the commonly known assessment (testing) equation --- *Raw Score or Observed Score = The True Score + Error* --- as an analogy example to describe the dramatic blow that these external barriers have to learning. This assessment (testing) equation is the same

equation used in standardized testing that reveals the competence and knowledge acquisition of the student. The assessment equation is identified by three components:

*The Raw Score or Observed Score*

*The True Score*

*The Error.*

In terms of the analogy, the *True Score* represents that portion operating "*within*" the individual student. The "true score" for each child is sensitive to the same three variables---time, conditions, and types of questions. The *Error* (+,-) or the "noise in the system" is characterized by the impact of emotions, test anxiety, or the degree to which question-linking on the part of the test-taker has occurred. Together, the True Score and the Error (+ or -) combine and emerge as the "Raw Score" ---the representation of success or achievement level for each student.

Historically educators have attempted to minimize the *Error* as symbolized in the assessment equation thereby hoping to more accurately identify the *True Score* (the internal configuration of the student). I believe that when the "*Error*" rate (caused by the more complex moral, ethical issues) becomes too great (too high or intense) for the child, and extends over an extended period of time, that "*error rate*" can be so encompassing and debilitating that the *true raw score* cannot be identified.<sup>76</sup> All the well intentioned, fancy-titled programs will not accomplish the goal of educating "these" children.

Why has there been so little progress in education over the last fifty years? Success in identifying the components of the "Error" requires understanding how the child 'works'. Unfortunately, the answer may be that the mental models held by traditional educational practitioners of children and family, who implement the educational program, dates historically to our ancestors. The status quo of the traditional paradigm could not permit the change in

family structure experienced over the last fifty years to impact its mental model, in terms of strategies in assessment development, teaching methods, intervention, and support. Practitioners still apply their understanding of family from years gone by, not an understanding of the children of today, who are the products of confused and conflicting family environments requiring interventions that address the challenges of day-to-day living. Techniques used in schools years ago when the family structure performed differently don't work for the challenges children face today.

Blatantly clear is: 1) decision-makers in the schools must consider all the systems interrelated within the education industry especially the “Child Factor”. 2) A badly needed “paradigm shift” that alters the mental model of the early 1900s from one of linearity to one of complexity---is a realization that the paradigm of the early 1900s has no place in the mechanized process for the “Child” who is not mechanize-able.

Consequently, juxtaposed to an emergent larger (coarse graining) educational systemic scale, the following four mental model evolving processes argue for a paradigm shift in the education system.

- Mental Model 1 depicts the traditional paradigm as applied to the organizational structure prevalent around the Industrial Revolution and which continues today.
- Mental Model 2 takes the concepts of the Mental Model 1 and adapts the linear process to fit the internal feedback loop cycles of living systems.
- Mental Model 3 applied the concepts of Model 2 to schools.
- Mental Model 4 evolves by adding the “Child Factor” from the “family system” and captures the child’s struggle to fulfill his needs outside of the school environment in a different system called “family.”

To regain, the autopoietic education system must address instruction as part of a nested system and consider the pressures imparted by the family structure on the student.<sup>77</sup>

Through feedback loops, on the larger scale, in behavior, and relationship on the finer scale,

when the needs of the whole child are embraced, all benefit including the families. Educators have a wonderful opportunity, though outreach into the community to become the hub for providing services for the holistic child, rather than the Morgan's "egocentric" stance and work alone (Morgan, 1997). It means sacrificing, giving up turf and comfortable traditions. It means a paradigm shift from the "mental model 1"---the traditional--- described below, and evolving and adapting into "Mental Model 4"---the ETCH alternative.

Mental Model 1, shown in Figure 14, below describes the linearity of the machine metaphor, or in Weber's terms the "mechanics of industry," applied to organization structures.<sup>78</sup> It describes a process of planning, organization, command, coordination and, most of all, control. Mental Model 1 begins at the top left-hand corner of the diagram below, and describes the logic as the machine metaphor of organization development in the beginning of the century. The decision-maker designed the organization and controlled the responsibilities of the employees. Decision-makers did the thinking, where as doing was assigned to the employees. The Design and Control of Work mechanized a division of labor that promoted the interchangeability of workers where jobs simplified, cheap, easy to train, easy to supervise and easy to replace. Rules and Regulations in terms of "Procedures and Techniques further routinized work responsibilities. The diagram suggests that although organizations run as machines that structure the organization, the side effect to the human is a reduced capacity for creativity and spontaneity that "Erode the Human Spirit".

## MORGAN'S METAPHOR OF ORGANIZATION AS MACHINE

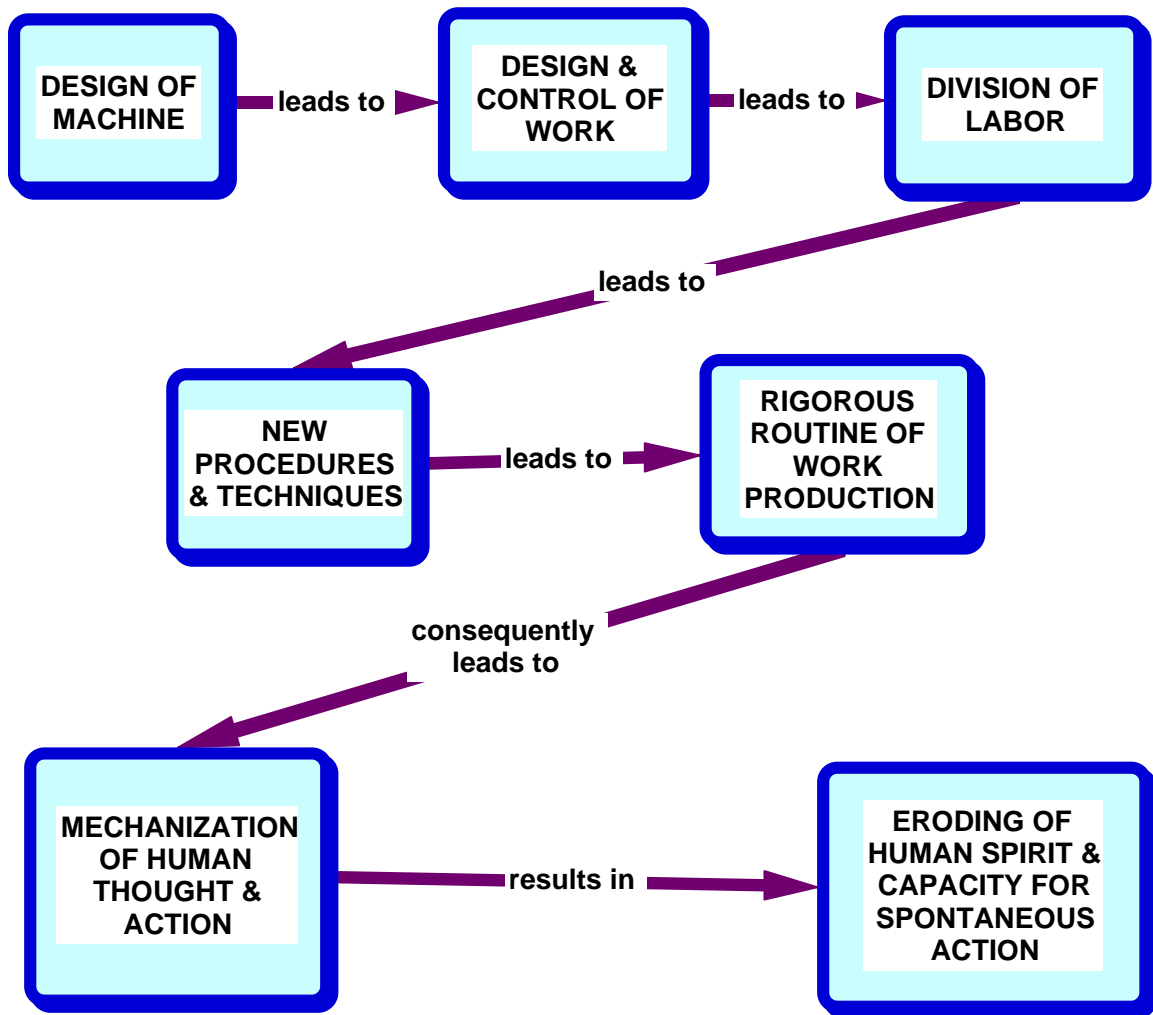


Figure 14. Morgan's Mental Model 1: Metaphor of Organization as Machine

Mental Model 2, shown in Figure 15, below, utilizes the same concepts of Mental Model 1; however, attempts to more accurately fulfill the purpose of mental models ---accuracy and authenticity. Mental Model 2 adapts the linearity of the organizational machine described by March and others to the concept of “circular causation.” Why? According to Senge, the linear and mechanistic thinking used in the early 1900s has become increasingly ineffective to address modern problems. Circular causation, as depicted by the curving arrows, where a variable can be

both the cause and effect of another, has become the norm rather than the exception, shares Senge as he explains that today, most important issues are interrelated and interconnected, and feedback causal loops now dominate the behavior of the important variables in our social and economic systems (Senge 1993) The results of this applicative experiment: 1) reveals a graphic that aligns more closely with reality by depicting the circularity of the cause/effect phenomena (missing in Mental Model 1), 2) reveals not only the top-down flow of decision-making as was true of the bounded, rational, scientific model, but also depicts the continual flow of feedback in a bottom-up circulation that eventually arrives at the top (decision-maker)

The school system also developed and mechanized during the early part of the 1900s, experienced noticeable changes. Some hypothesized that increased enrollment created pressure to expand and grow which resulted in resource lack which in turn... and the ripples continue. Just as the machine functioned as a metaphor explaining industry and business, with inputs (resources) and outputs (product), the school system also exemplified machine-like qualities. Its consciousness circled around “production;” building enough schools to meet “demand;” and getting at-risk children out of production (mainstream) because they were not able to meet the quota (learning objective criteria). Morgan in his 1994 book shares that this perspective was an “egocentric perspective” like a machine, punch the right buttons and the product emerges ---a citizen with economic potential and stability.

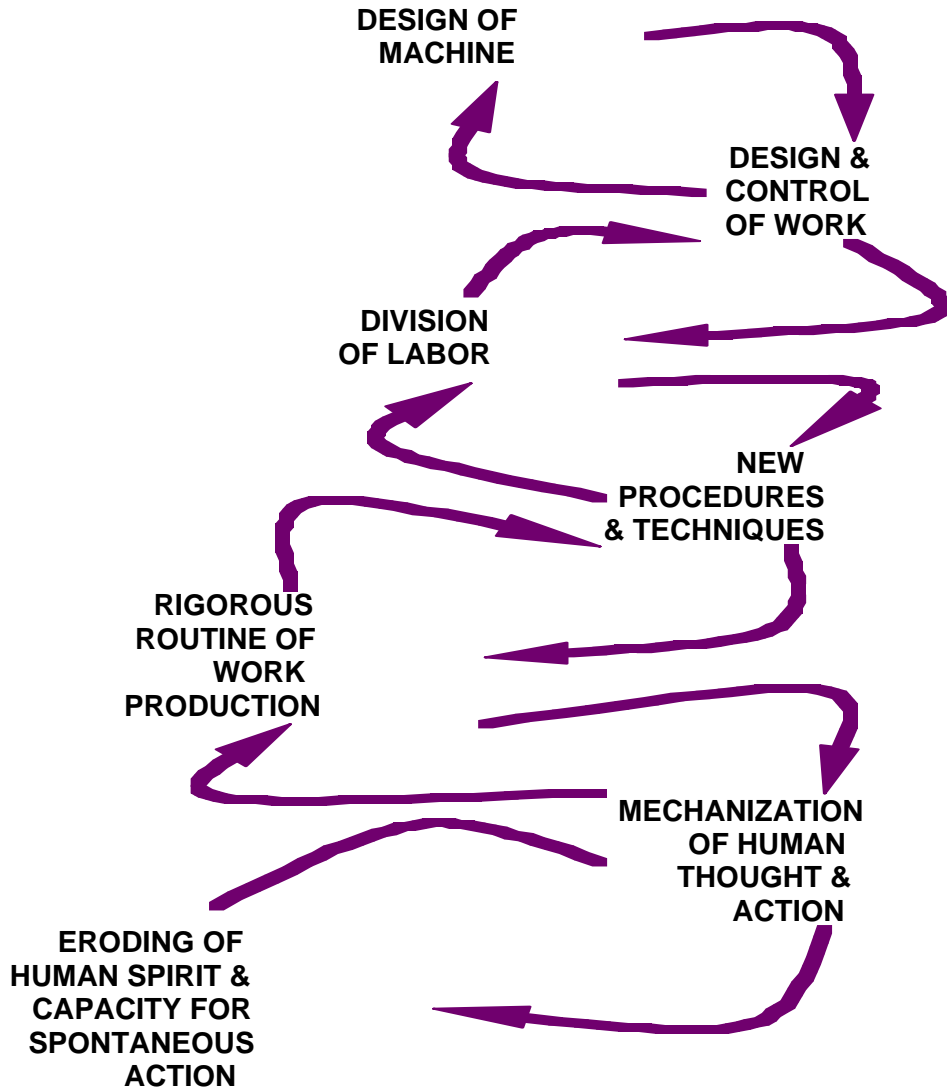


Figure 15. Mental Model #2: Organization as Machine in Circular Causation

**Mental Model 3:** With an attempt to depict the reality of the current status of schools, Mental Model 3, as shown in Figure 16, below, continues to utilize the concepts of the organizational machine, and applies the machine metaphor now to the school organization as described by Herbert Simon. It is through this mental model that the perplexing phenomenon of the at-risk child surfaces.



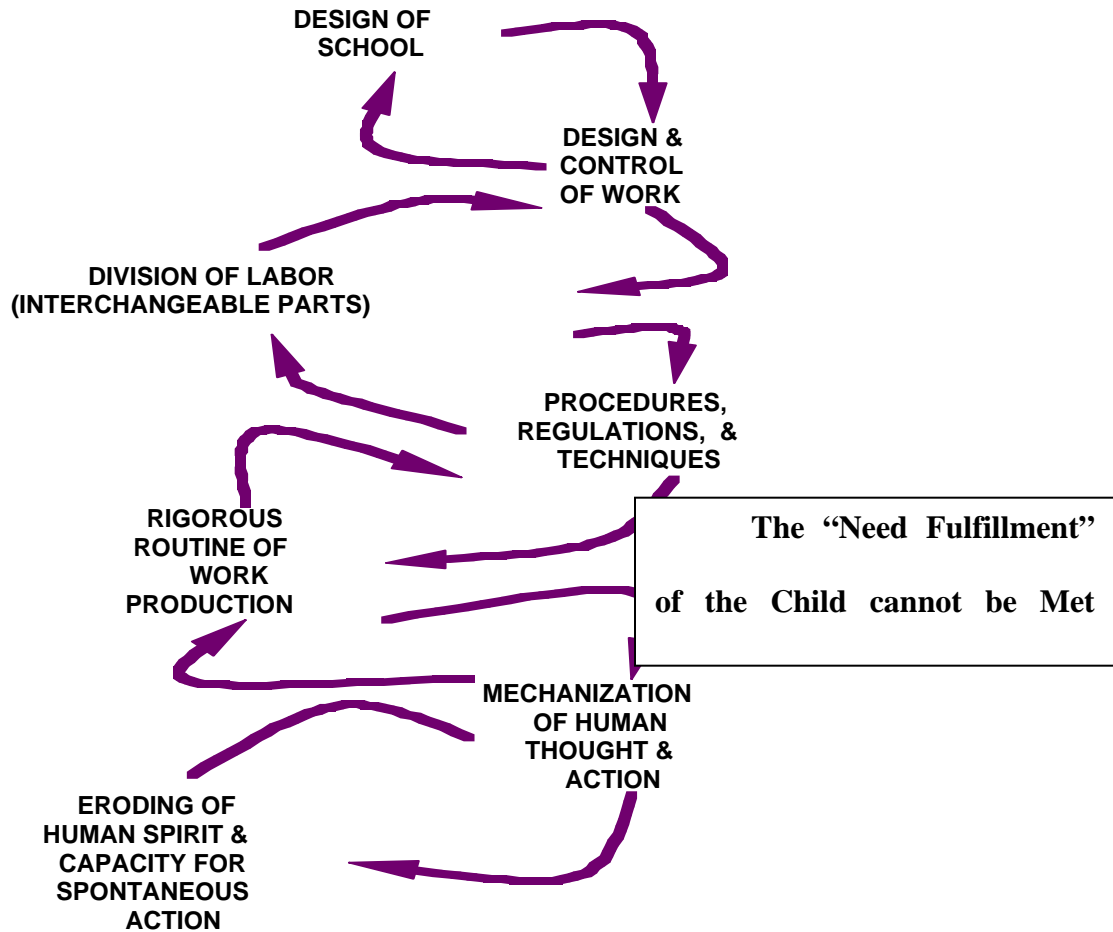


Figure 16. Mental Model #3: Herbert Simon's School as Machine

The diagram's description begins in the upper left-hand corner with the "School Design." The strategic intent of an organization (Design of School) is an idea that becomes explicit when actions by the decision-maker are taken to generate intent. Results are produced as a consequence of implementing the structure of the "Design of School" progresses downward through the "Division of Labor". Again, by adapting the linearity of the organizational machine model to the circularity of current-day thinking, the reader realizes that the results of the organization allow it to determine if the intent of the "Design of School" has been achieved. The

results having circulated back to the top (decision-making status) are analyzed in relationship to the strategic intent and can generate a new implementation of the intent.

The new addition to the structure of **Mental Model 4**, as shown in Figure 17, below, is the addition of **the “Child Factor”**. Into the **“Rigorous Routine and Factory Production”** that translates into the lesson plan/curriculum requirements of school system mandates, enters the **“Child Factor”** component. His/her actions/behavior require also a **“Mechanizations of Human Thought and Activity”** which eventually also **“Erodes the Human Spirit”**. Unlike **the “Division of Labor”** where in most cases the considered interchangeable parts that can be replaced if not functioning properly, the **“Child Factor”** MUST remain in the cycle mandated by Compulsory School Attendance. **“Behavior Symptoms”** also surface as a release valve. The machine metaphor applied currently to schools cannot consider the **“Child Factor.”** The machine metaphor was designed to routinize factory production where the human factor (labor) was expendable if not “producing”. The school system was designed to respond in like and responded to the **“Child Factor”** **“Behavior Symptoms”** of absence, truancy, drop out, deviance, etc by implementing

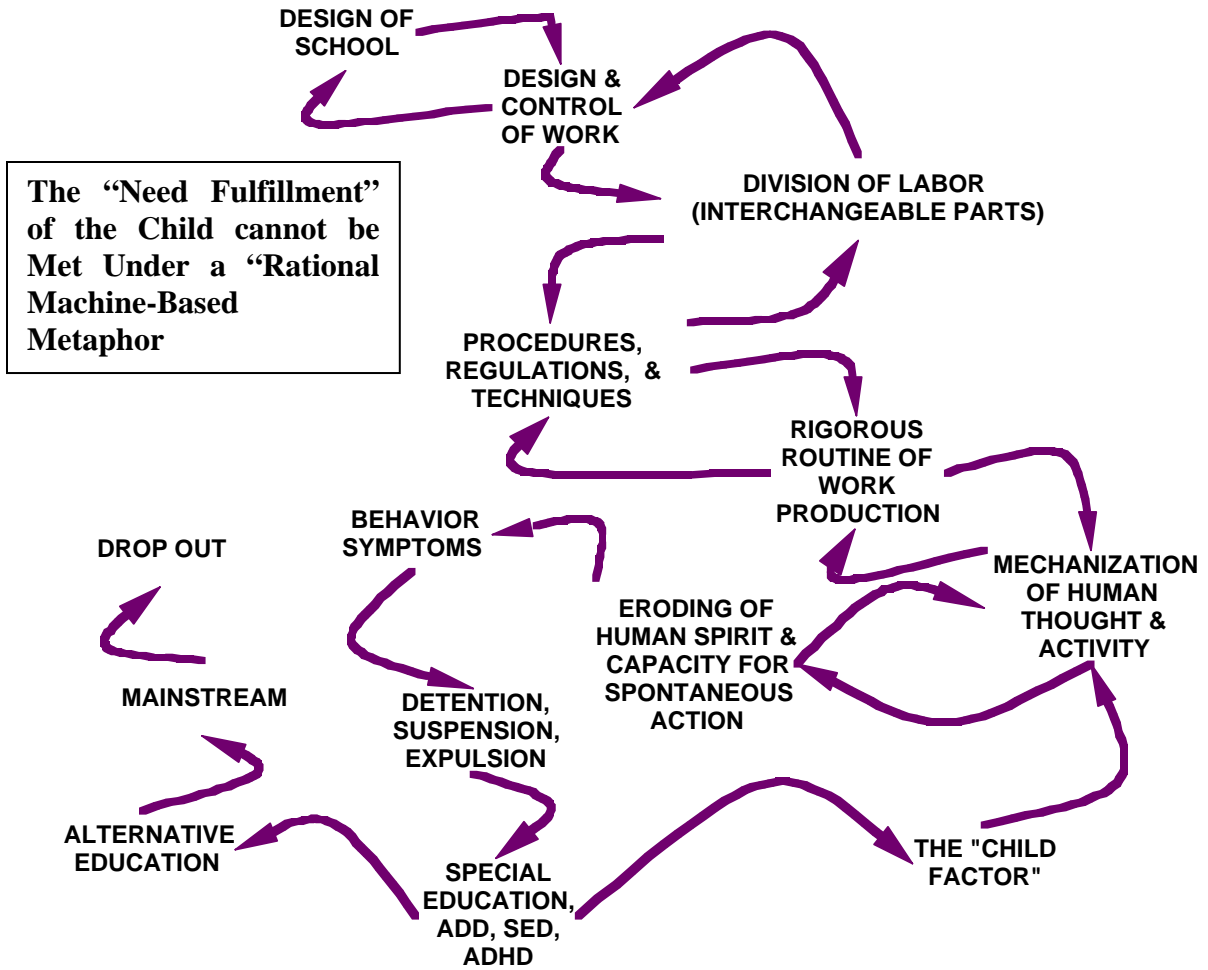


Figure 17. Mental Model #4: School as Machine plus the "Child Factor"

more regulations, procedures, and techniques. Detentions, Suspensions, Special Education and ultimately the Alternative School phenomena were designed to "control" "production." Unfortunately the "School Design" is not working. What evidence is there? The number of students in alternative schools is increasing. The dropout rate is increasing. Children that graduate without the basic skills to communicate, read, and perform simplistic calculations continue to increase.

## 4.5 THE AUTOPOIESIS PROCESS IN AN OPTIMAL LEARNING ENVIRONMENT AND ITS FACILITATOR

The ETCH Solution: How implementation of the Complexity Theory Hybrid can produce a considerably improved organizational system and leadership. As shown in Table 18, below, in order to understand the source and the solutions to modern problems, linear and mechanistic thinking must give way to non-linear and organic thinking, more commonly referred to as systems thinking.

**Table 18. Paradigm Shift to Optimal Learning Environment**

Paradigm Shift to Optimal Learning Environment				
	<u>Current Traditional Paradigm</u> <i>How present educational theory with its organizational structure and leadership is too linear, mechanistic, and reductionist</i>	<u>Educational Theory Complexity Hybrid</u> <i>How implementation of the theory can produce a considerably improved organizational system and leadership</i>		
	<u>Hierarchical leadership structure</u>	<u>Mechanistic organizational structure</u>	<u>Facilitator</u>	<u>Optimal Learning Environment</u>
<u>Autopoiesis - Processes</u> operating within the system	Impact on the Resultant patterns of observable leadership behavior described as the complexity universalities operate within the <u>hierarchical leadership structure and organizational structure</u>	Impact on the Resultant observable patterns of organizational structure behavior described as the complexity universalities operate within the <u>traditional organizational educational structure</u>	<b>Impact of Resultant Observable patterns of educational leadership behavior as <u>facilitator</u></b>	<b>Impact of Resultant Observable patterns of organizational structure behavior as the educational system operates within an <u>optimal learning environment</u></b>
<u>Dissipative Structure –</u> Processes of system interacting with its environment				
<u>Cognition –</u> processes of system adapting to change				

“The defining characteristic of a system is that it cannot be understood as a function of its isolated components. (True of the machine model) First, the behavior of the system doesn’t depend on what each part is doing but on how each part is interacting with the rest... Second, to understand a system we need to understand how it fits into the larger system of which it is part... (How the “school system” fits with the “child system”) Third, and most important, what we call the parts need not be taken as primary. In fact, how we define the parts is fundamentally a matter of perspective and purpose, not intrinsic in the nature of the “real thing’ we are looking at. (Kofman, and Senge, 1993, p27)

Raising the understanding of an optimal learning environment “should” nudge education theory to both align with the 21st century technology and vision, and create an environment where students thrive in a global, knowledge-based economy (Caine & Caine, 1997). Education has for many years, been stable, dwelling quite comfortably in an ordered state. However, recently, as has been discussed previously, there has been more and more interaction with the environment – more intensive media coverage, more concern from political and religious groups, more demands from business, more special needs to accommodate, and more impact from technology. All of these have *perturbed* the education system. Consequently, it is moving out of *stability* and into *disequilibrium* (Caine & Caine, 1997; Kiel, 1997).

However, although the education system is becoming more dynamic, there is no guarantee that the system will proceed through a *phase transition*<sup>79</sup>, a *bifurcation*,<sup>80</sup> and then emerge to meet the needs of our society, and therefore its children. (note to self: compare to cell example (intertwined in the purpose of the system) The movement does not guarantee that results will improve the system (Caine & Caine, 1997). The system merely adapts to the environment in which it actually finds itself, and not simply to the environment desired.<sup>81</sup>

Consequently, “perhaps” education can move toward creating an optimal learning environment for its students, known as the “the edge of chaos” in complexity language---but there are no guarantees.

#### **4.6 GENESIS OF A COMPLEXITY HYBRID THEORY: A PARADIGM SHIFT**

What is the alternative to the traditional paradigm with its linear history that no longer meets the progress demands to prepare students for the 21<sup>st</sup> century? The new mental model of my complexity hybrid depicts a system that allows the “Child Factor” (described in the previous section) to flourish---a student-centered system that creates an environment for the student to perform at optimal level. The fundamental reason to pursue complexity research is to link the systemic change processes in CAS to develop arguments for change mechanisms in the traditional education system as a whole.

“Schools are self-replicating, affected by interactions with the outside, and driven by what people think about information they receive, not purely by the content of that information in any abstract sense” “Because school systems have these characteristics, many of the principles used to understand other complex systems can be helpful in understanding school systems” (Lesgold, 2005).

Therefore, on a macro-level, when the traditional paradigm (described as separated and opposing in the traditional paradigm, shown in Figure 18, below) confronts a natural autopoietic process of living systems (without the constraint of the mechanistic, reductionistic, linear characteristics of the traditional paradigm), as shown in Figure 18, below, it is evident that the education system’s idealized and practiced goals, of a naturally autopoietic

process are synchronized into one ---the mission or goal is to create a student-centered environment for learning at optimal performance level.

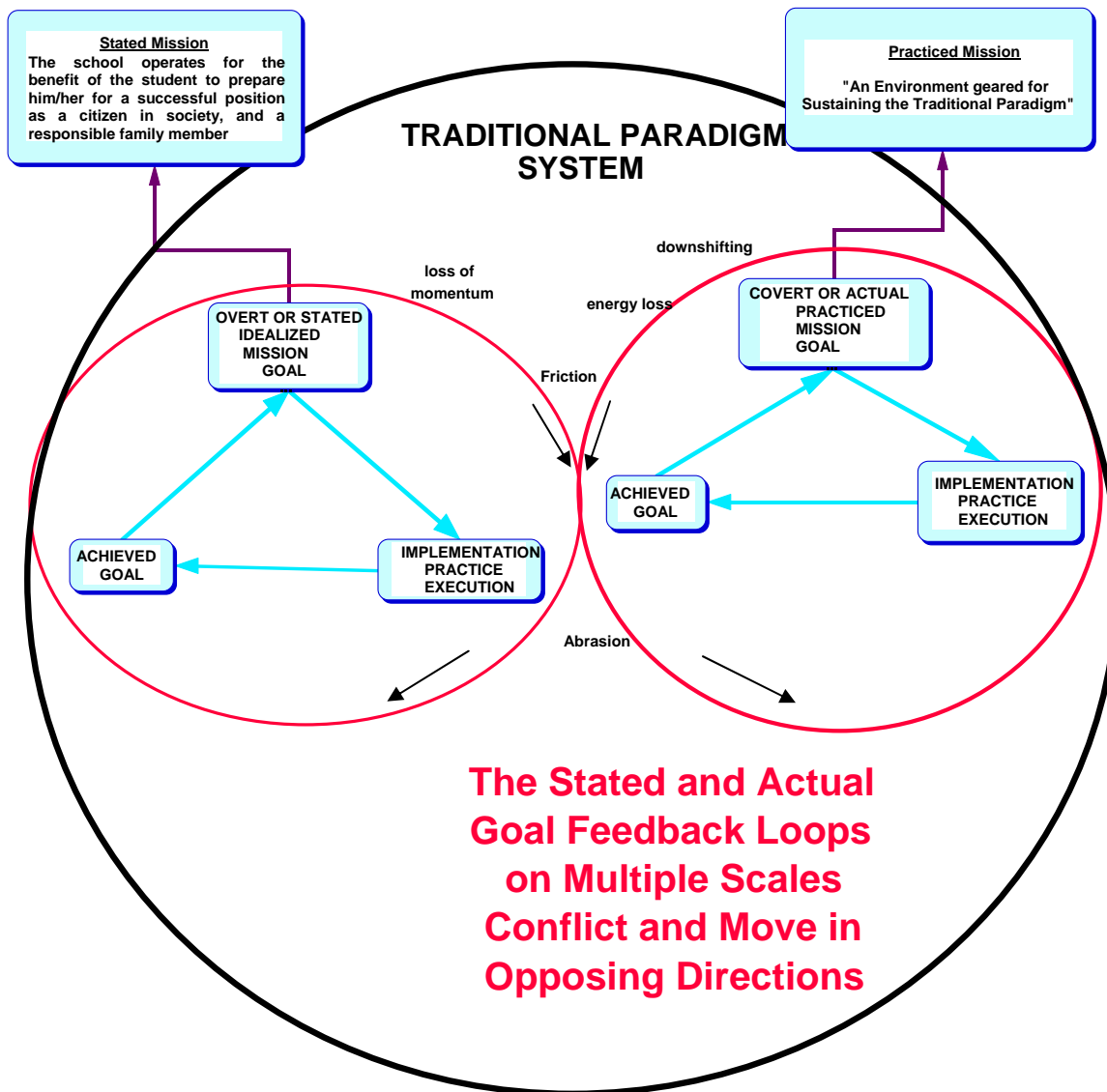


Figure 18. Traditional Paradigm System View

Unlike the present operating paradigm, there is no internal conflict, only a free flow of energy indicative of both change and stability. The agent receives resources, *adapts*, and sends

responding messages to other agents in the system. The system responds. This fuels the *interdependent* and *interconnective* aspects of the system. In the case of the student, through recurrent interactions, he/she will *structurally couple* not only to his/her environment but also internally to him/her-self, and thus bring forth not only an external, but also an *inner structural change* in his/her system (Maturana 1987) and effect the *patterns of connectivity* throughout his/her inner (personal) system. In other words this *internal structural coupling* produces the “self” or ego.

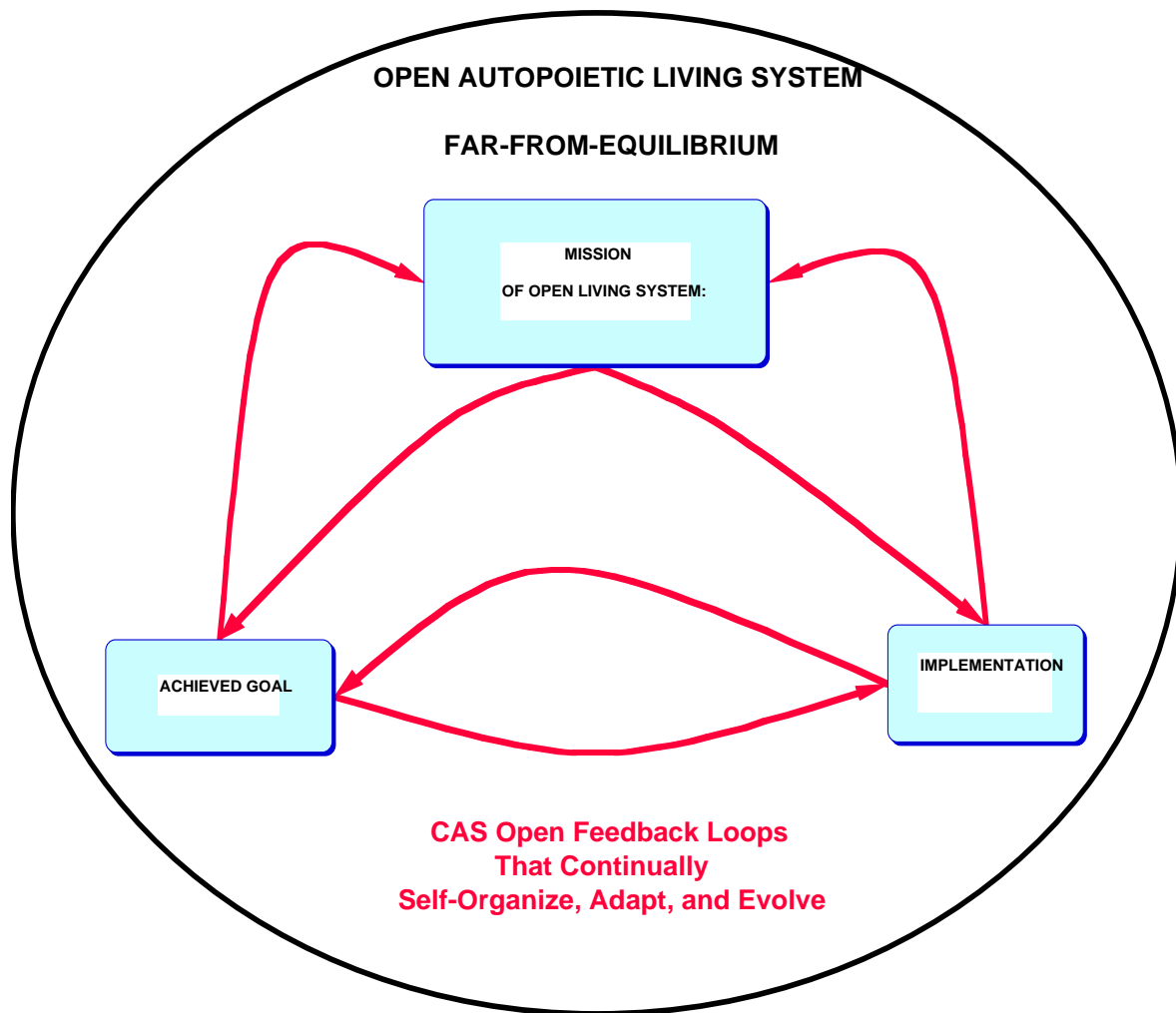


Figure 19. Open Autopoietic Living Education System



As a result the student is encouraged to think, not told what to think, and the student learns. When an optimal environment is facilitated, the student stretches his *structural coupling* to align with the system within which he takes part. The parts of the system, through mutual *structural coupling*, become part of each other's worlds as they communicate with one another and coordinate their behavior (Maturana 1987). The level of coupling in a system affects the amount of time required to propagate a change.

The Role of Facilitator in a Student-Centered Environment for Learning at Optimal Performance Level Requires a Paradigm Shift from Traditional Leadership Role to Leadership at the Edge of Chaos.

Review: To transform Education Theory to align with the ideas embedded in Complexity Theory and CAS requires a paradigm shift from the present traditional paradigm. For the educational practitioners, a reform shift would mean, a shift in basic ideas and beliefs that have governed education and the larger social system, and that penetrate all aspects of the system.

Understanding that the school/district is a whole and not a machine, isolated and insulated from the environment, now requires that fundamental truths about what makes the whole function be taken to task. Under the umbrella of Complexity Science, scientific understanding explains and applies the principles of system thinking<sup>82</sup> to the education system starting by accepting human beings as complex adaptive systems lying on the edge of the

continuous ability to self-actualize. Accepting Complexity Science requires understanding that a “something” is functioning at a deeper level that makes sense of the conflict and crisis in school systems, and that provides a handle on how to approach the enormous problems faced in today’s schools. It entails a process of coming to understand how systemic change takes place in school/districts both horizontally and vertically on and between levels of its system. It is a process with widespread love of learning that begins with formal education and continues long after formal education is over. “We cannot just rearrange the pieces in the box (**FIRST ORDER CHANGE**); we need – collectively – to conceive of what we do in fundamentally different ways (Caine & Caine, 1997).

As reflected in Table 19, below, this suggests a leadership that is comfortable with the concept and repercussions of change, process, system thinking, and the universalities embedded in Complexity Theory & CAS. Complexity theory and CAS are not reductionist, linear, or mechanical, and are not meant to yield generalizable models. Human beings are not machines. “To change fundamental beliefs means that human beings engage in that deeper type of learning (2ND ORDER CHANGE) that is capable of purposefully changing themselves” (Caine & Caine, 1997).<sup>83</sup>

**Table 19. Leadership Traits that Suggest Readiness or Paradigm Shift**

Leadership Traits that Suggest “Readiness” for a Paradigm Shift	<u>FROM</u> The Traditional Paradigm	<u>TO</u> The Complexity Hybrid Paradigm
<u>Positive</u> – Has security and self-assurance that view the environment as complex but filled with opportunity	<u>Is pessimistic about resolving problems and exploiting opportunities</u> Do not stretch beyond their school or district’s transition limits. Even though some new variable is tested	<u>Predisposed toward opportunities both inside and outside the organization</u> Demonstrate personal “resilience” to engage and sustain the various initiatives necessary to succeed in the market place
<u>Focused</u> – has a clear vision of what must be done to prosper	<u>Scatters efforts in unrelated directions</u> Often thinks 1 <sup>st</sup> order change will accomplish what only a 2 <sup>nd</sup> order transformational, transitional passage can achieve. (Display a tendency to drive toward transition outcomes under the mistaken assumption that the destination they seek is a terminal objective. The transformational nature of a transition is missing. Often what occurs is insignificant movement within existing confines)	<u>Remains attentive to the more critical objectives</u> Possesses the ability to diagnose and identify explicitly what to do when the danger signal is triggered, and how to protect or regain a fit status.  Creates a work environment that promotes fast, effective adaptation to disruptions

Leadership Traits that Suggest “Readiness” for a Paradigm Shift	<b><u>FROM</u></b> The Traditional Paradigm	<b><u>TO</u></b> The Complexity Hybrid Paradigm
<p><u>Flexible</u> – has creative ability when responding to uncertainty</p>	<p><u>Closes itself off from new information and innovative possibilities</u> Believes that uncertainty is to be ignored or denied</p> <p>Stability is sought as the ultimate bulwark against anxiety, which might otherwise become overwhelming</p> <p>Believes that the organization is entirely predictable, and good management should be able to get similarly reliable performance from the organization Believes that factors, targets, organizational structures need to be nailed down</p> <p>Believes that organizational transitions should unfold in an incremental fashion, where innovation is relatively sequential in nature</p> <p>Often fails to recognize when an old viewpoint or operating procedure has completed itself and a new one requiring a fresh paradigm should be started.</p> <p>Does not act decisively. Sometimes decisions appear to be made in a way that confuses people or leaves doubt about priorities</p> <p>Leaders flounder, during formalization, because they either, won’t act without a general consensus, or they go to the other extreme, and fail to adequately involve others in making sound judgments.</p>	<p><u>Displays pliability in the variety of information they consider when making decisions and considering the possibilities they create</u></p> <p>Requires the leader to be intuitive, innovative and is able to spot emergent strategies --- all without recourse of analytic crutches (Kupers, 2001)</p>

Leadership Traits that Suggest “Readiness” for a Paradigm Shift	<b><u>FROM</u></b> The Traditional Paradigm	<b><u>TO</u></b> The Complexity Hybrid Paradigm
<u>Organized</u> – structures approaches to manage ambiguity	<p><u>Fails to see and create patterns that can guide actions</u></p> <p>Is intolerant of ambiguity</p> <p>Does not recognize various trends and events, inside and outside their organization, that are likely to influence its future</p> <p>Believes that the management task is the enunciation of mission, the determination of strategy, and the elimination of deviation</p> <p>Believes that the board should preside over a cohesive management team with a vision or strategic intent supported by a common culture</p> <p>Believes in long-term planning, strategic management that includes tasks of goal formation, environmental analysis, strategy formulation, evaluation and implementation and strategic control</p> <p>Becomes intrigued with tactical change and fail to provide the organization with adequate “navigation” for the more strategic transition, or they err the other way around and leave a tactical guidance void. As a result, they are vulnerable to either providing too little specific guidance about the changes that are necessary or imposing too much direction and not enough latitude</p>	<p><u>Is able to structure the ways data and information is interpreted.</u></p> <p>Optimizes the life span of the primary “operating paradigms” the school/district relies on to perform at optimal level.</p>

Leadership Traits that Suggest “Readiness” for a Paradigm Shift	<b><u>FROM</u></b> The Traditional Paradigm	<b><u>TO</u></b> The Complexity Hybrid Paradigm
<p><u>Proactive</u> – engages change rather than defending against it</p>	<p><u>Waits for certainty before acting</u> When faced with new and significant challenges, does not identify which factors are affected or they cannot determine how to alter them in order to maintain alignment with the new requirements for success</p> <p>Believes that the dynamics of “group think” and the possible effect of divergence on promotion or even survival within the organization are potent pressures for conformity</p> <p>Believes that re-examination of cherished assumptions is unnecessary</p> <p>Tends to under perform when attempting change, and they fail to successfully orchestrate their broader transitions</p> <p>Do not have a clue as to what factors go into determining “<i>adaptation limitations</i>” and lack an understanding of the ramification of extending beyond the borders of what can be done to heighten the organization’s absorption level.</p> <p>Does not appreciate the struggle between the accelerating “transition demands” taking place and the diminishing “resources” (capacity available to help organization adapt to these disruptions)</p> <p>Does not prepare people for change. Rather, these leaders are camouflaged with plenty of macho posturing and solid dose of “I-know-we-can-do-it” motivational hype. The hope is that, through all this, individuals will somehow come up with the heroic effort needed to make it all work.</p>	<p><u>Builds implementation plans around their new ideas and eagerly tries new approaches</u></p> <p>Understands and conveys, meaningfully, the critical “change” priorities</p> <p>Exhibits and propagates a “mind-set” about “how” change should be addressed</p>

The energy that facilitators must provide to generate the power and precision of laser-sharp performance (Kelly & Allison, 1999) requires:

1<sup>st</sup> – A shift in both arenas---viewing the world and therefore the education system as simple, predictable, and settling to equilibrium, and acknowledging that both are complex, unpredictable, and far from equilibrium

2<sup>nd</sup> – A shift from viewing head-to-head competition as the key force shaping the school district/ecological community, to recognizing that each district/school and ecological community is a complex dynamic system in which competition is just one of the many factors that influence the life of the community

Facilitators that *structurally couple* to the system they lead and its surrounding environment, require tools unavailable through present traditional management theory designed for the industrial revolution. This type of facilitator has experienced a fundamental shift from the traditional mental models and execution strategies of many present leaders.<sup>84</sup> Therefore, if the attributes of facilitators are lacking, it is impossible to create a work environment throughout the rest of the organization that fosters an ETCH culture and structure. Consequently, a non-linear organizational world, embraces a facilitator that possesses traits/characteristics/attributes with the courage to operate in 2<sup>ND</sup> ORDER CHANGE, shown in Table 20, below, uncharted waters, and the wisdom to know there are no alternatives.

**Table 20. Leadership and 2nd Order Change <sup>85</sup>**

Chapter 3 of Dissertation The Traditional Paradigm  Change is Thrust on Schools			Chapters 4-5 of Dissertation  <b>A COMPREHENSIVE ALTERNATIVE: BUILDING THE EDUCATION THEORY COMPLEXITY HYBRID</b>  <b>Requires Change of System Not Within System</b>	Chapter 6 of Dissertation  PARADIGM SHIFT TO OPTIMAL LEARNING ENVIRONMENT  <b>Requires System Redesign</b>
<u>1<sup>ST</sup> ORDER CHANGE</u> Form: Reaction to symptoms and focus on surface change.			<u>2<sup>ND</sup> ORDER CHANGE</u> <b>Form:</b> Engage system holistically and focus on fundamental change	
Piecemeal Change	Incremental Change	Systematic Change	Systemic Change Is holistic not reductionist, dynamic not linear, a critical process not mechanical, and individually and locally relevant not generalizable	
“Once and done”	Make what exists more efficient and effective without disrupting the basic features	Make results generalized to a larger context		

Therefore rather than setting goals and setting the route to reach them, as would occur in 1<sup>ST</sup> ORDER CHANGE scenarios, the facilitator will now create conditions to nurture creativity rather than direct that creativity. Creativity is more likely to be enhanced rather than stifled.

“Once we start thinking of strategy as an emergent phenomenon, you realize that we have often attacked the wrong end of the problem” wrote strategy consultant Gary Hamel 1998 “Strategists and senior executives have too often worked on the “the strategy” rather than on the preconditions that could give rise to the strategy innovation...Order without careful crafting – I’d like to suggest that this be the goal of strategizing.” (Lewin, 1999)



Hardy with a steady hand at the helm (Conner, 1998), these facilitators possess the ability to diagnose and identify explicitly what to do when a danger signal is triggered, and how to protect or regain an ETCH operating system. Therefore leading at optimal performance level (“at the edge of chaos”) requires a leadership that is intuitive, innovative, and is able to spot emergent strategies---all without recourse of analytic crutches (Kupers, 2001). Additional skills/traits/attributes (distinguishing qualities) of an educational facilitator at the edge of chaos include:

- A keen understanding of the reasons the board identified certain changes as imperative to the school’s/district’s future, as well as the precise consequences, for the school/district, if these efforts should fail.
- A match between the facilitator’s ability to execute school/district change and the “magnitude of change” the school/district is currently experiencing, as well as the change-related pressure the school/district will confront in the next few years
- A demonstrated ability for mastery-level competence in the dynamics of change.
- A sufficient demonstration of personal “resilience” to suggest the facilitator can sustain the change-related challenges that will arise while in the position
- An ability to operationalize the knowledge and skills necessary to optimize the shelf life of the various organizational paradigms in place when hired, as well as those that will be developed in the future
- A capacity to create the proper working environment that will allow individuals to be hired and managed in such a way as to maximize optimal performance level.
- During change, a facilitator models resilience. Data from several thousand individuals indicate that resilience and leadership go hand-in-hand. There is a positive relationship between an individual’s strength in resilience characteristics and his level in the organization – the higher the leadership position, the more resilient over individuals at lower organizational levels, even after taking into account such elements as age and education.<sup>86</sup>

Often leadership in an interrelated, interconnected larger system, where many players are all *adapting* to each other, and where emerging future is extremely hard to predict, had originated in the mechanistic/linear/ reductionistic paradigm, as described in Table 21, below. These present traditional leaders, who rigorously hold on to the fundamentals of traditional

mechanistic, reductionistic, linear thinking that stress status-quo,<sup>87</sup> are frequently at odds with complexologists, who embrace the tenets of complexity theory, and the notion that the education system is a nonlinear, open, thermodynamic, complex adaptive system. These two groups speak profoundly different languages and profess different assumptions and meanings (Conner, 1998).

Rather than the more mechanistic cause-effect models of learning complexity theory suggests a viewpoint driven by basic properties of complex systems as shown in Table 21, below, Autopoiesis, Dissipative Structure, and Cognition in which these universalities emerge and interact with agents in observable patterns of behavior. Traditional values and assumptions about education are challenged by CAS reflected values and assumptions about education. Each materializes in patterns of behavior on several fronts as Table 21, below, reflects.

**Table 21. Assumptions about Education Practice**

	<u>Traditional Mental Model Values and Assumptions about Education</u>	<u>CAS Reflected Mental Model Values and Assumptions about Education</u>
Patterns of Behavior in Educational Practice	<p>“Provide instruction and the child will emerge ready to join the work force of society” (Stacey 1995)</p> <p>Educational practice is the result of an <u>unchanging set of underlying beliefs</u>. Acting on those beliefs means that the system is internally designed to function in a particular way, irrespective of how much additional activity there is, and irrespective of how meaningless or ineffective it might be</p>	<p>Prepare citizens for the rapidly changing and increasingly complex world of the 21<sup>st</sup> century (J Lemke, 2002)</p> <p>Education Practice reflects the mission and vision of the school district <u>Interactive/Interconnected Parts</u> (Sources, Users of information, Material, and Human Resources) are tightly enough coupled and interdependent in their behavior that they must be included within the system. Examining all the source institutions that contribute to students' understanding of particular topics within the formal curriculum. Included are informal educational institutions such as science museums and information sources and learning sites afforded by mass media, print publishing, and interactive communication technologies</p>

	<u>Traditional Mental Model Values and Assumptions about Education</u>	<u>CAS Reflected Mental Model Values and Assumptions about Education</u>
	<p>There is <u>increasing public concern</u> about whether the U.S. educational system as presently constituted, has the sufficient institutional flexibility and resilience to adequately prepare citizens for the rapidly changing and increasingly complex world of the 21<sup>st</sup> century (J Lemke, 2002)</p>	<p><u>Impact of Timescales</u> on institutions and their practice The longest timescales experienced by students within the system, extend their definition to consider pre-school education, post-graduate study, and continuing adult education, as all part of the cognitive learning process</p>
	<p>The <u>role of high-stakes standardized testing and assessment schemes</u> pull the system toward behaviors that maximize test results rather than deep conceptual understanding (unless, of course, these are the same)</p>	<p><u>Catalytic Cycles</u> High-stakes standardized testing and assessment schemes used for assessment could be optimal for both the purposes of diagnosing and providing feedback on learning to individual students, and for the purposes of comparing overall performance of programs, schools, districts, and states, or colleges and universities (J Lemke, 2002)</p>
<p><u>Patterns of Behavior in Learning Structure:</u></p>	<p><u>Faulty notions about how children learn:</u> The way schools, classrooms, and learning are structured and operated are based on faulty notions about how our world and the individuals that inhabit it actually work</p>	<p><u>Interactive/Interconnected Parts</u> (Sources, Users of information, Material, and Human Resources) are tightly enough coupled and interdependent in their behavior that they must be included within the system. The student examines all the sources that contribute to his/her understanding of particular topics within the formal curriculum. Included are informal educational institutions such as science museums and information sources and learning sites afforded by mass media, print publishing, and interactive communication technologies</p>
	<p><u>Present policy formation and execution infiltrated by the traditional paradigm:</u> Mechanism, Reductionism, and Linearity culminate to form the educational theoretical foundation, which has strongly infiltrated present policy formation and execution</p>	

	<u>Traditional Mental Model Values and Assumptions about Education</u>	<u>CAS Reflected Mental Model Values and Assumptions about Education</u>
	<p><u>Channels for Interaction:</u> In complex systems of many kinds that system behavior is limited because some elements are decoupled from others; interactions that might otherwise be expected to occur are blocked or strongly buffered.</p>	<p><u>Coarse and Fine Grain Scaling</u>            Defining the <u>significant levels of the school/district</u>, not simply or primarily in terms of lines of authority (control hierarchies), but in terms of characteristic structures, characteristic emergent processes, and patterns at each level.            Explores resource constraints and decision-making bodies---school boards, trustees, and state education authorities.            The role of researcher and teacher expands to include the interconnected relationship between research institutions and the communities which make use of research results.</p>
	<p>It is a common phenomenon in complex systems of many kinds that system behavior is limited because some elements are decoupled from others. Interactions that might otherwise be expected to occur are blocked or strongly buffered. Examples of this in the present educational system include teachers who <u>tend to be isolated</u> by the structure of schooling from significant professional contact with other teachers in their field. This applies not only within the school, but more widely, with teachers in other fields and even with colleagues in the same school who teach the same students on the same day.</p>	<p><u>Networking/Interaction/Interconnection.</u> To-date: there are existing research programs that have examined inter-disciplinary curricula and cross-age tutoring. This research can provide valuable data and perspectives for models of educational change that focus on creating new <i>couplings</i> between existing system components. Researchers studying the many experiments in integrating community study and workplace participation with academic learning can contribute to understanding this dimension of potential system change. Each offers an opportunity to unleash educational change by providing a new channel for interaction</p>

	<u>Traditional Mental Model Values and Assumptions about Education</u>	<u>CAS Reflected Mental Model Values and Assumptions about Education</u>
	<p><u>Limited community interaction:</u> Schools today have very <i>limited and controlled forms of interaction with the surrounding community and even with students' families</i>. Even young adult students in our society are not encouraged or given significant opportunity to take on real responsibility or experience the satisfactions of making real contributions to the wider community</p>	<p><u>Open dissipative structure:</u> Students benefit greatly from more contact with a wider variety of adults who can help them with their studies. The diversity of people filling the formal role of teacher in our schools, or our colleges, is far less than that of the community or population as a whole, in many ways, including many ways irrelevant to their ability to assist a student. <u>Effects of shifts in the definitions of roles and the distribution of the kinds of people filling them</u> In the case of teachers, new definitions of teachers' changing professional roles, and the kinds of preparation and training appropriate to such new roles.</p>
	<p><u>Internal barriers:</u> Within the school, two classic forms of segregation barriers contribute: those between disciplines and those between grades.</p>	
<p><u>Patterns of Behavior in Educational Reform Initiatives:</u></p>	<p><u>Initiatives without purpose:</u> Educational reform initiatives are missing a clear, coherent sense of purpose, including a how-to-proceed action plan, and are often characterized by faddism, superficiality, confusion, unwarranted and misdirected resistance, and consequent failure</p>	
	<p>Educational reform initiatives are confronted with deeply entrenched mindsets in the schools</p>	
	<p>Schools are part of the education system which in turn is part of a larger system that is grounded in similar ways of thinking –a paradigm that is reinforced through present educational policy execution.</p>	<p><u>Emergence:</u> The method of how information is transformed, filtered, re-organized, and added to from level to level. The types of material resource and information flows connect adjacent and non-adjacent levels. Information-overload can be avoided by emergent systems' pattern-recognition that extract from large data-flows only what matters for the dynamics of the next higher level</p>

	<u>Traditional Mental Model Values and Assumptions about Education</u>	<u>CAS Reflected Mental Model Values and Assumptions about Education</u>
	This unchanging set of underlying beliefs has also seeped into the individual (agent) level, and flourishes in the development of the mental models held by education leadership – a leadership that cycles to create the policy design and execution that in turn limits optimal learning potential for the student	
	Changing those fundamental beliefs is at the heart of a deeper type of learning which has the capability to change the individual	
	Where students are not encouraged to think, but told what to think.	

#### 4.7 SUMMARY:

##### *On the Autopoietic Educational Organizational level*

- The school/district would operate within a sphere of incessant novelty/creativity to design and deliver more creative solutions for its school/district, and to structure itself to exploit the energy created by its creative atmosphere. ( In fact many systems achieve their greatest performance when they are in a state of appropriate disequilibrium and on the edge of losing control ---at the edge of chaos)
- The school/district would seek resilient competent individuals/agents who accept frequent reassignment of their duties and perpetual reordering of their priorities as the norm

##### *On the Autopoietic Facilitator Level*

- The facilitator would have a keen understanding of the reasons the board identified certain changes as imperative to the district’s future, as well as the precise consequences, for the district, if these efforts should fail.
- The facilitator would have an ability to operationalize the knowledge and skills necessary to optimize the shelf life of the various organizational and operating paradigms, as well as those that will be developed in the future which the district relies on to perform its work

- The facilitator would have an ability to model and demonstrate “resilience” to engage and sustain various initiatives necessary for optimal student achievement. There is a positive relationship between an individual’s strength in resilience characteristics and his level in organization – the higher the leadership position, the more resilient over individuals at lower organizational levels, even after taking into account such elements as age and education.<sup>88</sup>
- The facilitator would have an ability to create an optimal learning environment that hires naturally resilient individuals who support the mission and vision of its system, and then provide the training coaching, and rewards to strengthen this quality to its fullest potential
- The facilitator would extend proper delegation as far down the organizational hierarchy as is feasible, and insists on empowered relationships around each individual in the decision-making chain
- The facilitator would create an environment that promotes fast, effective adaptation to change/disruptions

### ***On the Individual Level***

- Staff would demonstrate intuitiveness that goes beyond the guidance provided by the facilitator.
- Staff would demonstrate foresight that can contribute to emerging an ETCH school/district
- Staff would demonstrate vision of an ETCH environment, but knows much more than the facilitator about its fulfillment at a tactical level.
- Staff would demonstrate a predisposition for “resilience.”<sup>89</sup>
- Staff would require tough, high standards for the kind of behavior required to fulfill critically important initiatives
- Staff would insist that those who hold key positions in a change process in their area are trained and expected to perform in a manner that promotes success
- Staff would petition each person or team with implementation responsibilities for key initiatives to include in their plan of action an assessment of human barriers that could impede success and a description of how to plan to address these vulnerabilities

## 4.8 THE SCIENCE OF THE LIVING EDUCATION SYSTEM DISSIPATIVE STRUCTURE

System “STRUCTURE” is as important as AUTOPOIESIS (“pattern of organization” or “patterns of behavior”). Shown in Table 22, below, both materialize by the “interaction” between their components. By definition, a dissipative structure describes the system’s external behavior as it interacts with its environment in adaptation within its changing context (Kelly, 1999).

**Table 22. System Autopoiesis vs. System Dissipative Structure**

AUTOPOIESIS OR PATTERN OF ORGANIZATION	DISSIPATIVE STRUCTURE OR STRUCTURE
Defined: The Pattern of Organization/Behavior determines the “system’s identity” (its essential characteristics)	Defined: The Dissipative Structure is open to the outside and describes the system’s external behavior as it interacts with its environment in adaptation within its changing context. A living system’s pattern of behavior is a sequence of structural changes that determines the system’s behavior (Maturana, 1980 #362) through the flow through them (e.g. people come and go, inputs of energy, matter and information enter and after processing good, services or other products flow out)
Examples: Content/Curriculum Standards/Benchmarks Grading Certification requirements License requirements Scheduling & Attendance Requirements	Examples: Public Charter Religious State-licensed Alternative Independent



As shown on the right side of the table above, DISSIPATIVE STRUCTURES involve describing the system's actual physical components – their shapes, chemical compositions and so forth. The common denominator in both Conner's examples of dissipative structures listed below, and the examples of dissipative structures in the table above, is that each entry is really the conduit between the (internal) autopoietic part of the system and the external environment. Each is an example of information or energy flowing both within the system and between its components and the system's environment, maintaining its living state. In social systems, Daryl Conner exemplified dissipative structures to include:

- The way people are hired
- How new customers are secured and current customers are served
- How technology is used
- The way a company is perceived when compared to its competition
- The way the organization is “structured”
- How it utilizes “technology”
- The various ongoing “processes” that influence day-to-day operations

It became possible to integrate these two traditions of systems thinking – the patterns of organization (Autopoiesis) and structure--- into a coherent Theory of Living Systems<sup>90</sup> (Capra, 1996). In other words, the *physical embodiment* of the education system's ability to interact as a “web of connections” (pattern of organization-Autopoiesis) integrated with its external environment, describes the education system as a “dissipative structure” or a “structure of living systems”<sup>91</sup> (Prigogine, 1967).

### **Structure**

The “Structure” of a living system is the physical embodiment of its organization and is constituted by the actual relations among those physical components. To understand the properties of the components and their physical interactions, a description of the system's structure in

the language of physics and chemistry must be added to the abstract description of its organization (Capra, 1996, p 158).

#### **4.8.1 Open Dissipative Structure Systems**

Holistically, the dissipative structure component of a system is an *open interactive relationship with its environment*, where each has influence on the other as shown in Figure 20, below (Merry).<sup>92</sup> Unpacked, as shown in Figure 20, below, this means that through the interactive physical boundaries of a system's self-organizing, autopoietic pattern of behavior, (in terms of specific physical shapes, chemical compositions, etc),<sup>93</sup> and structurally coupled to the external environment, an open, self-organizing system is open to and uses energy, material, and feedback (information) far-from-equilibrium (Kelly & Allison, 1999). Examples include a cell within the human body, and weather (Kelly & Allison, 1999).<sup>94</sup> Due to these internally and/or externally driven "changes" (modifications), the system is always in some stage of development with a shape that is constantly changing.

## Open Thermodynamic

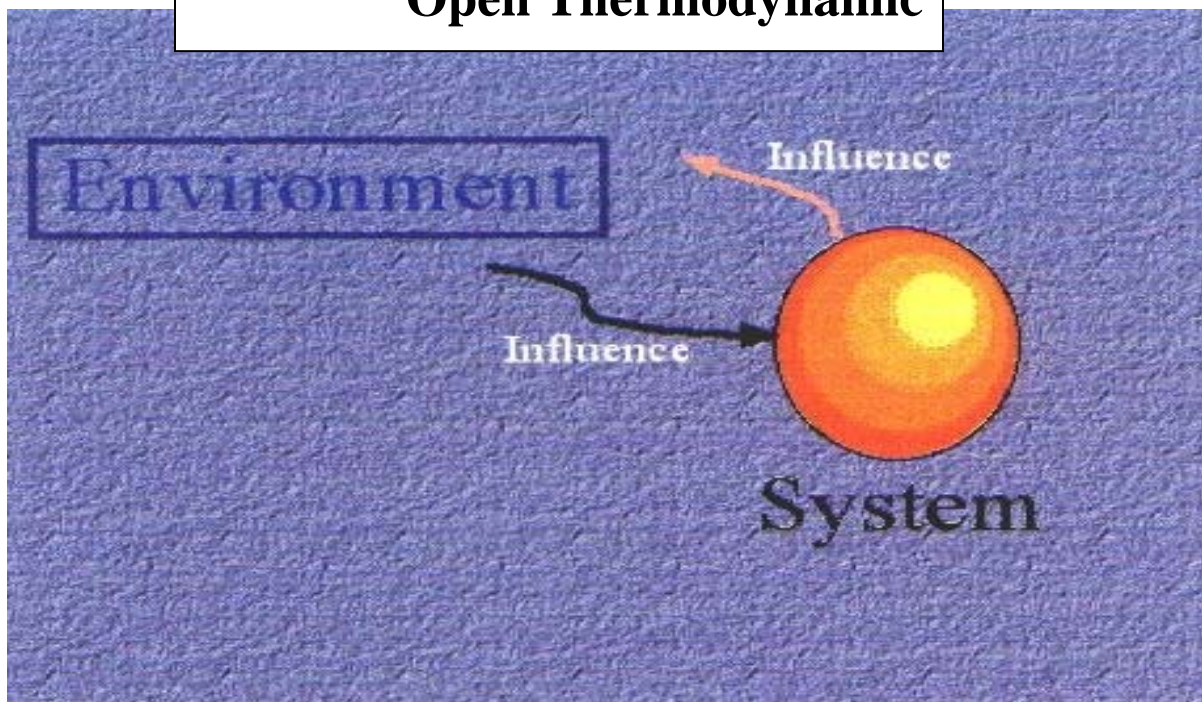


Figure 20. Open Thermodynamic Systems <sup>95</sup>

Prigogine's detailed analysis showed, as shown in Figure 21, below, that systems are dissipative structures as long as this steady flow from the environment through the structure continues<sup>96</sup> (Prigogine, 1967). The principles describing dissipative structures underlying Prigogine's scientific experiments are clear as shown in the flow-diagram below.

- That the system must be in a flow
- That it must be *fed initial reactants and allowed to discharge its final products.*
- That it must have *sufficient complexity of structure to persist in two or more steady states* when the values of the parameters – the boundary conditions – are suitably varied (i.e. it must have bi-or multi-stability)
- and last but not least, that the structure of the system must be *maintained in the flow by feedback loops and catalytic cycles* (Laszlo, 1996) As the Brusselator and other theoretical and experimental models demonstrated the *crucial property of "catalytic cycles" is their ability to act as self-balancing*

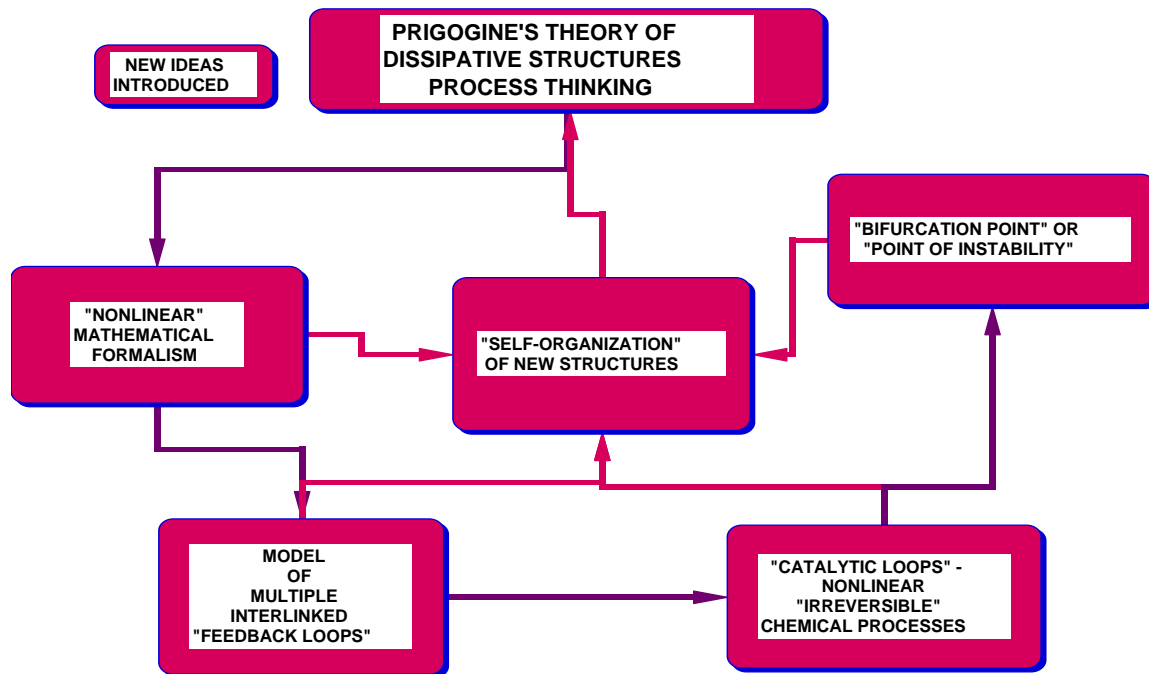


Figure 21. Prigogine's Theory of Dissipative Structures

However, the open flow of resources from an environment external to the system does not suggest that the structure of a system is not determined by external forces. In reality, it is formed by a succession of autonomous structural changes in its own structure. And the fact that the behavior is structure-determined also does not suggest that it is “predictable.” The organism’s structure merely “conditions the course of its interactions and restricts the structural changes that the interactions may trigger in it” (Capra, 1996).

#### 4.8.2 Dissipative structures are living and non-living

Although the structure of a living system is always a dissipative structure, not all dissipative structures are autopoietic networks (Maturana, 1988), as shown in Table 23, below. Classical thermodynamics lead to the concept of “equilibrium structures” such as crystals.<sup>97</sup> Bernard

Cells, Chemical Clocks (see endnote #9). However, Maturana and Varela found that a dissipative structure could be living or a nonliving system. Both types of systems (living and non-living) are built of components that interact, are mutually dependent, and mutually affect each other (Merry).

**Table 23. Non-living and Living Dissipative Structures**

Non-living Machine	Living system
In a machine such as a bicycle the parts have been designed, manufactured, and then put together to form a structure with fixed components.	<ul style="list-style-type: none"> <li>* The components change continually. There is a ceaseless flux of matter through a living organism. Each cell continually synthesizes and dissolves structures and eliminates waste products. Tissues and organs replace their cells in continual cycles.</li> <li>* There is growth, development and evolution.</li> <li>* From the beginning of biology the understanding of living structure has been inseparable from the understanding of metabolic and developmental processes (Capra, 1996)</li> </ul>

For example, the Bernard Cells and Chemical Clocks<sup>98</sup> studied by Prigogine, and crystals are dissipative structures but not living systems (Maturana, 1987). Crystals are dissipative systems because they are formed and maintained by the exchange of energy between the system and its environment and because they disappear if that exchange ceases (Prigogine, 1967). They live in symbiosis with their environment (Claessen, 1977). Benard cells, a non-living dissipative structure, also occurs in nature, like the flow of warm air from the surface of the earth toward outer space may generate hexagonal circulation vortices and leave their imprints on sand dunes in the desert and on arctic snow fields (Laszlo, 1987). The forces involved in “dissipative structures” organize everything from the way turbulent liquids flow, to how clouds curl up in the sky (O'Regan), to how whirlpools,<sup>99</sup> hurricanes, tornadoes, and thunderstorms can maintain their stability.

Similarly, a living Dissipative Structure, such as an organism, also requires a continual flow of air, water, and food from the environment through the system in order to stay alive and maintain its order. However, a living system is determined by its *pattern of organization and its structure*. This means, as shown in Table 24, below, that a living system is both structurally *open (Prigogne’s dissipative structure)* and *organizationally closed (Maturana’s self-organization)*. Matter continually flows through it, but the system maintains a stable form, and it does so autonomously through self-organization.

**Table 24. A Living System is a Combination of Autopoiesis and Dissipative Structure**

<b>Self-Organization “Autopoiesis”</b>	<b>Dissipative Structure</b>
<b>The Study of “Pattern” (or form, order, quality)</b>	<b>The Study of “Structure”</b> (substance, matter, quantity or the physical components)
A set of relationships among processes of production	Can be understood only in terms of metabolic and developmental processes
<b>Internal &amp; Closed in nature</b>	<b>Environmental and Open in nature</b>

#### **4.8.3 Universalities operational in Dissipative Structures**

Dissipative Structures, similar to the Autopoiesis process, also exhibit complexity theory universalities, as identified and defined in Table 25, below. In order to understand how the education system interacts, a description of the system’s structure as identified from physics and chemistry must be coupled to the abstract description of its organization (autopoiesis). The Science of Complexity identifies additional universalities that operate under the dissipative structure umbrella and include:

- open thermodynamic system quality
- system history

- nonlinearity
- far-from equilibrium (non-equilibrium)
- perturbation and bifurcation
- competition and cooperation
- interdependence and interconnectedness
- evolution
- adaptability
- scaling/multiple scales or coarse and fine graining
- randomness, uncertainty, and unpredictability
- evolution of co-evolution

**Table 25. Universalities Found in Dissipative Structures**

Components of Dissipative Structure	Universalities or Laws of Complexity Description
Open Systems	<ul style="list-style-type: none"> <li>• The boundaries of the system permits interaction with its environment. Because a CAS and its agents are open systems, transformation occurs across the system’s external boundaries.</li> <li>• While in this state of complex stability, the organized state carries information that assures its survival and reproduction.</li> <li>• An open system is permeable to influence, is unpredictable, and its behaviors are dependent on context</li> <li>• Due to internally and/or externally driven “changes” (modifications), it is always in some stage of development</li> <li>• The more diversity imbedded in organizational components, the less likely the organization will shut out information; the more sensitive the organization is to the changing nature of customers; and the more the organization is able to compete effectively (Kelly &amp; Allison, 1999).</li> </ul>
System History	<ul style="list-style-type: none"> <li>• An organism’s structure at any point in its development is a record of its <i>previous structural changes</i>. Its history of <i>structural coupling</i> will determine the new pathways that become available.</li> </ul>
Nonlinearity	<ul style="list-style-type: none"> <li>• Are typified by the potential for disproportionate or exponential relationship between variables, where small change in one variable may produce highly disproportionate effects in variables systemically connected to the changed variable.(Kiel, 1997 #146)</li> <li>• This pattern is exacerbated because CASs depend on iterative processes. They repeat the same processes over and over again. The output of a previous process becomes the input for the next one. Iteration magnifies the effects of the nonlinearity, so that simple causal relationships are virtually impossible to detect, to measure, control, or evaluate</li> </ul>

Components of Dissipative Structure	Universalities or Laws of Complexity  Description
Far-from-equilibrium	<ul style="list-style-type: none"> <li>• Described by the sudden leaps (points of instability) of interaction (that become more active and unpredictable) between the system and its environment that intersperse over relatively extended periods of stasis. (Prigogine and Stengers 1984)</li> <li>• As information is brought in, this increases the system's state of disorder, 'far-from-equilibrium', and the system begins to renew its own structures, hopefully resulting in strategies for collective action or the emergence of subgroups developing a coping strategy(White, 2001 #127).</li> <li>• Sociocultural systems exist in dynamic states far from thermal and chemical equilibrium (Laszlo #169).</li> <li>• The leaps (points of instability) into new steady states are called <i>bifurcations</i>. Periodically, the effect of many perturbations over time accumulates, and the affected entity – the business – must reorganize significantly to sustain itself in the new context (Kelly, 1999 #147). This coordinated activity and shared interpretations are, in part, self-generating as they influence each other in the process. Energy and information are drawn in to keep the system in a state of ongoing flux. At a point of discontinuity, flux takes on an ordered pattern. (White, 2001 #127)</li> </ul>
Perturbation and Bifurcation	<ul style="list-style-type: none"> <li>• When a living system reaches a bifurcation point it is unpredictable. Its history of structural coupling (fine or course grained), and various external conditions determine if the structure breaks down or breaks through to a new state of order.</li> <li>• Mathematically is the dramatic change of the system's trajectory in phase space</li> </ul>
Competition and Cooperation	<ul style="list-style-type: none"> <li>• Competition is part of the picture, but only a part. Cooperation and building mutually beneficial networks is important too</li> </ul>
Interdependence and Interconnectedness	<ul style="list-style-type: none"> <li>• Many CASs are driven by a large number of interdependent variables (Kelly, 1994 #0). These variables (individuals, groups, institutions) are related to each other, and influence each other's behavior in complicated and unpredictable ways---known as coupling. The complex interdependencies of these variables (agents) emerge into new and unexpected system-wide behaviors. The interdependent agents of a CAS are transformed and transforming in their interactions(Eoyang, 1993 #452)</li> <li>• These systems demonstrate cross-current causality, which. Kontopoulos (1993) describes as heterarchy, saying that their structures lie somewhere between the extremes of anarchy and hierarchy</li> </ul>



Components of Dissipative Structure	<p style="text-align: center;">Universalities or Laws of Complexity</p> <p style="text-align: center;">Description</p>
Scaling/Multiple Scales or Coarse and Fine Graining	<ul style="list-style-type: none"> <li>• A CAS functions simultaneously at many different scales of organization (West &amp; Deering, 1995)</li> <li>• Individual agents take relatively independent actions; various groupings of agents emerge in the dynamical course of events; and the system as a whole exhibits identifiable behaviors---behaviors that in each domain are both similar to and different from behaviors of the others.</li> <li>• An individual child may reflect the tension felt in an entire school, groups or gangs may form in response to this tension, and rumors may move through the faculty in response to specific incidents. Each of these domains is intimately associated with the others and exhibits both similarities and differences from them. ((Eoyang, 1998 #451)</li> <li>• Traditional evaluation systems are not designed to deal with self-similarity or the radical emergences that are evident in scaling phenomena of CASs ((Eoyang, 1998 #451)</li> </ul>
Uncertainty, Randomness, and Unpredictability	<ul style="list-style-type: none"> <li>• Given the complex interdependencies of a CAS, its exact state at some future time is unknowable.</li> </ul>
Evolution of Co-evolution	<ul style="list-style-type: none"> <li>• Co-evolution is the process of multiple populations of agents adapting to each other. For example, while the workers in one of two competing companies are experimenting with better production, the workers in the other company live in a changing environment. Their efforts to adapt may change the context of improvement efforts in the first company. This can lead to perpetual novelty for both sides. The system may never settle down (Axelrod, 1999). Co-evolution alters both the system and the ways the systems interact. In addition the very process of Co-evolution itself evolves. (It occurs in economic and cultural systems as well as between predator and prey species.) Co evolution is a powerful aspect of biological evolution. (Kauffman 1995). A computer program may live in a world of other programs. What makes it successful in achieving the needs of its user depends in part on actions of other programs it meets and on how they adapt to each other.</li> </ul>

Components of Dissipative Structure	Universalities or Laws of Complexity Description
Context Dependent	<ul style="list-style-type: none"> <li>• CAS are each unique, therefore the behavior of each CAS is context dependent and intimately related to its environment. A CAS depends on changes in the context as much as on changes that are arbitrarily considered a part of the system's internal dynamics. Traditional research methods expect that a system of focus can be isolated from its context (Miller, 1991) or that the contextual influences can be controlled over time. A CAS, on the other hand, depends on changes in the context as much as on changes that are arbitrarily considered a part of the system's internal dynamics. (For example, in the course of a school district's strategic planning, personal agendas of individual members may seem to be irrelevant, but these agendas pitted between members may introduce this variable into the discussion dynamics and shift the interactions of the strategic planning in critical ways.)</li> </ul>

#### 4.8.4 Equilibrium vs. Nonequilibrium (Disequilibrium) Systems

Complex Adaptive Systems, like the education system, are found on a continuum from *nonequilibrium* to equilibrium.<sup>100</sup> At equilibrium a CAS ceases to live. Under conditions of *nonequilibrium, disequilibrium, far-from-equilibrium,*<sup>101</sup> or otherwise known as a state of complex stability, the system functions in a “*stable*” mode for some period as energy and information are drawn in to keep the system in a state of ongoing flux.<sup>102</sup> The living system is able to develop and maintain its life processes (carry information that helps assure its survival and reproduction) as interaction between the system and its environment becomes more active and unpredictable.<sup>103</sup>

However, CAS rarely come to rest, as they both respond to the perpetual shifts in their environments, and further respond to the fluctuating dynamics of the system itself (as is observed in simulations of CAS and observations in nature). This sharing of information, perspective, and

coordinated activity are, in part, *self-generating* as they influence each other in the process. Information is brought in, the system's state of disorder *far-from-equilibrium* increases and at a point in time, the typical steady state is altered, by amplified positive *feedback loops*<sup>104</sup> that push the system farther *away from equilibrium*, the system reaches a threshold of stability. It changes the energy input and other crucial parameters. The functioning of the *catalytic cycles*<sup>105</sup> is destabilized (See Endnote 63)---the increased flow of energy and matter through its *feedback loops* creates a *bifurcating system*<sup>106</sup> behavior (a disturbance is critical for systems to bifurcate), the system gathers itself together and restructures in new context, in new instabilities, or transform itself into new structures of increased complexity. The hopeful result is collective action to meet and sustain the accumulated changes in its environment (Kelly & Allison, 1999)<sup>107</sup> or the emergence of subgroups that develop a coping strategies (White, 2001).

#### **4.8.5 Instability, Perturbations, Bifurcation & the Emergence of New Structures**

In general, the further a system is from thermodynamic equilibrium, the greater the number of possible steady states available to it (Laszlo, 1996). (As stated previously, the steady state is not necessarily a higher stage of organization with greater free energy and lesser entropy<sup>108</sup>) When critically destabilized, the system appears to search for, and if successful ultimately settles into alternative steady states maintained by new sets of *catalytic cycles* (Laszlo, 1996).<sup>109</sup> *Bifurcation*, occurs repeatedly as parameters change. Some *bifurcation* regions are quite large and stable over many values of the corresponding parameters. In others, however, the distance between *bifurcation* boundaries has shrunk until parameter space is a catacomb of regions so small that minor parameter changes in any direction trigger bifurcation.<sup>110</sup> (Marion, 1999).

The selection of alternative steady states at points of bifurcation is random. Even if the observer controls the perturbation that destabilizes a system (i.e. the input from the energy source), the transformation of its state remains unpredictable. The destabilization of a system at a specific point in space and time is not necessarily a conduit to higher stages of organization with greater free energy and lesser entropy. The system acts indeterminately, selecting among the steady states available to it by randomly employing some of its internal fluctuations (Laszlo, 1996). These periods of chaos are not only natural but sometimes desirable, as when old ways have to be abandoned and new ones found. These brief periods of chaos allow the exploration of many different possibilities in an innovative manner (Lewin, 1999).

#### **4.8.6 Instability, Bifurcations, & Perturbations in Living Systems**

The most intriguing aspect of the Theory of Dissipative Structures involves a system's points of instability. Significant evidence is now accumulating, in diverse branches of contemporary science, underscoring the fact that *nonequilibrium systems do not evolve "smoothly and continuously" over time, but do so in sudden "leaps"*, which intersperse over relatively extended periods of stasis. In nonequilibrium thermodynamics the "leaps" (points of instability) into new steady states, as shown in Figure 22, below, are termed "*bifurcations*,"<sup>111 112</sup> and generally occur when disruptions within the organization are brought to a critical point by *perturbations from outside* the organization (Merry). "*Bifurcations*" are defined as the threshold for instability, at which the dissipative structure may choose from among several possible paths, or states---the existing system structure can either breakdown or break through to one of several new emergent states of order that result in development and evolution.<sup>113</sup> Points of bifurcation

produce transformations where the system behavior is dramatic and unpredictable.<sup>114</sup>  
*Bifurcations* are the foundation of organizational change and learning.<sup>115</sup>

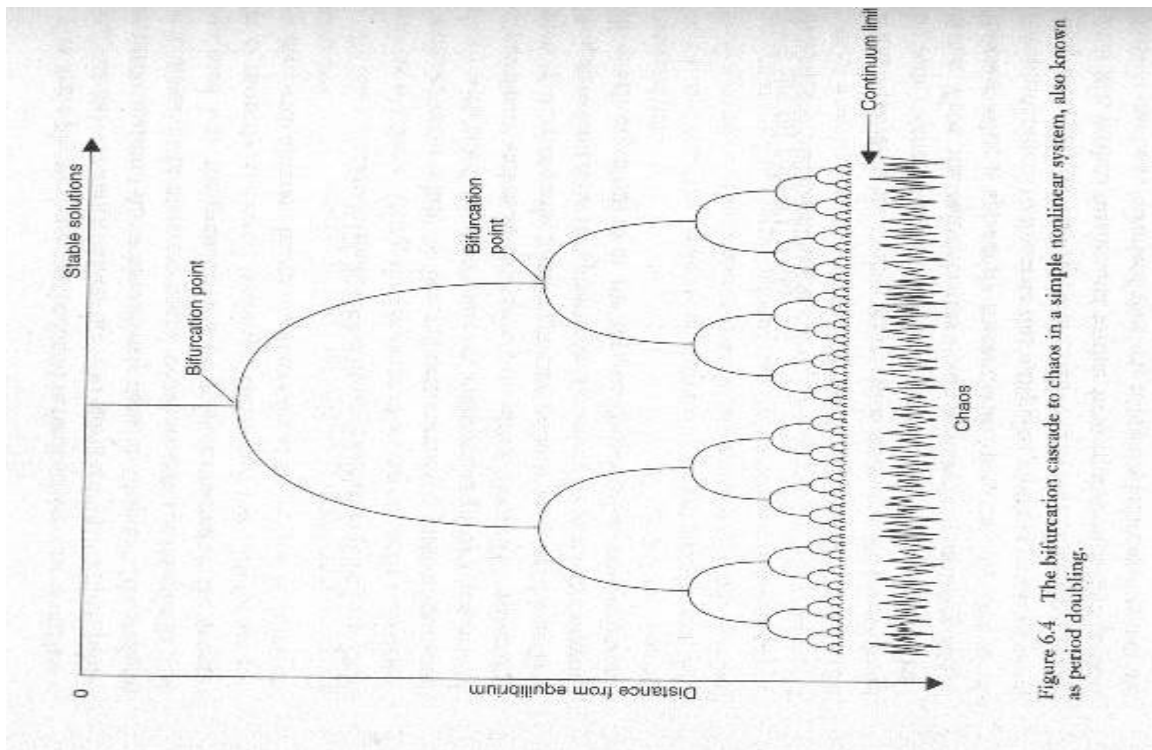


Figure 6.4 The bifurcation cascade to chaos in a simple nonlinear system, also known as period doubling.

Figure 22. Bifurcations

Dissipative Structures show extraordinary *sensitivity to small fluctuations in their environment*. Perturbations from outside, sometimes from non-average events,<sup>116</sup>(Prigogine & Stengers, 1984) can cause disruption within the system. Major *perturbations* are those introduced by wars and technological revolutions, for example. They *destabilize cycles and disrupt feedbacks*. Perturbations function with a large degree of indeterminism; however, but as a rule, randomness and chaos do not reign for long (Laszlo, 1998)and the system reaches a critical point or bifurcation. At this bifurcation point, a tiny random fluctuation in the environment, often called “noise,” can induce a choice of path in the system from among several possible paths, or states.<sup>117</sup> Since all living systems exist in continually fluctuating

environments, and since it is not possible to know which fluctuation will occur at the bifurcation point just at the “right” moment, it is not possible to predict the future path of the system.<sup>118</sup> Once the agent provides the trigger, there is no further influence, for *emergence* is the property of interaction, and the message becomes the servant of collective need (Marion, 1999, p41)<sup>119</sup>

To identify the “levers,” like non-average events, *in nonlinear complex systems* can be exceedingly difficult *since often there are multiple interacting variables* to consider.<sup>120</sup> (Holland, 1995; Kiel, 1997). A greater challenge is to encourage an experimental mode that “plays” with the many small changes that may emerge into the desired result (Kiel, 1997), especially since stable, control oriented organizational structures may destroy the opportunity for creative fluctuations that are necessary for event learning (Senge, 1990). Identifying an optimal leverage point requires more than just noting the dominant variable in a regression analysis (Kiel, 1997). The best strategies for organizational and process change are the employment of multiple levers in hopes of one, or some producing the desired result (Kiel, 1997).

#### **4.8.7 Influence of History at Bifurcation**

Prigogine has observed the importance of history even in simple chemical oscillations. In the traditional, deterministic paradigm, as shown in Table 26, below, history nor creativity are thought to impact the present occurring behavior of a system. In the dissipative structure paradigm; however, a record of previous development as well as structural changes is always present in living structures and plays an important role (Prigogine, 1984). For example, when a living system reaches a “*bifurcation point,*” (*a point where the system has been perturbed to a point of phase transition and a new pathway*) as described by Prigogine, its history of *structural*

*coupling* will determine the new pathways that become available. Which pathway the system will take; however, remains unpredictable (Prigogine, 1984).

**Table 26. Role of History in Traditional and Dissipative Structure Paradigms**

<b>IMPACT OF HISTORY ON SYSTEM BEHAVIOR</b>	
Deterministic World of Newton	Dissipative Structures
There is no history	History plays an important role, the future is uncertain
There is no creativity	Uncertainty is at the heart of creativity

Since each structural change influences the organism’s future behavior, this implies that the “behavior” of the living organism is determined by its structure (Capra, 1996).<sup>121</sup> Depending on which path it has taken to reach the point of instability, the system will follow one or another of the available branches<sup>122</sup> after the bifurcation.

What exactly happens at the “bifurcations point” depends on the system’s previous “history,” whether “fine-grained or coarse-grained,”<sup>123</sup> and on various external conditions. (Every CAS (e.g. human systems) has evolved to utilize some course-graining in a Quasi-Classical realm<sup>124</sup>) Examples of *points of bifurcations* in the development of societies occur in the nature of *sudden breakdowns and transformations* (examples include sudden transformations (whether due to evolution or revolution), wars, foreign conquests, radical (and not always desirable) cases of *societal mutation*, instances caused by effects of new technologies, or traumas and crises taken as the price of progress (Laszlo, 1998).<sup>125</sup>

A bifurcation is not a complete break with the past. It does; however, change the established system, adapting it to the stresses which brought down the previously dominant system. Although the *adaptations* are considered functional, it does not mean that they are

desirable (Laszlo, 1998). For example, all revolutions exhibit the basic dynamic of *historical bifurcations*, states Laszlo, which can establish dictatorial regimes and reigns of terror as well as democratic and enlightened forms of social order.<sup>126</sup>

#### 4.8.8 Linearity vs. Nonlinearity

When *nonlinearity* comes into play the pace of change increases everywhere and the entire system becomes more and more *unstable – as it moves away from equilibrium*. When that happens, nonlinearity is evident. *Nonlinear theory* teaches that *randomness and unpredictability* are givens, and that they can build order, albeit a rather complex one (Marion, 1999). Implicit in *nonlinear theory* is a dramatic break from Newton (Marion, 1999).<sup>127</sup> *Nonlinearity and specifically Chaos Theory* argue that linear notions are largely inaccurate, at least in the interactive world of real events (Marion, 1999). *Small changes can lead to large effects.*<sup>128</sup>

Prigogine's intensive investigation to find out under exactly what conditions nonequilibrium situations were stable, provided a crucial breakthrough when he realized that systems "far from equilibrium"<sup>129</sup> must be described mathematically by *nonlinear equations*.<sup>130</sup> Sally Goerner identifies a nonlinear system as any system in which "input is not proportional to output" and is best expressed mathematically. For example: 140 degrees Fahrenheit is not twice as pleasant as 70 degrees; 8 aspirins do not reduce a headache 8 times as much as one aspirin (Goerner, 1994).

Until recently, nonlinear mathematics was largely ignored because it often generated apparently random results without clear-cut applications to the empirical world instead of more organized structures consisting of controlled oscillations and regular limit cycles (Marion, 1999). In recent years chaotic and apparently random behavior has been discovered in a wide variety of



complex systems. Such behavior is exhibited by processes as varied as fluids in flow, blending of substances during solidification,<sup>131</sup> modeling past experience, increased instability of society (Kiel, 1997}, and more realistically, for use in forecasting probable future patterns (Kelly & Allison, 1999). Besides explaining uncertain environments, nonlinear behavior also explains the different interdependent states in which an organization may be functioning---some more and some less orderly and predictable. The Mathematics of “Nonlinear Dynamics” originally developed by Henri Poincare, for instance, includes “chaos theory.” Chaos theory suggests that the highly nonlinear nature of the mathematical equations causes chaotic behavior and exists even when there are no bifurcations. *Nonlinear chaotic relationships* are typified by the potential for disproportionate or exponential relationships between variables (Kiel, 1997). A small change in one variable may produce highly disproportionate effects in variables systemically connected to the changed variable (Kiel, 1997).<sup>132</sup> Therefore, in some systems, because of repeated feedback loops,<sup>133</sup> or mathematically, repeated iterations, the tiniest error in the calculations, caused by the practical need to round off arithmetic results will inevitably add up to sufficient uncertainty to make predictions impossible (Laszlo, 1996 #11).

Consequently, *Chaos Theory* explains why sometimes large efforts give no results and at other times a minor change leads to an organizational landslide. In other words, *Chaos Theory* helps clarify the limits of predictability of long term strategic planning, especially in the kind of environment created by the Information Age.

Built into *nonlinearity* is a need to rethink views of structure and process. Nonlinearity in education is identifiable in agitation and activity of political action, media interest, rewriting of standards and curriculum, and legislative action (NCLB, IDEA), etc. (Caine &Caine, 1997) Nonlinearity explains effects of the relocation of a teacher from one building to

another in a school system in the disproportionate effects on building culture or morale (Kiel, 1997). Nonlinearity is also visible in large organizations where an ill-considered and apparently minor policy change, aimed at improving efficiency, leads to client dissatisfaction and external political repercussions (Kiel, 1997) Lewin argues that although the nonlinear phenomenon grabs our attention, and stirs our emotions, it is essential for “*self-organization*” to work, so nonlinearity is a plus and not a problem (Lewin, 1999).<sup>134</sup>

#### 4.8.9 Summary: Key characteristics of Dissipative Structures

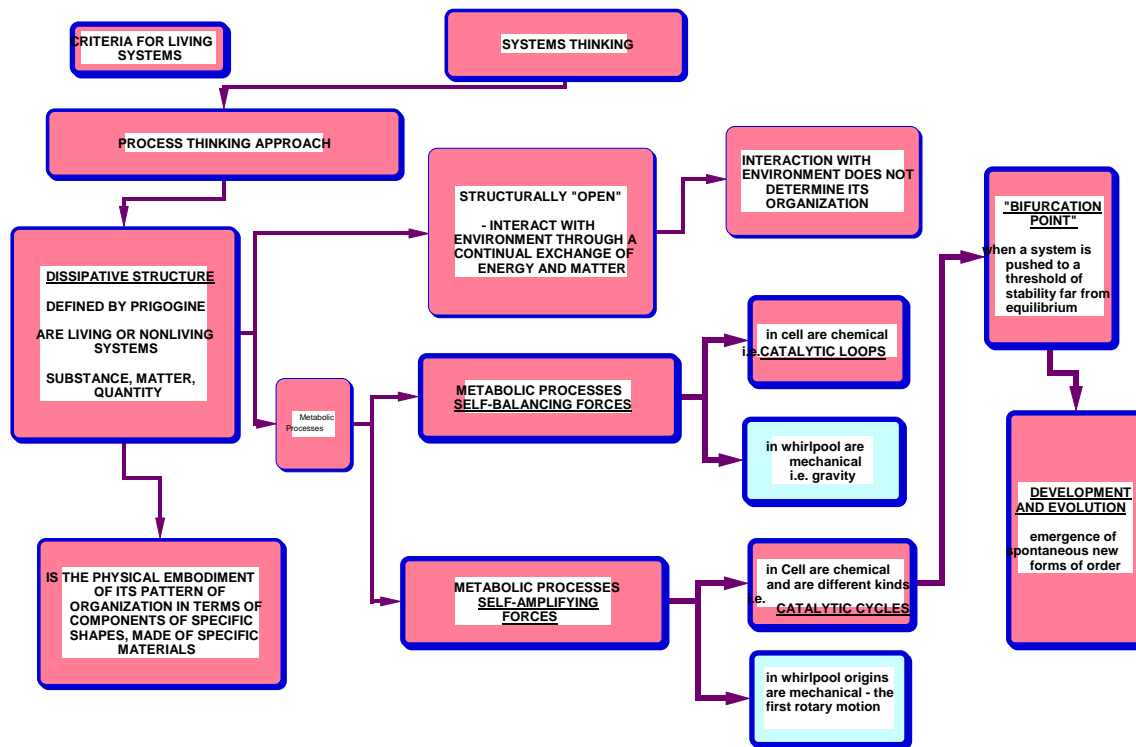


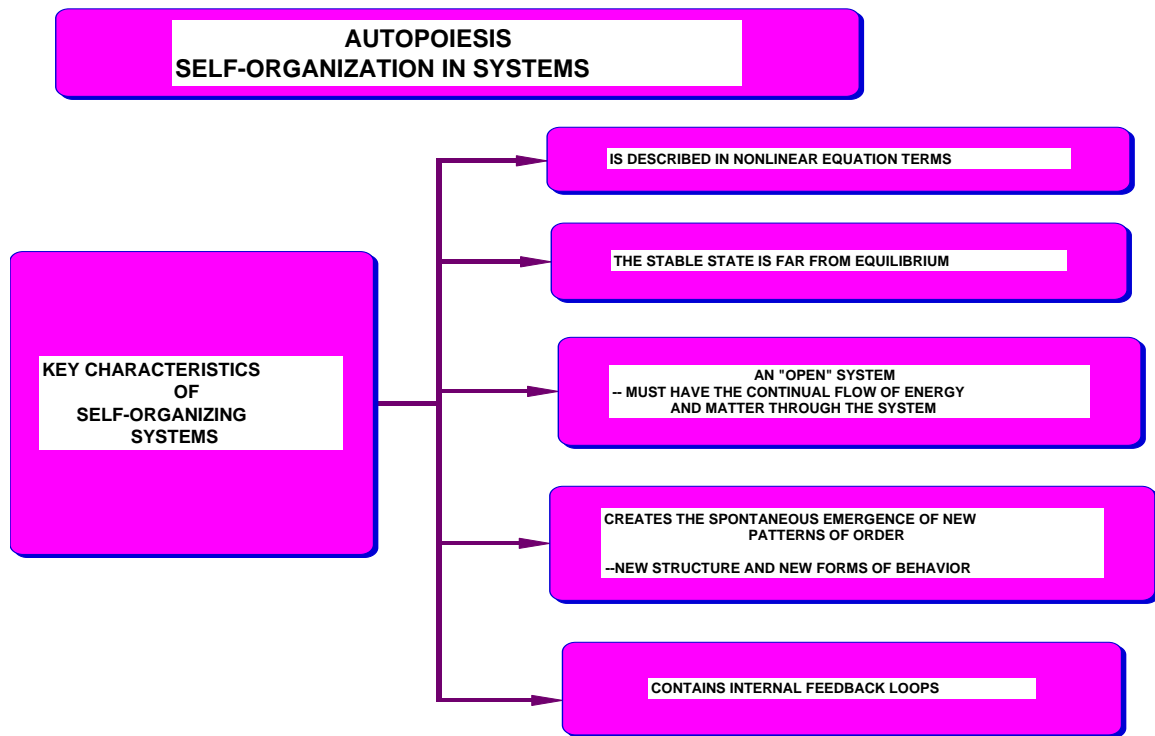
Figure 23 . Dissipative Structure of Living Systems<sup>135</sup>

#### 4.8.9.1 Common Characteristics of Autopoietic/Dissipative Structure Systems

A set of common characteristics have become apparent, through the mathematical theories and models of self-organizing systems, in a unified theory of living systems as shown in Figure 23, above and Figure 24, below.

Self-Generation & Self-Perpetuation – means that all components, including those of the boundary are produced by processes within the network. This includes the ability to create new structure and new modes of behavior in the self-organizing process that involves development, learning, and evolution. It means that the production processes continue over time, so that all components are continually replaced by the system's processes of transformation.

- Open systems operating far from equilibrium – A constant flow of energy and matter through the system is necessary for self-organization to take place. The striking emergence of new structure and new forms of behavior, which is the hallmark of self-organization, occurs only when the system is far from equilibrium.
- Nonlinear interconnectedness of the system's components. Physically this nonlinear pattern results in feedback loops mathematically it is described in term of nonlinear equations.



**Figure 24: Characteristics of Living Systems that Include  
Autopoietic & Dissipative Structure Universalities**

Ultimately, Autopoiesis (self-organization) is the spontaneous emergence of new structure and new forms of behavior in open systems far from equilibrium. It is characterized by internal feedback loops and described mathematically by nonlinear equations.

#### **4.9 DISSIPATIVE STRUCTURE AND THE CURRENT TRADITIONAL PARADIGM**

The focus of this specific section, as highlighted in Table 27, below, is to establish the Dissipative Structure language as a universal thread to compare and contrast both the current traditional paradigm vs. ETCH.

**Table 27. Description of Dissipative Structure in the Traditional Education System Paradigm and the Educational Theory Complexity Hybrid**

Paradigm Shift to Optimal Learning Environment				
	<b><u>CURRENT TRADITIONAL PARADIGM</u></b> <i>HOW PRESENT EDUCATIONAL THEORY WITH ITS ORGANIZATIONAL STRUCTURE AND LEADERSHIP IS TOO LINEAR, MECHANISTIC, AND REDUCTIONIST</i>		<u>Educational Theory Complexity Hybrid</u> <i>How implementation of the theory can produce a considerably improved organizational system and leadership</i>	
	<b><u>HIERARCHICAL LEADERSHIP STRUCTURE</u></b>	<b><u>MECHANISTIC ORGANIZATIONAL STRUCTURE</u></b>	<u>Facilitator</u>	<u>Optimal Learning Environment</u>
<u>Autopoiesis</u> - Processes operating within the system				
<b><u>DISSIPATIVE STRUCTURE</u></b> – Processes of system interacting with its environment	<b>IMPACT ON THE RESULTANT OBSERVABLE PATTERNS OF ORGANIZATIONAL STRUCTURE BEHAVIOR DESCRIBED AS THE COMPLEXITY UNIVERSALITIES WORK BETWEEN THE TRADITIONAL ORGANIZATIONAL EDUCATIONAL SYSTEM AND INTERACTIONS WITH ITS ENVIRONMENT</b>	<b>IMPACT ON THE RESULTANT OBSERVABLE PATTERNS OF ORGANIZATIONAL STRUCTURE BEHAVIOR DESCRIBED AS THE COMPLEXITY UNIVERSALITIES WORK BETWEEN THE TRADITIONAL ORGANIZATIONAL SYSTEM AND INTERACTIONS WITH ITS ENVIRONMENT</b>	Impact on the Resultant observable patterns of leadership behavior described as the complexity universalities work between leadership in an authoritative hierarchical structure and the system’s external environment	Impact on the Resultant observable patterns of organizational structure behavior described as the complexity universalities work between the traditional organizational educational system and interactions with its environment
<u>Cognition</u> – processes of system adapting to change				

How living systems interact with one another, but only generally, with their environment, is an integral part of the *Theory of the Autopoiesis process*. Conversely, Dissipative Structures help to explain “how” a system interacts with its environment; “how” an organization is “perceived” to function; or and “how” it represents its true rules for success.”

#### **4.9.1 Closed & Open Education Systems**

As a Dissipative Structure, the education system, its schools and school districts, obviously do not operate in a vacuum, but are also *open to the flow of energy and matter with their environments*, in the form of information, resources, and human capital, for example . Unfortunately, many school systems appear only partially open (shut out certain kinds of information or information that matches the ways in which they already see the world)(Kelly & Allison, 1999). For many years, the education system has been *stable*, dwelling quite comfortably in an ordered state, where a command-and-control, or mechanistic style of management kept schools close to the *static state*. Interactions among its agents were held to a minimum. These education systems were and continue to be basically *closed systems*---systems that neither import nor export energy, information, or material (Kelly & Allison, 1999). They do not interact much with their environment, nor are they sensitive to it (Caine & Caine, 1997).

#### **4.9.2 Education System Interconnectedness**

The mechanistic, reductionistic, linear model of management from the Industrial Age is much less effective in the connected Information Age where globalism encourages more interaction with the environment, more intensive media coverage, more concern from political and religious groups, more demands from business, more special needs to accommodate, and more impact from technology. Many organizations encounter great problems in dealing with the wider world because they do not recognize “how” they *are a part of their environment*, states Morgan (Morgan, 1997 p. 258). School organizations are a great example of this viewpoint. They

continue to view relations, structure, and sustainability from what Morgan refers to as an egocentric (self-absorbed) perspective.

By “enacting and dealing with their environment in an egocentric way, organizations often do not understand their own complexity and the numerous recursive loops on which they depend....As a result of this kind of egocentricism, many organizations end up trying to sustain unrealistic identities or to produce identities that ultimately destroy important elements of the context of which they are part” (Morgan, 1997, p. 259).

“Everything flows and nothing abides; everything gives way and nothing stays fixed... Cool things become warm, the warm grow cool; the moist dries, the parched becomes moist...It is in change that things find repose” (Heraclitus – Greek philosopher 500 BC)

Most education systems have yet to grasp the critical universality of *interconnectedness* to recognize “how” it is *part of its environment*.

Consequently, education reform, historically, rarely has had more than very temporary first order change effects as “new and creative programs” are implemented to teach children. One year it’s “outcome-based” and “learning objectives.” The next year practitioners shout the glories of “standards and benchmarks.” Somehow changing the title on the same goods makes them improved. With the entire “new and different” program lingo that permeates education, something is still missing the mark. The student is still graduating unable to read and write while the many creative, new, and innovative programs (full service, inclusion, cooperative learning, and team teaching) all have faced problems in implementation. A child unwilling to “act white” may not benefit from some of the learning opportunities available in the classroom, and more than the classroom has to change for that social effect to change. Educators still teach for the middle performing student at the expense of the learning disabled and the gifted. The child has changed but methods of instruction remain unchanged.

Forgotten is “how” these objectives interconnect, link, and are dependent on each other. In “Mindshifts,” Caine & Caine (1994) wrote that “we will finally turn education around, in our classrooms and in our communities, when we adequately grasp the nature of “connectedness”... “We will also see how to deal with our problems simultaneously” ( Caine et al., 1994). “This means realizing that the education system is interconnected and includes the teachers, students, administrators, building maintenance, health providers, dieticians, parents, the union, and politicians, etc, etc (Horn & Carr, 2000).

### **4.9.3 Traditional leadership in the education system dissipative structure**

Leaders in basically closed or “fixed systems” have not defined, much less updated and adequately monitored, the “critical factors” that contribute to the organization’s success.

Traditional leaders:

- Do not recognize various trends and events, inside and outside their organization, that are likely to influence its future
- Do not stretch beyond their company’s known transition limits. Even though some new variable is tested.
- Do not appreciate the struggle between the accelerating “transition demands” taking place and the diminishing “resources” (capacity) available to help organizations adapt to these disruptions
- When faced with new and significant challenges, do not identify which factors are affected or they can not determine how to alter them in order to maintain alignment with the new requirements for success
- Do not act decisively leading to their downfall. Sometimes decisions appear to be made in a way that confuses people or leaves some doubt about priorities
- Flounder, during the formalization, because either they won’t act without a general consensus, or they go to the other extreme, and fail to adequately involve others in making sound judgments, that can be embraced by enough people within the organization.
- Do not better prepare people for change. Rather, these leaders are camouflaged with plenty of macho posturing and a solid dose of “I-know-we-can-do-it” motivational hype. The hope is that, through all this, employees will somehow come up with the heroic effort needed to make it all work.



- Do not have a clue as to what factors go into determining “adaptation limitations” and lack an understanding of the ramification of extending beyond the future shock borders or what can be done to heighten the organization’s absorption level.

#### **4.10 DISSIPATIVE STRUCTURES & ETCH**

This particular section explores the dissipative structure of an ETCH system, and “how” the Autopoietic Process and Dissipative Structure *interconnect* with the complexity universalities (for example: *open, nonlinear, nonequilibrium*) between levels within education, and “how” they *interconnect* and are *interdependent* with other systems as they *co-evolve*. As identified in Table 28, below, this section explores how implementation of ETCH can produce a considerably improved organizational system in its leadership.

Table 28. Description of Dissipative Structure Found in the Educational Theory Complexity Hybrid

PARADIGM SHIFT TO OPTIMAL LEARNING ENVIRONMENT				
	<b><u>CURRENT TRADITIONAL PARADIGM</u></b> <i>How present educational theory with its organizational structure and leadership is too linear, mechanistic, and reductionist</i>		<b><u>EDUCATIONAL THEORY COMPLEXITY HYBRID</u></b> <i>How implementation of the theory can produce a considerably improved organizational system and leadership</i>	
	<b><u>HIERARCHICAL LEADERSHIP STRUCTURE</u></b>	<b><u>MECHANISTIC ORGANIZATIONAL STRUCTURE</u></b>	<b><u>FACILITATOR</u></b>	<b><u>OPTIMAL LEARNING ENVIRONMENT</u></b>
<b><u>AUTOPOIESIS</u></b> Processes operating within the system				
<b><u>DISSIPATIVE STRUCTURE</u></b> Processes of system interacting with its environment	Impact on the Resultant observable patterns of organizational structure behavior described as the complexity universalities work between the traditional organizational educational system and interactions with its environment	Impact on the Resultant observable patterns of organizational structure behavior described as the complexity universalities work between the traditional organizational educational system and interactions with its environment	Impact on the Resultant observable patterns of organizational structure behavior described as the complexity universalities work between the traditional organizational educational system and interactions with its environment	Impact on the Resultant observable patterns of organizational structure behavior described as the complexity universalities work between the traditional organizational educational system and interactions with its environment
<b><u>COGNITION</u></b> – processes of system adapting to change				

#### 4.10.1 The Facilitator as a Dissipative Structure at the Edge of Chaos

The ability to execute change is a key success factor in a highly *turbulent* system of any kind.<sup>136</sup>

As conditions of ambiguity and uncertainty dramatically rise in our society, exemplified by reduced “predictability,” a reduced “sense of control,” and jobs that will occur at ever-shrinking intervals, this new era of perpetual unrest pressures the education facilitator to accommodate the

new and unfamiliar, which according to Conner, will soon be measured in quantum leaps rather than increments. The education leader is pressured to shift from the old “manual approach” of implementing first order change (relying on instinct and slow reaction time) to the new ETCH paradigm.

Armed with traits/attributes/characteristics (all internal-“autopoietic”), and the resultant mental model of a leader in an ETCH education system near or at the edge of chaos, the 21<sup>st</sup> century leader’s internal autopoietic system emerges into that of a “facilitator” (an external – dissipative structure). The school board insures that their learning institution facilitator has the skills and desire to engage in activities that will increase the organization’s *adaptability in a changing environment*. Unlike the traditional leadership role, a facilitator *interconnects* (through structural coupling<sup>137</sup>) to *create an environment* that is conducive for the system to operate at optimal level at the edge of chaos. The following threefold facilitator role is critical for an organizational environment at the edge of chaos (Conner, 1998). The facilitator must:

1. Ensure that the school/district is an “*open system*” (i.e., keeping people and things in an unending growth-and-renewal mode)
2. Take steps to *increase the school’s capacity to absorb disruption*.
3. Constantly *stretch the school/district’s boundaries of its capacity*, by introducing as many important changes as possible without overextending available *adaptation resources*.

1. A Facilitator at the Edge of Chaos Ensures That the Enterprise is an “Open System” -

The ETCH education systems at the edge of chaos, are *open systems* to constant energy exchange in the form of information flow, exploration, opportunity, social capital between schools and the society/community in which they are embedded, as expressed through the dissipative structure process. A facilitator, at the edge of chaos ensures an “open system” of its learning institution by removing hurdles that deter the learning institution’s natural inherent capability to renew itself through *self-organization* (U. Merry). By releasing its natural inherent capability to renew

itself, the organizational behavior of the open system is changed (U. Merry). For example, the facilitator will create an environment where resilient people are the desired norm.<sup>138</sup>

As part of an *open system*, “agents” (individual teachers, for instance, interacting and interconnecting) would embrace new ideas and processes as they joined with others in different groups and for difference purposes. As part of a *nonlinear system*, agents would bounce ideas off each other with one thing leading to another in a way that was never anticipated, and play with endless variations and possibilities. This energy exchange “of” the learning institution rather than change “within” the system further suggests an *interconnected, interdependence* of behavior in the context of the larger whole.

All systems---mechanical, human, or social/political---have limits to their operations (Conner, 1998), yet ETCH facilitators understand that static or fixed states are not an option in an open, self-organizing, cognitive system. Nor is its observable behavior mechanistic, reductionistic, or linear. In fact the observable behavior of an open system conveys speed, grace, dexterity, resourcefulness, and fitness. In an open, self-organizing, cognitive education system, where the mission and vision priority is creating a “student-centered” environment, then:

“In this type of environment, education is much more learner centered, with genuine student interest as its core---This kind of teaching is more fluid and open. It includes elements of self-organization as students focus individually or gather collectively around critical ideas, meaningful questions, and purposeful projects. The teaching is also highly organic and dynamic, with educational experiences that approach the complexity of real life” (Caine & Caine, 1997).

The learning institution agent maintains a self-image of a continuous *interdependent, interconnected* learner with the awe of a child at play, instead of the possessor of answers. The facilitator for an *interdependent, interconnected* learning system (cognizant of the latest brain research that *interconnects* mind and body) would replace lectures, worksheets, and rote memorization by interactive hands-open materials, drama, and project work. Music and gym

would be daily requirements. Schedule changes would align with optimal timeframes for learning. Subjects such as foreign language and geometry would be offered to much younger children. And teachers would pay greater attention to children's emotional connections to subjects (Begley, 1996).

“They (the students) are taking what they are learning home. For probably the first time, they are talking to parents about it and they are extending it even further. Some of the projects that are taking place in my classroom – one little boy is trying to make a flying gecko... Anyway, he said that he was going to go home tonight because he knew they had an old... model airplane engine in the garage and he was going to get his dad to work on this airplane engine with him and they were going to make a flying gecko. So they are taking what they are learning home. They're excited about it and they're transferring that by talking about school to their parents. And in this area where we are in Rio Linda, that's so valuable. And I think that makes the parents have a link to the school “ ---A learning system (captured at a recorded group meeting) (Caine & Caine, 1997)

Through each level of the system ---student/class/school/district, the key is an appreciation of the *connected and interdependence (operational universalities)* that each part (agent) contributes to the system as a whole, as well as to its environment. As is true for all living systems at the edge of chaos, it is a distinction that is contingent on the circumstances/context (environment) in which an organization finds itself.

2. A Facilitator Takes Steps to Increase the School/District Capacity to Absorb Disruption - A facilitator focuses on the removal of environmental hurdles that enables common threads of emergent creative disorder and enables complexity universalities to operate. A facilitator must change the mechanistic, reductionistic, linear mental model through which he/she perceives organizational reality---must facilitate/stimulate a paradigm shift (U. Merry). The role of creative disorder requires that the facilitator have an active appreciation for nonlinearity, mutual causation, organizational histories and non-average behavior in organizations.<sup>139</sup> The ETCH facilitator and his/her learning institution face the formidable challenge of keeping a constant watch on the “magnitude” and the “failure costs of change” throughout their school/district. When the facilitator and his/her organization welcome disorder

as a partner, and use instability positively,<sup>140</sup> only then, will organizational behavior align with the natural world.<sup>141</sup>

To be prepared for change is a critical standard that a facilitator sets as part of excellence within the organization.<sup>142</sup> Consequently, facilitators give the *Butterfly Effect* serious attention – particularly at “*leverage points*,” such as launching new initiatives to provide vouchers or fund cyber charter schools (Kelly & Allison, 1999).<sup>143</sup> Facilitators within an ETCH learning institution embrace their ability to manage the unexpected (external event) as a strategic asset (Conner, 1998). The very energy generated by consistently preparing to embrace unpredictable, contested environments by facilitating the execution of important changes, successfully solving problems, and exploiting more efficiently and effectively as compared to other institutions of learning, and all while maintaining its desired “return on change,” can leverage strategic advantage from an ETCH learning institution.

ETCH facilitators realize that their school/district can be won, lost, and reclaimed in a very brief period of time. These facilitators realize that after years of work advantages can vanish overnight should there be a decrease in ability to meet quality standards, an increase in community expectations, an external introduction of a new directive/initiative, or a spryer, less encumbered charter, private or cyber school submits application.

Increasing an organization’s preparedness to accommodate change is a moving state on the continuum within the edge of chaos.<sup>144</sup> The facilitator realizes that a place exists on this continuum, where the best time to invest in building a stronger capacity<sup>145</sup> to digest the human reaction to transition appears immediately before the critical threshold for “chaos” is reached. Although this kind of chaotic “change load” is dangerous and can be destructive, within this realm also lies the zone where ETCH organizations thrive. Research on *bifurcations zones*<sup>146</sup>

shows that the period just before a system goes out of control is perilous, but this is also when a system can squeeze the optimum agility from its resources <sup>147</sup> (Conner, 1998). Caine and Caine, (1997) describe systems at the edge of chaos as being in *states of disequilibrium*, where change is constant and cannot be controlled, and outcomes are often unpredictable (Caine & Caine, 1997). In fact many systems achieve their greatest performance when they are in a *state of appropriate disequilibrium and* on the edge of losing control. They believe they must operate within a sphere of incessant novelty. In fact, Prigogine suggests that “*disequilibrium* <sup>148</sup> is the necessary condition for a system’s growth” (Wheatley, 1992).

Consequently, the objective is to facilitate an environment that balances the system’s inputs, outputs and processes while displaying minimal dysfunction.<sup>149</sup> The ETCH system is able to absorb large amounts of disruptive change without a significant drop in quality and productivity. The facilitator will eliminate peripheral, less critical initiatives that drain adaptation resources. The environment to stretch and strengthen the adaptation capacity of the system includes critical components of focus as described in Table 29, below.

**Table 29. Critical Components to Stretch Adaptation Capacity**

Critical Characteristics of ETCH Education Systems	Organizational Variables		
	Applied to “Facilitating” Leadership	Applied to “Context” (Vision, Mission, & Strategy)	Applied to “Culture”
Positive –  security and self-assurance are based on a view of the learning institution as complex but filled with opportunity	Predisposed toward opportunities both inside and outside the organization  To differentiate: <u>low-resilience</u> leadership is pessimistic about resolving problems and exploiting opportunities	ETCH education systems prepare staff to readily alter processes to meet shifting demands.  Themes stress that opportunities exist and can be grasped	Facilitators look for and talk about the opportunities to succeed, even when how to do so is not clear
Focused –  The learning institution has a clear vision of what must be done to prosper	Remain attentive to the more critical objectives  To differentiate: <u>Low resilience</u> leadership scatters efforts in unrelated directions	That a direction, whatever its content may be, has been set	Use a well-defined set of priorities as a means of differentiating and prioritizing activities
Flexible –  The learning institution is a creative ability when responding to uncertainty	Display pliability in the variety of information they consider when making decisions and considering the possibilities they create  <u>Low resilience leadership</u> closes itself off from new information and innovative possibilities	That the gathering of information and the creation of new approaches are essential	Seek out novel perspectives and incorporate them into their work



Critical Characteristics of ETCH Education Systems	Organizational Variables		
	Applied to “Facilitating” Leadership	Applied to “Context” (Vision, Mission, & Strategy)	Applied to “Culture”
Organized – The learning institution structure approaches to managing ambiguity	Are able to structure the ways they interpret data and information  <u>Low-resilience leadership</u>  Fails to see and create patterns that can guide actions	That high levels of ambiguity can be addressed through judicious application of structure	Create structure approaches to deal with the ambiguity they feel
Proactive – The learning institution engages change rather than defends against it.	Build implementation plans around their new ideas and eagerly try new approaches  Low-resilience leadership  Waits for certainty before acting	That engaging action in the face of uncertainty is critical	Take measured risks in trying new ways of doing things
	Low and even marginally resilient leadership consumes high levels of resources in responding to the challenge of change and usually meets with little success		In addition to any predisposition toward these behaviors that a person may display, an organization’s culture must overtly state and reward the value it places on these actions

In addition, the facilitator will prepare the environment and its agents for the inevitable resistance that will surface during major change initiatives. By establishing the processes for

interventions that emphasize the interconnections and the interdependent nature on every level of the system, the groundwork is established for attempting more change than has been absorbed in the past. Figure 25 and Figure 26, below, based on Conner's experience, provide examples of how facilitators convey and model the self-organizing, interdependent, interconnective universalities that empower the school/district's agents to increase their capacity for change

Messages that Facilitators Convey and Model  
to Empower Employees

The "Do's" of Ongoing Turbulence

- Be honest with yourself and your employees---more, not less, turmoil lies ahead
- Interpret extended periods of calm as a distress signal – it means your sensors aren't working properly
- Think of things that appear stable as really being composed of rhythms or fluctuating waves of movement that form predictable patterns
- Pay more attention to how you learn than to what you know
- Concern yourself with whether people you are responsible for can successfully assimilate additional changes when new initiatives are being considered
- Remind yourself and your employees that everyone's job now is to succeed in unfamiliar environments
- Increase your tolerance for ambiguity during periods of uncertainty
- View some of today's disruptions as the bases for tomorrow's new possibilities
- Operate as if anything that looks like "the answer" to a major problem or opportunity is more expensive and less durable than is apparent
- Think about many contradictions as paradoxes
- Recognize when to slow down (and do things right the first time) in order to move faster through change
- Translate "either/or" choices into "both/and" thinking
- Experiment with everything you can, but remember to maintain the core values of who you are so you will have an internal reference not for making key decision
- Take some of the mystery out of change by learning to understand its patterns and dynamics
- Learn from your previous attempts at implementing change, and incorporate these lessons into new behaviors when facing major transitions
- Take responsibility for architecting the future

**Figure 25. The Do's of On-Going Turbulence (Conner, 1998)**

Messages that Facilitators Convey and Model

to Empower Employees:

The “Don’ts” of Ongoing Turbulence

- Stop waiting for things to slow down
- Stop promising yourself and your employees that your organization is just one change project away from tranquility
- Stop feeling sorry for yourself because life has become so challenging
- Stop feeling like a victim when you don’t get what you want
- Stop assuming stress is always bad; a certain amount is necessary for learning
- Stop thinking that you and your employees are entitled to always feel comfortable during change, or that your organization has failed if this doesn’t happen
- Stop being distrusting or resentful when your boss doesn’t have all the answers about the future
- Stop depending more on rhetoric and hype than on action to achieve your change goals
- Stop being enamored with our own achievements – complacency and arrogance inhibit your ability to develop new expectations
- Stop being drawn to the excitement of initiating change but bored or distracted with what it takes to sustain it
- Stop relying on your own knowledge, assumptions, and perceptions as the only valid bases for determining what to do next
- Stop thinking that any one person or any single group can resolve the really important issues in isolation
- Stop running from the unexpected – instead, move closer to identify what new dangers are to be avoided and what new opportunities can be expected
- Stop thinking only in terms of your own survival during change – it will invariably destroy the people and things around you and ultimately lead to your own self-destruction
- Stop being afraid of abandoning things that have worked for you in the past
- Stop being surprised at life’s surprises

**Figure 26. Don'ts of Ongoing Turbulence (Conner, 1998)**

To facilitate at the edge of chaos means drawing out the strengths and talents of those who choose to participate. Changes at the edge of chaos can only be propelled by energy from within people who willingly make a commitment to a continually learning system. Leaders can articulate a vision that attracts attention, but people ultimately decide on their own whether the process is worth their personal time and other resources (Conner, 1998).

A consequence of Complexity Science implies that a facilitator must give up control – or, rather, the illusion of control – when he/she is trying to lead their organization to some goal. The facilitator creates the environment in which creativity can emerge. Too little control is just as misguided a strategy as too much. Some structure is necessary. The degree and nature of control that the facilitator establishes, strongly influences what emerges, in terms of culture, creativity, and adaptability (Lewin, 1999).

“In the case where a team, department, and company portrayed cohesive and responsible behavior, and did not have interference by putting obstacles in their way, they found within themselves the ability *to self-organize*, so as to deal with novel situations and function differently. In this case, seasoned workers who were used to sitting in the same place and doing a specific job, showed sufficient resilience to do many different kinds of other jobs and displayed the initiative to organize themselves differently, according to the work they took over. With each order, they transferred tools, products and packaging materials from other departments, and organized themselves efficiently to fill the order, according to specifications”(U. Merry).

Therefore, the selection of people who would assist the effort is at least as important as the coaching techniques used to strengthen existing capabilities once someone has been hired (Conner, 1998).

The Critical Role of Staffing ---What Facilitators Look for in Hiring and Retaining Agents Under Constant Learning Institution Turbulence-- Leaders who realize that organizations often need to approach the edge of chaos tend to create environments where most changes are introduced to highly resilient, agile individuals who are also able to struggle with, but value the tension that comes from living between the various paradoxical extremes chosen by organizations (Conner, 1998). Highly resilient, agile individuals in organizations at the edge of chaos are empowered and are both malleable within its existing boundaries of operation and capable of redefining those boundaries so it can shift its success formula whenever necessary.

Sought are those agents who can translate the desired vision into tangible reality. These empowered agents are proactive, with change-related knowledge applied to clearly define, track, and measure not only in terms of financial and technical objectives, but also in terms of human and opportunity costs. These agents inherently make a huge investment to condition and strengthen innate abilities to maximum efficiency and effectiveness to fulfill change initiative.

Consequently, operationalizing a successful change initiative goal depends on who (with what skills) is part of the team, not how they are structured or the responsibilities they are assigned.<sup>150</sup> The “who” (of the team) needs a clear sense of what it will take to succeed and a practical view of how that translates into day-to-day behavior for themselves and those they work with. Finding these agents is not easy. However, by applying the “80/20 rule,” the overwhelming majority (80%) of an organization’s time and resources is applied to possible agents that already possess the requisite skills and predisposition, where only 20% of resources is allocated to trying to “mold” everyone into being an ETCH learning institution contributor.

- 80% of resources toward hiring agents who are already prone toward the desired attributes, and then training and coaching them to expand their capabilities even more
- No more than 20% of your resources should be allocated to assisting those who say they are willing to work against their own instincts and biases and who try to develop completely new propensities that would help them contribute to an ETCH learning institution environment

Creating the proper predisposition in agents’ minds about ongoing nature of change translates into long hours of training devoted to practicing basic skills and rehearsing proper mind-set so that when called to task, they are at their peak of readiness.<sup>151</sup> The ETCH education system heavily depends on the following kinds of expectations being firmly embedded within individuals as well as within the collective corporate culture. Characteristics/traits (autopoietic in nature) sought in the recruiting process of ETCH learning institution agents include:

- Intuitiveness that goes beyond the guidance provided by the facilitator.
- Foresight that can contribute to inventing an ETCH learning institution future
- Vision of an ETCH learning institution environment, but who also know much more than the facilitator about its fulfillment at a tactical level.
- Demonstrate a predisposition for “resilience”.<sup>152</sup>
- Demonstrate a strong tolerance for “ambiguity” – being able to deliver high performance despite the discomfort and confusion that typically exists when facing uncertainties<sup>153</sup>
- Identify appropriate expectations about life within an ETCH learning institution
  - The ETCH learning institution continually reinforces for agents that the learning institution is competing in volatile, extremely inconsistent, risky environments
  - The self-life for assignments, responsibilities, solutions, tools, and techniques are measured in days, weeks, or maybe months, but probably not often in years.
  - Agents are taught that change is about dealing with the unfamiliar and, given the number of unforeseen events taking place, they should not waste much energy being caught off guard by the unexpected
  - The broad range of emotional reactions to change includes fear, anger, elation, anxiety, relief, discouragement, happiness, grief, and satisfaction. Some reactions are more pleasant than others, but as long as they are appropriately expressed and don’t become destructive, any of these responses is considered understandable and acceptable
  - Only one response to change is considered unsuitable – being surprised at surprises. Don’t want agents diverting their attention and spirit to the unproductive, self-indulgent exercise of being aghast when life does not unfold as expected. Analyze, study, plan, and train as much as possible before facing the unknown – You can’t sidestep the inevitable surprises coming your way, but you can avoid being surprised that you are surprised
  - There is little patience for agents who register major surprise about changes – this reaction is considered a waste of time and resources
  - Energy is invested into problem solving and opportunity exploitation
  - Expect the unstable nature of today’s work environment as a normal phenomenon
  - The humbling factor – can never fully eliminate the inevitable surprises that will occur.
  - “Anticipate all you can, and then expect more”

ETCH agents are prepared for the continuous escalation of change in their organization’s future.<sup>154</sup> They understand that warnings are sounded at the first signs of data that could put the existing balance at risk. Consequently, to have agents prepared for change can sometimes even involve intentionally withdrawing from a strategy that is still working in order to prevent complacency and arrogance from establishing a foot hold. An ETCH facilitator will “preempt” external or internal detection or problems, (such as intentionally injecting “strange data”, novel

clusters, new chains, and creative “patterns of information” into their learning institutions’ existing framework, before the old configuration of information defaults), to disrupt and ultimately strengthen their learning institutions’ capacity to compete. The extent that facilitators can weave resilience into the learning institution’s formal statements of context will create guides to action that lead agents toward resilient behavior. This is the opposite of many present organizations that never get anywhere because they never focus on accomplishing a specific set of goals and implementing a specific plan but rather keep reacting to the latest disturbance (Lesgold, 2006).

3. Constantly press the envelope of these boundaries by introducing as many important changes as possible without overextending available adaptation resources -

Consequently, facilitators who strive for or maintain the ETCH learning institution status, know that the only way to “test” the results of their efforts to increase “change capacity,” is to cautiously but decisively thrust the system past its previous benchmark and into uncharted waters, beyond previous change boundaries as they shape a resilient system. In order to build a sustainable competitive advantage, the challenge of facilitators is to maximize the resilience of those around through modeling resilience, while continuing to refine their own skills. So whenever facilitators are unable to offer control, high resilience among the agents involved can be relied on to help them regain a sense of themselves.<sup>155</sup> These facilitators realize that if the boundaries of change are not seriously challenged on an ongoing basis, a learning institution will be unable to keep pace with the accelerating magnitude of transition demands being imposed from the environment.

Through its self-organization and dissipative structure processes new ideas emerge and the organization builds on its strengths, fine-tunes its adjustments – and succumbs to more

innovative rivals (Stacey, 1996). However, the frames of reference that facilitators must possess and the cultural infrastructure that must be in place to create an environment at the edge of chaos are not a set of circumstances that are achieved overnight (Conner, 1998). Those who operate at the edge of chaos realize that more time and investment is required to construct an ETCH learning institution. ETCH education systems have a soul that can't be faked.<sup>156</sup> It can take years to create an “environment” conducive to becoming the ETCH learning institution.

#### **4.10.2 Tools used by the Facilitator**

Timing coupled with type of data are two tools at the facilitator's disposal. Timing is a function of how accurately the facilitator identifies potential threats to the “status quo.” Facilitators will focus on bringing about indicators rather than tracking indicators, and they remain vigilant about the earliest signs that the current success is waning. Facilitators take action, based on this data, before actual breakdowns have occurred. Conversely, most traditional leaders wait until customers, analysts, and/or shareholders have discovered problems before they act. A majority of traditional leaders hold on to their outdated logic flows long after they should have released their clutch.

Although ETCH facilitators rely on early sightings of evidence, especially by agents within the organization, who signal that a breakdown in productivity or quality has occurred, they are prepared to take preemptive, corrective action. Even before any of the standard metrics can confirm a problem, this kind of facilitator views the appearance of threatening, scary data as an unwelcome but inevitable occurrence and actually treats it as an ally that must be embraced rather than shunned.



Armed with observable diffuse feedbacks (design), the facilitator is better equipped to observe processes and modifications in accord with multiple overlapping and conflicting goals (Segel, 2000).<sup>157</sup> Diffuse feedbacks enable the facilitator to capture the timelines of processes as they move within pre-assigned tolerances (Horowitz, 1993).<sup>158</sup>

#### **4.10.3 Summary: The ETCH Education System as a Dissipative Structure**

##### At the Learning Institution Level

- It would not hide from reality of change, realizing that change is constant and cannot be controlled. It would balance the school/district's inputs, outputs and processes while displaying minimal dysfunction. School/District outcomes are often unpredictable (Caine 1997).
- It would operate within the tensions generated by uncertainty, and use the stress that exists, rather than trying to maneuver around them.
- It would demonstrate superior capacity to deal with the school's/district's unanticipated problems and opportunities. It would assume that transition will create emotional strain, intellectual intensity, physical tension, and psychological pressure. It would support associates (agents) to view a continuous flow of unplanned activities as simply the inevitable price to be paid for competing in volatile marketed society
- It would focus on the trends and patterns of education system change on the horizon.

##### At the Facilitator Level

- A match would be sought between the facilitator's ability to execute organizational change and the "magnitude of change" the school/district is currently experiencing, as well as the change-related pressure the school/district will confront in the next few years
- Would demonstrate ability for "mastery-level" competence in the dynamics of change.
- Would demonstrate "resilience" to change-related challenges
- Would establish procedures and processes that provide structure to ongoing operations while, at the same time, provide the flexibility needed to accommodate ongoing, continuous change.

- Would create a powerful network that would sanction needed change in their respective areas
- Would continually reinforce for agents that the learning institution is competing in volatile, extremely inconsistent, risky environments
- Would clarify that the self-life for assignments, responsibilities, solutions, tools, and techniques would be measured in days, weeks, or maybe months, but probably not often in years.
- Would hire and train naturally resilient agents about the dynamics of change to minimize feelings of victimization and strengthen resiliency to its fullest potential
- Would exhibit and propagate a “mind-set” about “how” change should be addressed
- Would condition agents, at all levels of the learning institution, for ongoing upheaval and constantly changing conditions
- Would extend proper delegation down the learning institution hierarchy, and insist on empowered relationships around each agent in the decision-making chain

#### At the Agent Level

- Would prepare for the continuous escalation of change in their organization’s future. <sup>159</sup>
- Would understand that warnings are sounded at the first indicators of data that could put the existing balance at risk.
- Would demonstrate a strong tolerance for “ambiguity”<sup>160</sup> – being able to deliver high performance despite the discomfort and confusion that typically exists when facing uncertainties
- Would invest energy into problem solving and opportunity exploitation
- Would expect that change is about dealing with the unfamiliar and would not waste energy being caught off guard by the unexpected. Diverting attention and spirit to the unproductive, self-indulgent exercise of being aghast when life does not unfold as expected is considered a waste of time and resources.
- Would expect the unstable nature of today’s work environment as a normal phenomenon. Would analyze, study, plan, and train as much as possible before facing the unknown. The inevitable surprises coming your way cannot be sidestepped, but you can avoid being surprised that you are surprised. “Anticipate all you can, and then expect more”

**4.11 THE SCIENCE OF THE LIVING EDUCATION SYSTEMS COGNITIVE  
PROCESS**

**4.11.1 In a nutshell: To understand living systems**

All living systems are cognitive process systems and the cognitive process always implies the existence of an *autopoietic network* and an organism’s *Dissipative Structure*--- “interactions” with its environment (Margulis, 1995).

**Table 30. The Interconnected, Interdependent Processes of Living Systems**

Pattern of life	Structure of Living Systems (Maturana, 1987)	Process of life
Autopoiesis – Through its pattern of behavior, Autopoiesis determines a system’s essential characteristics, and whether the system is living or nonliving (Maturana, 1987). It explains how interaction (cognitive <i>structural coupling</i> ) with the environment triggers agent interactive communication and coordinated behavior within a system emerging into structural changes within that system.	Dissipative Structure as defined by Prigogine: A dissipative structure may be living or a nonliving system. Although the structure of a living system is always a dissipative structure, not all dissipative structures are autopoietic networks. <i>Dissipative Structure</i> are open to the outside, as the system interconnects with its environment and is part of other living system’s worlds (Maturana, 1987), through the flow of energy matter and information. Their “form” and wholeness are created by the flow through them and their cohesiveness is maintained by using some of the energy, which flows through. Examples include people come and go, inputs of energy, matter and information enter and after processing goods, services or other products flow out	Cognition As defined initially by Gregory Bateson and more fully by Maturana and Varela (Bateson, 1979): Cognitive system processes can be natural or artificial, and are inextricably linked to autopoiesis. The cognitive processes allow the system to respond to disturbances, or “stimuli” from the environment through continual “structural” changes in its nonlinear, organizationally closed, autopoietic network (web-like pattern of organization) and its dissipative structure (Maturana, 1987)

Pattern of life	Structure of Living Systems (Maturana, 1987)	Process of life
Bicycle design sketches that are used to build the bicycle	The bicycle is a specific physical bicycle	The bicycle is in the mind of the designer
In living systems the pattern of organization is only recognized if it is embodied in a physical structure	In living systems the structure, patterns of organization and cognition are inextricably linked	In living systems cognition is the ongoing process of continual embodiment

Table 30, above illustrates that all three (Autopoiesis, dissipative structure, cognition) are actually different aspects of the same phenomenon of life. Through these three interconnected processes (autopoiesis, dissipative structure and cognition) the following complexity universalities emerge contributing to our understanding of “how” living systems interact with their environment and make the necessary internal adaptations for sustainability.

- structural coupling
- adaptation
- attractors
- trajectory development

Identification of these universalities, as defined in Table 31, below, by the “facilitator” of an environment that operates at optimal level of performance is critical.

**Table 31. Universalities Found in the Cognitive Process**

Components of Cognition	Universalities or Laws of Complexity Description
Structural Coupling	<ul style="list-style-type: none"> <li>• At a certain level of complexity a living organism structurally couples, through recurrent interactions , not only to its environment but also to itself, and thus brings forth not only an external but also an inner structural change in the system (Maturana 1987) ---the patterns of connectivity throughout the network</li> <li>• Since structural changes are acts of cognition, development, associated with learning, are both expressions of structural coupling. In other words, a structurally coupled system is a living, cognitive, learning system.</li> <li>• Human internal structural coupling produces the “self” or ego</li> <li>• Through mutual structural coupling, individual living systems are part of each other’s worlds as they communicate with one another and coordinate their behavior (Maturana 1987)</li> <li>• Through mutual structural coupling, communication is not a transmission of information, but is a coordination of behavior among living organisms. (Maturana 1987). Such mutual coordination of behavior is the key characteristic of communication of all living organisms, with or without nervous systems, and it becomes more and more subtle and elaborate with nervous systems of increasing complexity (Capra 1996)</li> <li>• Two parts of a system are said to be tightly coupled if they have a great influence on each other. Parts are loosely coupled if the influence is present, but not extreme. They are uncoupled when neither influences the other</li> <li>• The level of coupling in a system affects the amount of time required to propagate a change from one part of the system to the other</li> <li>• In an organization, coupling affects the speed of information transfer and the effectiveness of efforts to encourage change.</li> </ul>
Adaptation	<ul style="list-style-type: none"> <li>• Adaptation is a process that leads to improvement according to some measure of success. When a system contains agents or populations that seek to adapt it is referred to as a complex adaptive system (CAS). In many CAS, all the agents’ strategies are part of the context in which each agent is acting. It is difficult for an agent to predict the consequences of its actions and therefore to choose the best course of action. The implication is that they have learned and discovered various ways of positioning itself in its context.</li> </ul>

Components of Cognition	Universalities or Laws of Complexity Description
Attractors	<ul style="list-style-type: none"> <li>• An attractor is a trajectory to which motion gravitates. An attractor describes the predominant pattern of behavior in a CAS. The pattern emerges from the interaction of the parts, but it also constrains the behavior of the parts. In this way, the attractor becomes a self-fulfilling prophecy (Goldstein). Attractors ensure that a system is stable (Kauffman, 1995). External activity causes a system to jump from one attractor to another</li> <li>• Resistance to change is really attraction. Frequently in human systems, the behaviors that contribute to perceived resistance are merely the consequences of a powerful, though counter-productive attractor.</li> <li>• Systems exhibit certain classical patterns of behavior over time (Briggs &amp; Peat, 1989; Kaplan &amp; Glass, 1995). Chaos scientists describe these patterns as attractors. Wherever an agent enters the system, it will move toward the established pattern of behavior, the predominant attractor regime (Eoyang &amp; Berkas, 1998)</li> <li>• Four categories of attractor are generally recognized: point, periodic, strange, and random. Each one describes an emergent pattern of behavior that is exhibited by a system, even though the behavior of any individual agent in the system is unpredictable from one moment to another. The attractor is the primary method of “seeing” system-wide changes in behavior over time (Eoyang &amp; Berkas, 1998)</li> <li>• A point attractor describes the fact that a system moves to a single value</li> <li>• A periodic attractor(sometimes called a limit cycle because the behavior of the system does not move outside of the limit of the attractor) describes the fact that a system moves from one value to another at regular time intervals</li> <li>• A strange attractor, which is characteristic of chaotic systems, describes the tendency of a system to cluster its behavior around a set of acceptable values, though one, exact value or sequence of values is never repeated. (Eoyang, 1993)</li> <li>• Studies of system maturity and creativity (Van de Ven 1993) indicate that as systems mature, they tend to move from one attractor regime to another, beginning with random and moving through periodic, strange, and point attractor regimes in sequence</li> <li>• Attractor patterns can be discerned only from carefully designed time series analysis</li> </ul>

Components of Cognition	Universalities or Laws of Complexity Description
Trajectory Development	<ul style="list-style-type: none"> <li>Is the process that nonlinear systems use to identify solutions (trajectories). Dependent on the initial state, or pattern over time, a system would pass repeatedly through a sequence of states cycles (attractors).<sup>161</sup> Eventually the system hits a state it has previously encountered and eventually will repeatedly cycle around a recurrent loop of states called a state cycle attractor. Different trajectories may all converge on the same state cycle, like water draining into a lake. If a system falls into a small state cycle, it will behave in an orderly manner. But if the state cycle is too vast, the system will behave in a manner that is essentially unpredictable (Kauffman, 1995).</li> </ul>

As Table 31, above illustrates, an *Autopoietic network* suggests agent interactive communication and coordinated behavior within a system. The organism's (agents) *interactions* enable it to continue its autopoietic network in *self-generation* and *self-perpetuation*, and thus to continue living in its environment (Margulis, 1995). Through its *Dissipative Structure* the individual living system interconnects with its environment and is part of other's worlds (Maturana, 1987). The cognitive network allows the system to respond to disturbances, or "stimuli" from the environment through continual "structural" changes in its nonlinear, organizationally closed, autopoietic network (web-like pattern of organization) and its dissipative structure (Maturana, 1987).<sup>162</sup>

The Cognitive Process Challenges the Notion of Information & Learning: The "Cognitive Process" questions the notion that "information" in the world exists ready-made, to be extracted by a cognitive system. (Varela, Thompson, & Rosch, 1991) The traditional view holds that information is somehow "lying out there" to be picked up by the brain---to abstract a fact from its context, associate it with the meaning inherent in the context, and call it "information." As long as the "fact" is embedded in a stable context that is encountered with

great regularity, it is considered logical in the traditional viewpoint. The symbols of our language, both spoken and written, are considered representations of those things and ideas. Daily, facts such as the time of day, the date, the weather report, or the telephone number of a friend, are pieces of information that are considered relevant. These abstractions have become so common that the meaning now resides in the piece of information rather than in the context from which it has been abstracted (Varela et al., 1991).

Our whole era called the “information age” beckons an alternative viewpoint, that a piece of information, a quantity, name, or short statement is not out there in ready-made form, but has been abstracted from a whole “network of relationships,”--- “a context,” in which it is embedded, and which gives it meaning (Varela, Rosch, 1991). The color red, for example provides nothing “informative” unless embedded in a cultural network of conventions and in the technological network of city traffic. It is associated with stopping at an intersection and it becomes culture specific (Varela et al., 1991).<sup>163</sup> A more extreme example is the color black. Small regions of intermediate darkness will be represented as black if surrounded by brighter regions and as light grey if surrounded by darker regions. And the “whiter shade of pale” is partly an internal construction (Lesgold, 2006).

Consequently, the new view of cognition now involves the entire *process of life* – including emotion, perception, and behavior.<sup>164</sup> It results from a “process” of living through a “pattern of distinctions” (otherwise known as “perceptions” of difference) that do not necessarily require a brain and a nervous system. A bacteria or a plant, for example, has no brain but has a mind. The brain is not necessary for mind to exist (Varela et al., 1991). As some of the simplest organisms they are capable of perception and thus of cognition. They do not see, but they nevertheless perceive changes in their environment – differences between light and shadow, hot



and cold, higher and lower concentrations of some chemical.<sup>165</sup> Perception, then, cannot be viewed as the presentation of an external reality but must be understood as the continual creation of new relationships “within” the system’s neural network – the nervous system’s process of circular organization.

#### **4.11.2 Bateson Maturana and Varela – the Santiago Theory of Cognition**

Internal Structural Coupling Universality: As individual living systems interconnect and interact in each other’s worlds, they do so through the *structural coupling processes* (not linear change of cause and effect) that operates within the cognition process.<sup>166</sup> The “*structural coupling*” process is key to the Santiago Theory of Cognition and is the specific phenomenon underlying the “process of cognition” (Maturana, 1987). Caused by a sensory response that a living organism (plant, animal, human, or social system) has to environmental influences (or complex behaviors of “simple” physico-chemical systems”(Lumley, 1997), it suggests that at a certain level of complexity, a living organism “structurally couples,” through recurrent interactions, not only to itself but to its environment, and triggers both external and inner structural changes of the system (Maturana, 1987). From these recurrent underlying interactions (structural coupling with environment),<sup>167</sup> the system changes its future behavior in terms of continued adaptation, learning, and development in perception, emotion, and behavior within that living system (Maturana, 1987).

The Cognitive Process challenges the notion of “an independent world”: Within this process of “Structural Coupling,” as illustrated in Figure 27, below, certain disturbances will trigger specific structural changes---patterns of connectivity throughout the network.

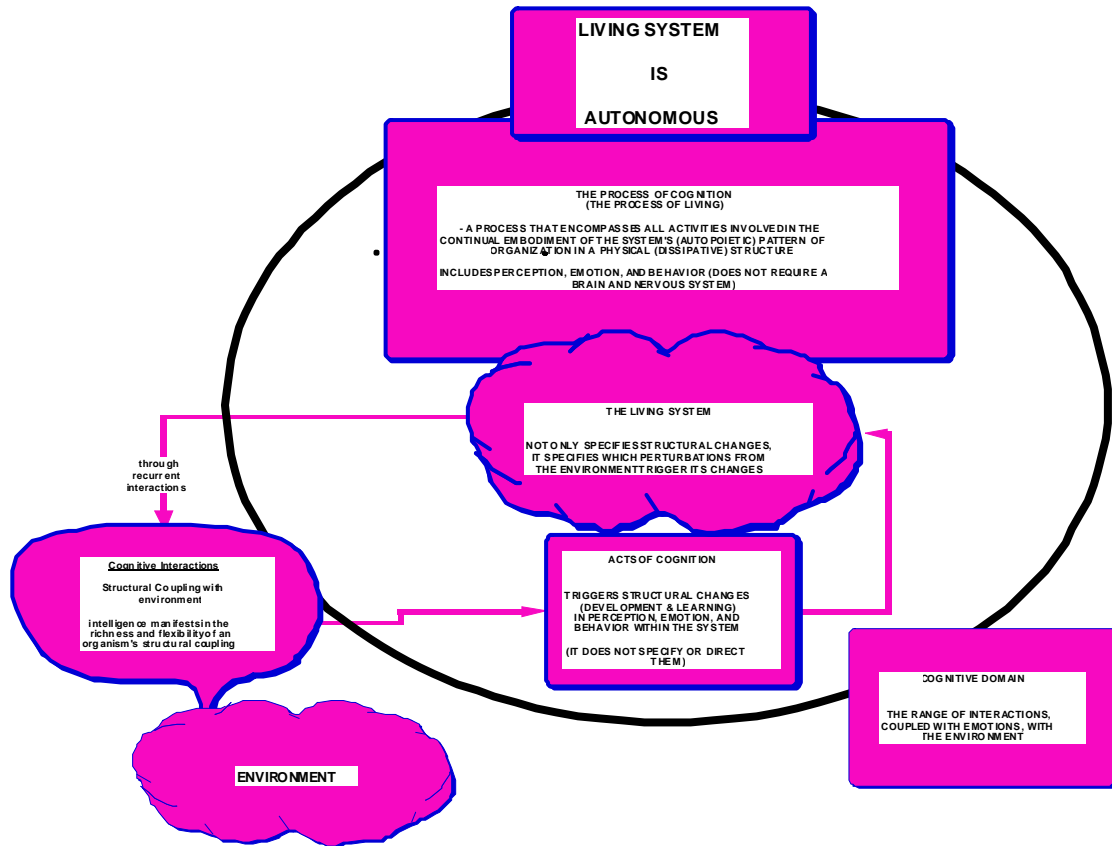


Figure 27. The Process of Cognition <sup>168</sup>

The ways in which a living system delineates objects and identifies patterns out of the multitude of sensory inputs received depends on the individual organism's physical constitution. The Cognitive Process acknowledges that individual organisms within a species have more or

less the same structure, and that different organisms change differently, and that over time each organism forms its unique, individual pathway of structural changes in the process of development.<sup>169</sup> As Maturana and Varela would say, “the ways in which living systems couple structurally to their environment, and thus the “world brought forth,” depends on the structure” of the living organism. Each living system not only specifies these structural changes, it also specifies which perturbations from the environment trigger them in order to “bring forth a world.” Therefore structural changes in a living system constitute acts of cognition and are associated with learning. Both development and learning are then expressions of “structural coupling.” Consequently, a structurally coupled system is a “learning system.” Living systems are cognitive systems (Maturana, 1987).

The adaptation process: A key to change in complex systems are adjustments in the agents and their strategies (Axelrod, 1999). *Adaptation* is a system process that involves attempting to turn interactions to system improvement according to some measure of success.<sup>170</sup> A system that contains agents or populations that seek to adapt is referred to as a *complex adaptive system (CAS)*<sup>171</sup> (Axelrod, 1999). A CAS and all its agents are part of an autopoietic context in which each agent interacts and interconnects. Each change by an agent alters the context in which the next change will be tried and evaluated, making prediction of action consequences difficult, as well as choice of best course of action (Axelrod, 1999). The implication is that each agent and the collective behavioral culture discover and refine choices to better position themselves in their context (Axelrod, 1999). Learning in this circumstance implies the capacity to sort out information within a context.

When multiple populations of agents adapt to each other, the result is a co-evolutionary process. For example while the coaching staff in one of two competing schools are

experimenting with better student performance, the coaching staff in the other school live in a changing environment. Their efforts to adapt may change based on improvement efforts in the first school. This can lead to perpetual novelty for both sides. The system may never settle down. This scenario provides the setting for adaptive behavior which is dependent on how agents adapt to each other.

For a system to exhibit *adaptation* that enhances survival (or another measure of success) it must increase the likelihood of effective performance criterion and reduce the likelihood of ineffective performance criterion (Axelrod, 1999). There are many processes of change strategy known as different forms of *selection*. *Selection* can be the result of mechanisms such as trial-and-error learning, or the imitation of apparently successful agents strategies (Axelrod, 1999). Selection can also result from population changes like birth and death, hiring and firing, immigration and emigration, or start-up and bankruptcy. Selection need not be beneficial.<sup>172</sup>

The Cognitive Process of Living Systems Unifies the Mind/Matter Split: Through the structural coupling process, the Santiago Theory of Cognition or “Cognitive Process” unifies the mind/matter split. The Santiago Theory of Cognition by Gregory Bateson, Maturana, and Varela, is a conceptual advance from the traditional mind/matter split theories known as the Cartesian Split. The Santiago Theory of Cognition provides the first coherent scientific framework to overcome the Cartesian Split. Mind, matter, and life no longer belong to separate categories but are seen as different aspects or dimensions of the same phenomenon of life (Varela et al., 1991). As Figure 28, below explains, this theory suggests that “relationships” and “connections” are the path of organization, the common thread through the phenomenon of life, common to all living creatures, which include people who obviously think in relationships (Bateson, 1979).

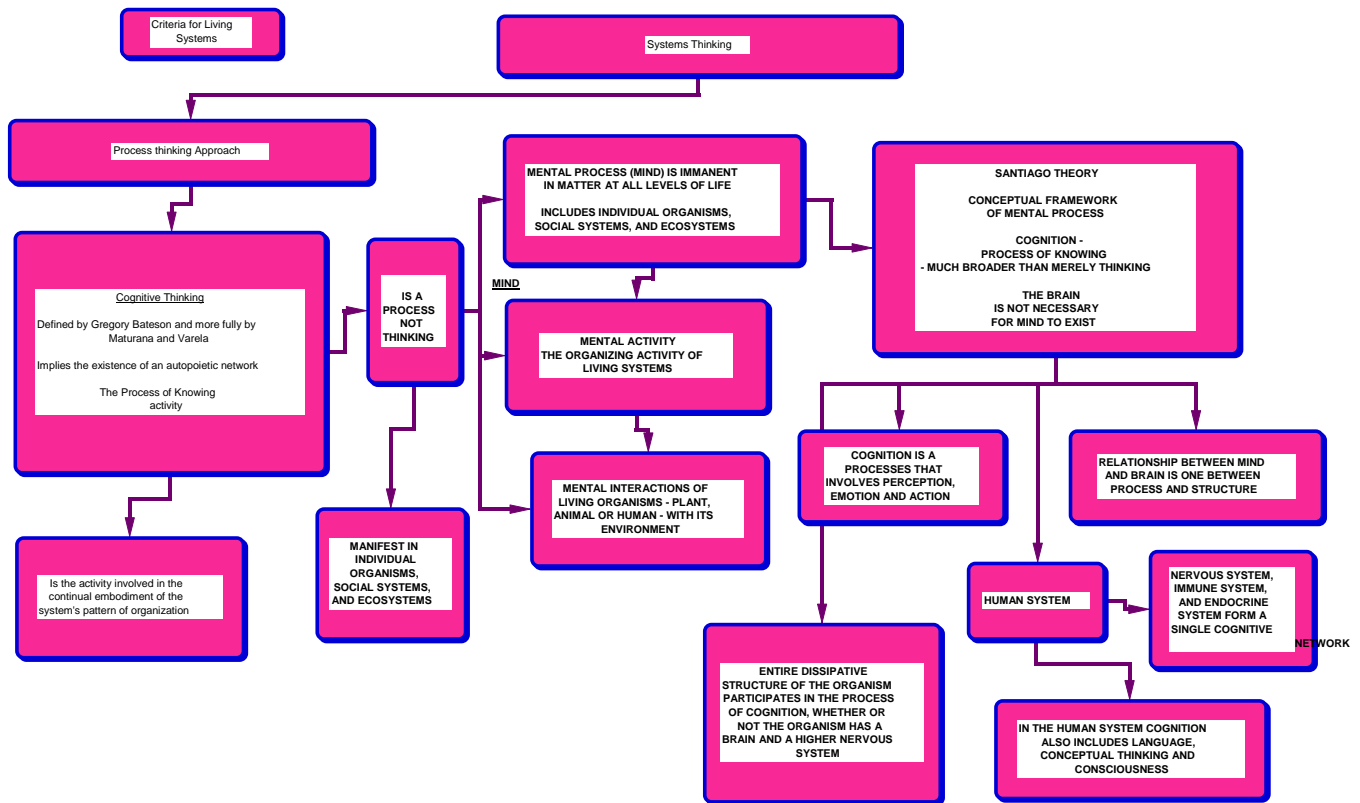


Figure 28. Theory of Cognition as Criteria for Living Systems <sup>173</sup>

As Figure 28, above depicts, The Santiago Theory of Cognition proposes cognition as a “*process of life*” that involves all activities in the continual embodiment of the system’s (Autopoietic) “*pattern of organization*” in its physical (Dissipative) “*structure*” (Varela, Maturana, & Uribe, 1974). Traditionally brain structures and mental functions were thought to be intimately connected, but the exact “*relationship*” between mind and brain has continued to be open for debate. As late as 1994 “*even though everybody agreed that mind had something to do with the brain, there was still no general agreement on the exact nature of this relationship*” (Revonsuo & & Kamppinen, 1994). A good example would be the nervous system, the immune system, and the endocrine system of the human organism that were traditionally described as

separate systems. Recent research; however, strongly suggests that in fact the three form a single “cognitive network” (Varela et al., 1991).

Thought, Language, & Communication---a coordination of behavior (actions) through structural coupling: In social systems, structural changes in the cognitive process are intimately linked to thought, consciousness, emotion, intelligence, and language (Varela, Rosch 1991). A careful analysis of communication is useful in understanding language. The general process of cognition, common to all living systems, does not require language or abstraction (Capra 1996). Through recurrent mutual interactions or mutual structural coupling, a “coordination of behavior” (not a transmission of information) is the key characteristic of communication of all living organisms, with or without a nervous system (Maturana 1987).<sup>174</sup> The following example illustrates this meaning of language with a hypothetical communication between a cat and her owner (Maturana, 1987).

“A cat meows and runs to refrigerator. I follow her, take out some milk, and pour it into a bowl. The cat begins to lap it up”.

That is communication – a coordination of behavior through recurrent mutual interactions or mutual structural coupling. Such mutual coordination of behavior is the key characteristic of communication of all living organisms, with or without nervous systems.

The range and differentiation of an organism's “structural coupling” is significantly expanded by the cognitive domain’s inclusion of both brain and nervous system.<sup>175</sup> Animal behavior may be inborn (instinctive) or learned, and accordingly it can be distinguished between instinctive and learned communication. The dances of honeybees indicating the location of flowers, is partly based on instinctive behavior and partly learned. The linguistic (or learned) aspects of the dance are specific to the context and social history of the beehive. Bees from different hives dance in different “dialects”, so to speak (Maturana, 1987). Maturana calls the

learned communicative behavior “linguistic”(Maturana, 1987). Although it is not yet language, it shares with language the characteristic feature that the same coordination of behavior may be achieved by different types of interactions. Like different languages, in human communication, different kinds of structural couplings, learned along different developmental paths, result in the same coordination of behavior (Maturana, 1987).

Through linguistic distinctions, meaning arises as a pattern of relationships that is created by languaging that exists in a “semantic domain” (an exchange of information that carries some meaning). The inner world of concepts and ideas, emotions, and body movements become tightly linked through conversation in a complex choreography of behavioral coordination. With human language arise abstract thinking, concepts, symbols, mental representations, self-awareness, and all the other qualities of consciousness (Maturana, 1987)

Suppose, for example, that one morning:

“I don’t follow the meowing cat because I know that I’ve run out of milk. If the cat were somehow able to communicate to me something like “Hey, I’ve now meowed three times; where is my milk?”

That would be language. Her reference to her previous meowing would constitute a communication about a communication, and thus, according to Maturana’s definition, would qualify as language (Maturana, 1987). Cats are unable to use language in that sense, but higher apes may well be able to do so. In a series of well-publicized experiments American psychologists showed that chimpanzees are able not only to learn many standard signs of a sign language, but to create new expressions by combining various signs (Maturana, 1987)

### 4.11.3 Reflection and Consciousness

Among human beings, communication and the use of language includes *consciousness*. According to Varela, the primary *conscious* experience, common to all higher vertebrates, is not located in a specific part of the brain. It is the manifestation of a particular cognitive process – a “transient synchronization of diverse, rhythmically oscillating neural circuits” which are linked intimately to thought, language,<sup>176</sup> and *intelligence*,<sup>177</sup> it is part of the richness of an organism’s structural coupling (Capra, 1996; Varela, 1991).<sup>178</sup> The fact that neural circuits tend to oscillate rhythmically is well-known to neuroscientists. Recent research, though, has shown that these oscillations are not restricted to the cerebral cortex but occur at various levels in the nervous system.

Varela recently published a paper in which he sets forth his basic hypothesis and proposes a neurological basis for the distinction between conscious and unconscious cognition in all higher vertebrates (Varela, 1995). Neuroscientists have been looking for this approach to cognition ever since Freud discovered the human unconscious (Capra, 1982).

The numerous experiments cited by Varela in support of his hypothesis indicate that cognitive experiential states are created by the synchronization of fast oscillations in the gamma and beta range that tend to arise and subside quickly (Varela, 1995). Each phase locking is associated with a characteristic relaxation time, which accounts for the minimum duration of the experience. The key idea is that transitory experiential states are created by a phenomenon known as “phase locking” in which different brain regions are interconnected in such a way that all their neurons fire in synchrony.<sup>179</sup> Through this synchronization of neural activity, temporary “cell assemblies” are formed, which may consist of widely dispersed neural circuits (Varela, 1995).



Each cognitive experience is based on a specific cell assembly, in which many different neural activities, associated with sensory perception, emotions, memory bodily movements, and so on are unified into a transient but coherent ensemble of oscillating neurons (Varela, 1995). According to Varela, the primary conscious experience, common to all higher vertebrates, is not located in a specific part of the brain, nor can it be identified in terms of specific neural structures. It is the manifestation of a particular cognitive process – a transient synchronization of diverse, rhythmically oscillating neural circuits.

A “mental state,” then, that is composed of many dimensions, is created by many different brain functions - and yet it is a single coherent experience (Capra, 1996). An example would be the smell of perfume that evokes a sensation, is experienced as a single, coherent mental state composed of sensory perceptions, energies, and emotions. This experience is not constant, and may be extremely short. Mental states are transitory, continually arising and subsiding (Capra, 1996). Another important observation is that the experiential state is always “embodied” – embedded in a particular field of sensation. In fact, most mental states seem to have a dominant sensation that colors the entire experience (Capra, 1996).

The ability to abstract is a key characteristic of human *consciousness* and because of that ability; it is possible to use mental representations, symbols, and information. However, *abstract thought* is only a small part of human cognition and generally is not the basis for everyday decision and actions. *Self-awareness (reflection)* arises when the notion of an object and the associated abstract concepts to describe ourselves are used. Self-awareness and the unfolding of our inner world of concepts and ideas are not only inaccessible to explanations in terms of physics and chemistry, they cannot even be understood through the biology or psychology of a single organism (Capra, 1996).

#### 4.11.4 Emotion

Recent research strongly suggests that emotions are an integral part of the cognitive act (Capra, 1996). For example, a human response to an insult, in general, is to get angry. The entire pattern of physiological processes – a red face, faster breathing, trembling, and so on – is part of cognition. In fact, human decisions are never completely rational, but are always colored by emotions, and human thought is always embedded in the bodily sensations and processes that contribute to the full spectrum of cognition.

TO SUMMARIZE: “Mind” is not “thinking” but a “process” – the very process of life. The interactions of a living system – plant, animal or human - with its environment are cognitive interactions and the process of living, itself is a process of cognition (Maturana, 1987). The range of interactions that a living system can have with its environment defines its “cognitive domain.” As complexity increases, so does a living organism’s cognitive domain.

Language results in a very sophisticated and effective coordination of behavior. The evolution of language allowed the early human beings to greatly increase their cooperative activities and to develop families, communities, and tribes that gave them tremendous evolutionary advantages. The crucial role of language in human evolution was not the ability to exchange ideas, but the increased ability to cooperate (Capra, 1996). Simultaneously, humans developed the ability of abstract thinking, of bringing forth an inner world of concepts, objects, and images of ourselves (Capra, 1996). Gradually, as this inner world became ever more diverse and complex, humans began to lose touch with nature and became ever more fragmented personalities (Capra, 1996). Among all the species, humans are the only ones that kill their own kind in pursuit of religions, free markets, patriotism, and other abstract ideas (Capra, 1996).

One's self, or ego, does not have any independent existence but is a result of our internal "structural coupling." Humans are autonomous individuals, shaped by their own history of structural changes. Humans are self-aware of their individual identity – and yet when they look for an independent self within our world of experience they cannot find any such entity (Capra, 1996). Capra believes that the origin of our dilemma lies in our tendency to create the abstractions of separate objects, including a separate self, and then to believe that they belong to an objective, independently existing reality (Capra, 1996). To overcome the counterproductive aspects of our Cartesian anxiety, humans need to think systemically, shifting a conceptual focus from objects to relationships in order to address the complexity of organizations that humans have formed in the last half-dozen generations. Only then, can it be realized that identity, individuality, and autonomy, do not imply separateness and independence.

The power of abstract thinking encourages the natural environment to be treated as if it consisted of separated parts (Capra, 1996). Humans have extended this fragmented view of our human society, dividing it into different nations, races, religious and political groups (Capra, 1996). The belief that all these fragments, in us, in our environment, and in our society, are really separate has alienated humans from nature and from fellow human beings. The result is a perceived diminished value. Humans have to regain their experience of connectedness with the entire web of life. This is the essence of the spiritual grounding of deep ecology (Capra, 1996).

#### **4.12 COGNITION PROCESS**

The Cognition Process language is a common thread that runs through the remainder of this Chapter # 4. Through the Cognitive Process lens both the CURRENT TRADITIONAL

PARADIGM and ETCH, as shown Table 32, below, are compared and contrasted. This section specifically explores the CURRENT TRADITIONAL PARADIGM through the Cognition Process lens in both ORGANIZATIONAL AND LEADERSHIP STRUCTURE, shown in tan in Table 32, below.

**Table 32. Cognition and Traditional Education Paradigm**

Part III Paradigm Shift to Optimal Learning Environment				
	<u>Current Traditional Paradigm</u> <i>How present educational theory with its organizational structure and leadership is too linear, mechanistic, and reductionist</i>		<u>Educational Theory Complexity Hybrid</u> <i>How implementation of the theory can produce a considerably improved organizational system and leadership</i>	
	<u>Mechanistic organizational structure</u>	<u>Hierarchical leadership structure</u>	<u>Optimal Learning Environment</u>	<u>Facilitator</u>
<u>Autopoiesis - Processes operating within the system</u>				
<u>Dissipative Structure – Processes of system interacting with its environment</u>				
<b>COGNITION – processes of system adapting to change</b>	<b>Impact on the Resultant observable patterns of organizational structure behavior described as the complexity universalities work between the traditional organizational educational system and its ability to adapt to change</b>	<b>Impact of the Resultant observable patterns of leadership behavior described as the complexity universalities work between the traditional organization educational system and its ability to adapt to change</b>	Impact on the resultant observable patterns of system behavior as it operates in a phase transition at the edge of chaos poised for change and able to adapt	Impact of the facilitator who creates an environment where adaptation to change is embraced by the system and an optimal learning environment is maintained

Adapting to Change. The broader system says that what education has is not good enough, but those in that broader system have difficulty changing the way they think or the bureaucratic procedures they have developed (Caine & Caine, 1997). Caine and Caine (1997) address resistance to change by suggesting that many of the problems in the education system, explored thus far, have been visible, but ignored. Although the overall structure of the education system may be destabilized, they suggest, the delivery model of education, where information is treated as a commodity, has not changed.<sup>180</sup> The system “tries to *adapt* in that it is making some responses to its perceived environment”, state Caine and Caine, but it is “resisting evolution.” All the reports, state Caine and Caine (1997), of how difficult it has been to change education, support this logic .

Many administrators continue to follow and implement policy using the mechanistic, reductionist mental model perspective that many believe is outdated. Through traditional administrators, traditional education was built on this machine-like model, characterized by a strong sense that outcomes can be predicted and controlled.<sup>181</sup> The machine model requires a type of leadership to maintain and control the bureaucratic structure. Training of education administrators reflects an understanding that facts, skills, information is coveted by the educators in the system or the learning institution, and are warehoused only in schools to be distributed much like a conveyor-belt, or a packaging-and-delivery system, where products that conform to design specifications are identified and selected, and where much that does not conform is discarded or rerouted as an inferior product (Caine & Caine, 1997).

This way of thinking, has penetrated all learning institutions especially in terms of "cause and effect relationships." The education system requires accountability (control).<sup>182</sup> Based on linear cause-effect relationships, clearly identified rewards are offered for "things done right".

In turn, "poor results are caused by poor teaching.., or poor textbooks.., or an inadequate curriculum" (Caine & Caine, 1997), or poor students.

The power and achievements of this traditional thinking continue to be visible in many scientific disciplines. Any system can be divided into separate parts and dealt with in isolation. "This is important," states Lesgold. "Without rich computational capability, often reductionism is the only strategy with predictable effects." Reductionistic thinking breaks complex systems apart where components are studied in order to figure out how the system works as a whole. Much of what is known about nature came from this approach (Lewin, 1999).

Maintaining a Bureaucratic Structure. Maintaining and controlling the education mechanism through bureaucracy incorporates many mutually reinforcing methods and thinking visible in the system's organizational structure. In schools, the practical implication of this view is that schools could be changed and restructured by working out what each part does and then changing the parts so that they worked better. The parts could be redesigned, but the underlying belief is that control of change is a human prerogative. When parts break they are fixed.

This notion is translated into all types of educational structures. Schools as subsystems are constrained by the larger system: Every school is a part of the larger education and social system that influences it. The structure and information was linked through a timetable so that places (classrooms), teachers, and subject matter were connected and managed (Caine & Caine, 1997).<sup>183</sup> The schools they observed operated for five days a week on nine month cycles. Content was broken apart and usually taught in fifty to fifty-five minute sections in clearly delineated subjects, and based on the assumptions that school and learning are linear and predictable processes.

Control of Information. The understanding is that schools survive and thrive for as long as central players are in the control and flow of this information. Instructional institutions reflect the cognitive mechanistic influence through the notion that ‘only’ its experts can create knowledge, exemplified in information about people, grades, assessments, or reports.

The mechanization of Teachers and Teaching. The teachers also reflect a cognitive mechanistic behavior. The skill of teaching is viewed as a job that has more to do with assembly-line production, than with creating experiences linking learning to genuine shifts in understanding. In elementary schools, one group of children often far too large - tends to be the responsibility of one teacher. In secondary schools, teachers are allocated groups of children from small chunks or blocks of time with directives to deliver prescribed curriculum content. Specific responsibilities and job descriptions---each function and is treated as separate and out-of-context, and only connected in a specific and limited manner (Caine & Caine, 1997). Caine and Caine (1997) observed that an intricately designed system of administration was used, where administrators supervised teachers<sup>184</sup>, to make certain that only the appropriate knowledge, in the form of information was dispersed in classrooms, although the actual day-to-day distribution of this ready-made information (knowledge) to the student was ultimately a task for the teacher.

The teacher has significant freedom in how to "teach" the material, usually with the use of texts, film, and videos. However, teachers are isolated within classrooms and subject-specific departments, with little time or opportunity to connect knowledge to other subjects or to the real world - or to students. Teachers, observed Caine and Caine (1997), “act in a didactic-relationship with mostly passive participants who are forced to attend.” Thus, in teaching, the contention is that the greater the input through hard work, practice, and rehearsal, the greater the result in the

form of test scores and grades. The focus is on fixing or altering the structure instead of a better understanding of what keeps the structure in place (Caine & Caine, 1997).

Increasingly, “states require us to teach teachers to “teach to the standards.” Moreover, “the testing process puts emphasis on this, since it tests for the individual little tidbits of knowledge identified in a reductionist process. Much of the reductionistic approach is frozen into law. Further, for the worst schools, such an approach does produce improvement, just as Taylor found for the least efficient machine shops” (Lesgold, 2005). Continuous emphasis on grade-based evaluation acts as feedback to control the system---an emphasis that stems from the community at large (Caine & Caine, 1997). The modes of assessment are used to ensure that information flows in the “right manner” and that people, both students and adults, perform in the “right ways.” Standardized tests are used as gatekeepers for students passing from one grade level to the next (Ginsberg, 1997).

The Linearity of Learning. Many people think that learning means memorization. Traditional approaches in the neurosciences, and approaches that educators had adopted in interpreting the neurosciences, still persist in viewing the learner in fragmented and limited ways consistent with a mechanistic thinking (Caine & Caine, 1997).

Curriculum. The Cognitive mechanistic thinking also presides in a curriculum that is separated by disconnected subjects. Each of a set of core subjects, at the core of which are "the basics," such as reading, writing, and math, with others as secondary, was assumed to have a logical developmental sequence, with one segment sequenced in each year of a student's education. The Scope and Sequence Chart was the primary representation of the plan for a class's schooling.



The Mechanized Student. Even the students reflect the cognitive mechanistic perspective, and are organized into groups by reference to age, grades, and academic year. They were then age-batched into cell-like classrooms, each with separate but connected functions. They are funneled into separate parts of the building throughout the day to make efficient use of teaching resources and the physical plant. Children are graded on how much of the information they have stored. If students are not learning enough, the solution is a need for even more on-task behavior. The assumption being that more such behavior translates into better results. The assumed solution then is to improve by repairing or fixing the defects.

#### **4.12.1 Subsequent Effect of the Traditional Paradigm on the Education System**

Why does the education system prepare individuals for a "predictable", "controllable" world when the reality of life which society faces is both uncertain and ambiguous? Evidenced by core beliefs about the nature of learning and teaching, Caine and Caine (1997) suggest that the educational system has *been resistant to change*, and further suggests an intentionality for stability, and an unquestioned adherence to the present educational system. There may be some innovations and some good results, particularly when a teacher or school is given a moderate degree of autonomy (Caine & Caine, 1997); however, when highly innovative people leave, the norm has been for the school to revert back to the pattern of the basic system (Caine & Caine, 1997). The memes about education seem to be stuck in the minds of the people who make decisions (Caine & Caine, 1997).

Resistance to change is exemplified by the example where many teachers attend staff development meetings only to return to the classroom, close the door, and teach as before

(Guskey, 1995). Stanley Pogrow exemplifies resistance to change when he argues that “the biggest problem in education is with the reformers themselves and with the academicians and researchers who develop the ideas and rationales for the reformers’ pet reforms” (Pogrow, 1996, pg 657). Pogrow reports that “almost none of the widely advocated reforms of that period (the mid-60s to the mid 70s – open space, individualization, community-based education – survived (Pogrow, 1996, pg 657). According to Pogrow educational change to the present is characterized by the “repeated failure of reform initiatives, massive waste of resources on staff development, and dissemination, and repeated cycling of inadequate progressive and traditional reforms” (Pogrow, 1996).

Michael Fullan describes resistance to change as encompassed by a host of misconceptions where the vast majority of change efforts “fail to understand and harness the combined forces of moral purpose and skilled change agency” (Fullan, 1993, p 42). Fear-based differing conversations “could” open the system to power disruptions, causing power brokers to generally avoid conversation as a method for change – particularly moral conversation. Subsequently, educators “fail to address fundamental instructional reform and associated development of new collaborative cultures among educators” (Fullan, 1993, p 46).<sup>185</sup> Reform of any persuasion cannot occur if the individuals in the system “fail to learn and apply the change” (Fullan, 1993).<sup>186</sup> Arthur Combs (1991) replies to the question of why the field of education has not changed by stating that:

“It isn’t because we haven’t tried. We’ve tried a hundred things. Here are a few: the Palmer method, phonics, teaching machines, psychological testing, audio-visual...techniques, open schools, open classrooms, team teaching, teacher aids, social promotion, the New Math, the New Sciences, languages in the early grades, tracking, homogeneous grouping, inquiry learning, behavior modification, rewards and punishment, systems analysis, grades, competition, and ...behavior objectives, competency based instruction, “back to basics,” computer technology, and voucher systems. Each of these, in its time, was enthusiastically advanced as a solution to education’s major ills. As it became evident that it, too, was as disappointing as its predecessors, it was soon laid aside. Changing public education is like punching a pillow or, as someone has

suggested, “Like moving a cemetery; after you’ve done all the work, you still have a cemetery” (A. W. Combs, 1991).

Seymour B. Sarason (1990) wrote, “The Predictable Failure of Educational Reform,” in which he reveals that for almost half a century he witnessed efforts to improve the education system. He believes the characteristics, traditions, and organizational dynamics of school systems are “lethal obstacles to achieving even modest, narrow goals.” The agents in a particular school system need to understand the system goals and how to recognize when and how well they are being achieved. The problem, though, is that simplistic measurers, embodying the existing approach of the failed system, are used to generate the measures (Lesgold, 2006). “How does one deal with the abstraction called a system that is embedded in and reflective of a society that created and nurtured that system?” (Sarason, 1990).

Robert Branson (1987), on the other hand, explains resistance to change as a problem with “system design,” and proposes that schools can’t improve because they have “reached the upper limit of their capacity under the current structure and system”. He suggests that traditional education has attained about ninety-seven percent efficiency. “There is almost no room for improvement in the current system” (Branson, 1987).

Enlightenment through Psychology. Each individual has basic instincts of fight/flight, security, and safety, innate in all living systems. Each responds to perceived threat with varying degrees of fear. Our instincts then emerge into deep beliefs about the nature of our environment. Those deep beliefs for many people translate and justify stability, power, mechanism----a perception that enables protection of security and safety and avoids the perception of threat and subsequent fear. As a result an accompanying paradigm emerges to those deep beliefs, with

influence on behavior that feeds back to reinforce basic needs for security and safety, and an avoidance of threats that cause fear.

Subsequently, that paradigm of reductionistic, mechanistic, and linear thinking (paradigm)---a thinking that focuses on control of the concrete --- on the physical parts that can be identified and their functions, which can be categorized and classified, provides solace for the individual's basic instincts (Caine & Caine, 1997). As a result, reductionistic, mechanistic, linear thinking has led to the design of social systems as social machines, the essence of which has been to remain stable and unchanging over long periods of time, even when perturbed. This provides an illusion of safety.

Mechanistic thinking has led to a perception and subsequent behavior that encourages the forces that prevent change. Indeed, the paradox - and the frustration - is that most of the effort that has been put into changing education has actually reinforced the basic dynamics that make change exceedingly difficult. In other words, resistance of schools to change lies in a "system" that is itself maintained by a set of absolutely compelling deep beliefs about learning, teaching, and the nature of reality itself. And the education system is part of a larger system that is grounded in a way of thinking- a paradigm- and that also is deeply entrenched (Caine & Caine, 1997). On an even broader note, the universities, parents, and businesses, all of whom love the idea of A's and objective measurements, also resist change. So education struggles.

If a well-ordered universe is like a well-oiled machine, then disorder, uncertainty, sudden change, unpredictability, and turbulence are signs of a machine that is malfunctioning, suggest Caine and Caine. Therefore embedded into changing a paradigm is a perception that a paradigm shift means uncertainty. That suggests something is wrong. It has a perceived expected personal cost, which for many is viewed as too extreme. In short, western society, in particular, has

bought deeply into the notion that stability, predictability, and planned change are the real signs of health, and fears their opposites. For many people, stability, power, and mechanism represent security and safety.<sup>187</sup> Too fearful is a life seen as complex, emergent, and organized at ever-higher levels of complexity. And too uncontrollable is the child or adult that self-actualizes; accesses creativity; lives in dynamical balance; and grows in spirit. Mechanism becomes extremely compelling because it combines an explanation of reality with immense power to take charge of that reality. That combination, Caine & Caine (1997) suggest, has been intoxicating. It is no wonder, share Caine and Caine (1997) that attempts to change are inordinately difficult (Caine & Caine, 1997).

Perhaps when mechanistic thinking is coupled with reductionism or the reducing into parts or categories, uncertainty and ambiguity appear to be constrained (at least in perception) (Caine & Caine, 1997). However, the resultant effect appears to be a mechanistic thought pattern that has robbed individuals of an understanding of personal meaning; of trust in our own strengths; and power to change conditions or behavior. Confusion of what is expected on the job and elsewhere emerges, and a fearful apprehension that change could happen randomly leaving the individual in the wake. Overall, mechanistic thought patterns have a dehumanizing effect.

Psychophysiological responses to a perceived threat (Threat = any stimulus that triggers fear) as described above fall under the umbrella known as "downshifting" (Caine & Caine, 1997). It is often accompanied by a sense of helplessness or fatigue or both. Over time, it is associated with a lack of self-efficacy. Understanding "downshifting" is pivotal. When people downshift, they revert to more primitive instinctual responses or to early programmed behaviors. In terms of the learner, underlying all of these conditions is a belief structure that denies his/her own purpose and meaning, even though it is a critical part of the learning process. When these

conditions exist, the learners' ability to solve problems is impeded. As they encounter feelings of helplessness, they tend to revert to early-programmed behaviors indicative of conformity to the status quo. Additional reactions include becoming territorial, using and yielding to hierarchical command-and-control behaviors, and having little tolerance for thinking appropriate for complex issues like diversity and individuality.

As a result, individuals are less able to access their entire knowledge base or see what is really there. Their ability to consider subtle environmental and internal cues is reduced. The individual is also less able to engage in complex intellectual tasks, those requiring creativity, and the ability to engage in open-ended thinking and questioning (Caine et al., 1994). Therefore, downshifting inhibits many of the basic capacities that education seeks to develop (Caine et al., 1994). In "Making Connections" (Caine & Caine, 1994; Caine et al., 1994) argue that the design of the educational system induces downshifting in administrators, teachers, and students. The combined effect is to reduce the capacity of participants at all levels to think and act "out of the box."

The traditional mental model of the individual *structurally couples* with his/her social community, and that community has also responded with similar types of mental model beliefs. Mechanistic thinking in psychology insists that the mind is an artifact. In part of the Social Sciences freedom is an illusion. Purpose and meaning are intrinsically unreal. Behaviorism and the applications of rewards and punishments, that are externally controlled and relatively immediate, are compatible with a cognitive mechanistic thinking approach to fix and control behavior one bit at a time. Smiley stickers, grades, training, detention, promotion, awards, incentive schemes, penalties, and so on---the tools or implements with which the parts could be fixed; the school and students that are urged to do what was necessary to become a part of, or

take their place in society, are packaged with a pre-specified correct outcome established by an external agent.

And finally the "Fix-me" or "Fix-it" philosophy plays out best in pharmaceutical intervention, particularly in fixing unpleasant and frightening (especially frightening to observers) emotional states (Freeman, 1995). Freeman discusses the crippling effects of pharmaceutical interventions on society, families, children, and consequently, schools.<sup>188</sup> The argument is not against the use of medication; however, the issue is that an inappropriate set of mental model beliefs may lead to an inappropriate use of medication. With children, this kind of thinking leads to even more insidious consequences, culminating in a lifetime of dependence and sense of helplessness (Freeman, 1995).

#### **4.13 THE COGNITIVE PROCESS AND THE ETCH FACILITATOR ROLE AT THE EDGE OF CHAOS**

The current behavioral mental model of education, based on a mechanistic, reductionistic, linear paradigm, assumes a stable system, created to control and disseminate information and then used to analyze, solve problems and impact policy execution in education. This traditional mental model emergent from an outdated paradigm is being undermined on multiple fronts and is really ineffective, (Caine & Caine, 1997; Lewin, 1999) as gauged by key factors such as the student dropout rate, student performance assessments, increased enrollment in alternative programs, charter and cyber schools. The reason is that many aspects of the larger system that sustain education are crumbling (Laurillard, 1999).

In this section, thinking about education in the U.S. as a living, organic, holistic, learning system is an intentional move from this present traditional paradigm of a mechanistic, reductionistic, linear machine.<sup>189</sup> As a living system, the tightness, control, and predictability in education is replaced by adaptability, flexibility, extraordinary resilience, and the capability of generating perpetual novelty or creativity.

The focus of this last section of chapter three is to establish the language of the Cognition Process as a universal thread. In particular, as shown in the highlighted portion of

Table 33, below, the ROLE OF FACILITATOR in an OPTIMAL LEARNING ENVIRONMENT will be explored from the standpoint of cognitive process, thus further elaborating the ETCH viewpoint. This viewpoint leads beyond the limits of the traditional paradigm to an education system that is not machine-like and to schools that are not comprehensible through a cataloguing of their parts.



**Table 33. Role of Facilitator in an Optimal Learning Environment**

Part III Paradigm Shift to Optimal Learning Environment				
	<u>Current Traditional Paradigm</u> <i>How present educational theory with its organizational structure and leadership is too linear, mechanistic, and reductionist</i>		<u>Educational Theory Complexity Hybrid</u> <i>How implementation of the theory can produce a considerably improved organizational system and leadership</i>	
	<u>Mechanistic organizational structure</u>	<u>Hierarchical leadership structure</u>	<u>Optimal Learning Environment</u>	<u>Facilitator</u>
<u>Autopoiesis - Processes operating within the system</u>				
<u>Dissipative Structure – Processes of system interacting with its environment</u>				
<u>COGNITION – processes of system adapting to change</u>	Impact on the Resultant observable patterns of organizational structure behavior described as the complexity universalities work between the traditional organizational educational system and its ability to adapt to change	Impact of the Resultant observable patterns of leadership behavior described as the complexity universalities work between the traditional organization educational system and its ability to adapt to change	<u>Impact on the resultant observable patterns of system behavior as it operates in a phase transition at the edge of chaos poised for change and able to adapt</u>	<u>Impact of the facilitator who creates an environment where adaptation to change is embraced by the system and an optimal learning environment is maintained</u>

“How” does a facilitator of an ETCH education organization *structurally couple* and become a *catalyst* of agility in a complex adaptive system “environment”---the school’s day-to-day operation as it interacts with its environment? Assuming the leader has the internal (autopoietic) individual traits/attributes/ characteristics and the external (dissipative structure) role and style of the leadership, the ETCH facilitator at the edge of chaos is than poised to

embrace the “how” (cognitive) of an ETCH *adaptable* leadership. The “how” is an expected skill of a facilitator at the edge of chaos.

From the ETCH viewpoint creating the environment for a school/district involves a simultaneous management of the many first order superficial, short-term inconsequential changes, while also creating an environment where individuals in the system understand and deal with their second order, long-term, core-changing anxieties. The alternative where first order changes are pursued without the overall direction provided by more strategic second order change is an unwise use of resources <sup>190</sup> (Conner, 1998). Yet, Conner found that leadership is caught between first and second order change in terms of “how” to orchestrate major transitions in the work environment. The issue is that leaders of schools don’t always understand “how” to execute the “how.” (The focus has been on “what” leaders do and say to help or hinder their school’s or district’s ability to remain agile and productive during periods of extreme instability) To facilitate at the edge of chaos requires a shift from a preoccupation with “what” (event) will occur in the future to a process mentality---a focus on “how” (Process) to address key events as they unfold. (“what” are the particular needs of stakeholders is replaced by “how” (process) to address the needs of those stakeholders) In turbulence concrete predictions are unreliable; therefore maintaining a sense of balance by attempting to foresee distinct events is fruitless.<sup>191</sup>

School/district change efforts obviously imply forces at play and movement from one behavior state to another of both the organization and its leadership. The key is to embrace a balance between the “what” and the “how,” for the facilitator to achieve stability within himself, as the environment becomes increasingly *far from equilibrium*. *Adaptation* and maturation by the facilitator is a process that Conner refers to as a “journey,” and includes ten junctures of key

learning opportunities ranging from relative ignorance to mastery – in orchestrating large-scale change in major organizations as shown in Table 34, below.

**Table 34. Ten Learning Junctures of an Optimal Learning Environment Facilitator**

<b>10 LEARNING JUNCTURES FOR A LEADER OF AN EDGE OF CHAOS ORGANIZATION <sup>192</sup></b>	
<b>Levels in Leadership Mastery</b>	<b>Type of Comment Prevalent</b>
Level 1 - Ignorance	“This is easy; send a memo”
Level 2 - Education	“I got it –no problem”
Level 3 - Insight	“Oh, that’s what it means”
Level 4 - Intent	“I’ve really got to be careful this time”
Level 5 - Commitment	“This is serious. I can’t afford to fail”
Level 6 - Structure	“Now I’ve got the process and tools I need. Let’s go”
Level 7 - Discipline	“I’ll follow each step when it is required, and I’ll do it well every time.”
Level 8 - Antabuse	“When, not if, I falter, I need direct, explicit, confrontive feedback and a reminder of the cost I’ll pay if I don’t succeed with this change.”
Level 9 - Cycle back	“The only way to move forward is to go back to some earlier lessons and learn the nuances I missed”
Level 10 - Mastery	“The confidence I have gained from my past success is proportional to the humility I feel because of how much there is left to learn”

Simultaneously, as the education system facilitator progresses through levels of mastery, listed in Table 34, above, in creating an environment for optimal learning performance, the school/district itself also progresses through stages of its life within an operational paradigm in Conner’s Figure 12.1 as shown in Figure 29, below. Based on their *basin of attraction*, operational paradigms in the education system have two *trajectories*:

- Reflecting the natural course of events (unaided by a leader’s intervention)<sup>193</sup>

- Reflecting a leader’s intentional facilitating efforts to influence a paradigm’s shelf life.

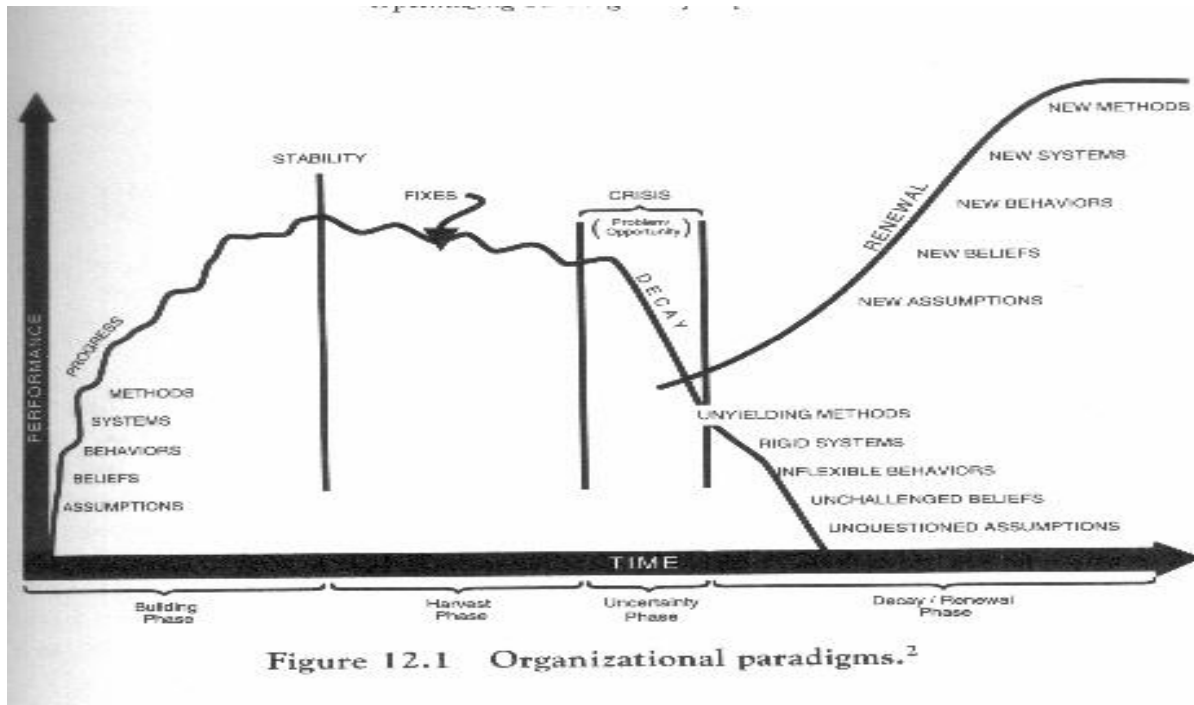


Figure 12.1 Organizational paradigms.<sup>2</sup>

Figure 29. Conner's Organizational Paradigms

Transformative second order change emerges from differences in *energy gradients* where *fluctuations* in such systems pass a *critical bifurcation point* and the system enters a chaotic *transition phase*. The readiness of the complex adaptive system “environment” to shift from current to a desired state during critical transformative change may be slight (first order change)<sup>194</sup> or dramatic (second order change). From that phase the organization may disintegrate or alternatively transform itself and emerge into a new more complex order (Merry, 1995). When faced with the need to pursue multiple options, individuals from ETCH schools/districts performing at optimal learning level tend to utilize one of two maneuvers---to ‘float’ among the alternatives, or to ‘synthesize’ a solution from the choices available.<sup>195</sup>

Second order change in the education system is a *structurally coupled* fundamental shift that unfolds as an uninterrupted progression of experiences, not as a series of disjointed events. As a learning system, when education embraces a transformative process from first order to second order paradigm shift, it would incorporate the flexibility and resilience of the complexity universalities ---universalities comprised of critical processes that enable the system to remain viable and poised for change. The existing school/district belief systems would revamp. Altered mental models comprised of new categories of unconscious thoughts, values, convictions, judgments, and unchallenged frameworks of understanding that relate to how people and things operate, would develop into new fields of meaning---a new paradigm. As compared to first order change in

Table 35, below, second order education system change transforms experiences and defies total predictability.

**Table 35. Comparison between First and Second Order Change 196**

<b><u>1<sup>ST</sup> ORDER CHANGE</u></b>	<b><u>2<sup>ND</sup> ORDER CHANGE</u></b>
May or may not lead to a 2 <sup>nd</sup> order change	Are comprised of many 1 <sup>st</sup> order changes
Produces changes in tangible aspects, but not in its nature. 1 <sup>st</sup> order change does not alter character or represent a defining moment	Is a significant experience. (like being exposed to profound knowledge; recognizing previously untapped skills; first meeting a lifelong partner; or losing the ability to perform one's profession) 2 <sup>nd</sup> order change can occur without traveling very far from home, and contain powerful hidden surprises
1 <sup>st</sup> order change begins from a particular standpoint and has a specific goal as desired outcome	Often begins with only a broad vision that may or may not ever materialize, but what always does take place is a dramatic shift in the makeup of whoever takes that path

<u>1<sup>ST</sup> ORDER CHANGE</u>	<u>2<sup>ND</sup> ORDER CHANGE</u>
Tends to produce fear of the unknown. (Fears have specific objects: a sense of impending threat from a particular person, thing, or circumstance and can be reflected as “How can I acquire enough time to learn the new system” or “I’m not sure I’ve got the experience to handle...”)	Tend to generate anxiety, not fear. (Anxiety is more free-floating than fear. It is not attached to anything specific, yet there is a sense of dread. 2 <sup>nd</sup> order change anxieties reflect unidentified and unspecified potential threats: “I don’t know where this merger is taking us as a company.” 2 <sup>nd</sup> order change anxiety has to do with longer-range issues than 1 <sup>st</sup> order change, and is dealt with not by providing specific answers, but by establishing a broad context of expectations
Directed by linear administrators	2 <sup>nd</sup> order changes are guided by creative, facilitating leaders.
Is steered by pilots	Are kept on course by navigators
Management addresses 1 <sup>st</sup> order change fears by answering precise questions about current and expected events	Leadership responds to 2 <sup>nd</sup> order change anxiety by describing possibilities and probabilities
Are inevitable	Are discretionary with purpose to advance, over time, the organization’s capacity to absorb major disruption, and include preparing an organization for even more challenging turbulence in the future
Are brief in duration	Are extensive in duration
Implement a specific objective	Build a paradigm with change at the center
Execute a precise action	Succeed in ongoing disequilibrium
Move from spot to spot	Move from place to place
Have final distinctions that represent slight modifications to what is seen today	Have final distinctions that represent a means for continued progress
Expect the short-term future to be variations of what is seen today	Expect the long-term future to be whatever it is
Treat change as a strategic or tactical shift	Treat real change as an evolutionary process
Rely on skill to execute	Rely on learning from the failures that occur
Apply what you know	Enhance how you learn and build knowledge

Consequently, instead of trying to predict which single implementation strategy would work for all initiatives, ETCH schools/districts facilitators would rely on a general collection of guidelines, principles, and procedures from which certain elements may be used for a given situation (depending on the nature of the change and circumstances presented). Really a process within a process— there is a process for determining what elements will go into the process that will be used to execute a particular change. These facilitators believe it is more important to create an environment where a plan emerges to make key decisions, than to know specifically what decisions will be faced in the future. The flexibility and agility that this strategy offers becomes a key asset that, in the long run, proves more dependable.

“How” can a facilitator orchestrate so that when important initiatives are announced, individuals within the school listen, understand the urgency, and execute their assigned tasks, on time and within budget? A facilitator at the edge of chaos aids an environment that influences individual beliefs, behaviors, assumptions, and actions, as well as the human interactive *adaptation capacity*. An ETCH facilitator will strive to create an environment, where each understands both, that factors/forces that influence the outcome of a particular change, and the “how” of change ---its “generic implementation process” itself (Conner, 1998). Five resilience characteristic behaviors (Positive, Focused, Flexible, Organized, Proactive) and three organizational variables (Leadership, Context, Culture) are practiced, committed to, and are accountable for, contribute toward creating a powerful, ETCH quality in an organization (However, maximizing any one component of a system has a cost for the system as a whole).

Creating an ETCH environment begins with a facilitated functional School Board, one that establishes an ETCH-based mission/vision, goals, and priorities, and reflect the importance of maximizing the district’s ability to identify and implement critical changes.<sup>197</sup> It is a necessary

prerequisite. Responsibility for accelerating an entire organization's "capacity" to absorb major change starts at the top – not near the top, at the top. Board members must declare an ETCH district a critical issue worthy of vigilance, then hire and retain the team capable of meeting the challenge.<sup>198</sup> The School Board provides the leadership that is prepared to provide the proper frame of reference about how change should be approached, and to ensure that the organization increases its ability to *adapt* to the advancing pressures of change. Leadership in part is fashioning a work "environment" that is specifically structured to encourage the absorption of change, and growth is change. This is best done by increasing "*adaptation capacity*" and lowering "implementation demands." Creating an ETCH environment is accomplished by facilitators who can:

- Understand and convey, meaningfully, the critical "change" priorities
- Exhibit and propagate a "mind-set" about "how" change should be addressed
- Demonstrate personal "resilience" to engage and sustain various initiatives necessary for learning success
- Create a work "environment" that promotes fast, effective adaptation to disruptions

Once the leadership is in place, the task is to prepare staff for ongoing change through a work environment established to help people adjust to change---The edge of chaos environment:

- Hires naturally resilient people and provides the training coaching, and rewards to strengthen this quality to its fullest potential
- Conditions people, at all levels of the organization, for ongoing upheaval and constantly changing conditions
- Teaches people about the dynamics of change so they feel less victimized by it and more able to manage the challenges it presents
- Extends proper delegation as far down the school's hierarchy as is feasible, and insisting on empowered relationships around each individual in the decision-making chain
- Establishes procedures and processes that provide structure to ongoing operations while, at the same time, encouraging the flexibility needed to accommodate ongoing, continuous change.
- Creates a powerful network of sponsors to properly sanction needed change in their respective areas.



Concrete, sustained change is typically the result of focused attention and dedicated resource allocation. Absence of this level of commitment from key players creates an unnecessary drain on existing adaptation resources and could jeopardize a project's success altogether.

“How” does each of the autopoietic and dissipative structure aspects, on all levels, for both the facilitator, and the organization he/she facilitates, *structurally couple* to form the *interdependent relationships that compose the whole*? In other words, assuming the facilitator commits to the ETCH mental model, and possesses the insight and foresight to embrace an ETCH mission and vision for his/her school, and the resources to provide the necessary infrastructure, “how” does the ETCH facilitator execute (tactically implement)? The assumption is focus on the “*process*” (the “how”) at each school/district level, not the event (what). In other words, a facilitator at the edge of chaos will aid an environment to invest resources to directly influence what is possible, and then rely on *responsive processes* to meet the rest of his/her school/district's security needs.<sup>199</sup> “Processes” are designed to ride the energy of the wave, not fight against it. This means understanding and knowing “how” to utilize various forces that can influence a situation as their strategy for securing control. The process to identify what changes a school/ district should make has several elements:

- Identify the specific key success factors (Provide what the stakeholders want now)
- Identify the impact indicators of internal or external pressures (React quickly to unanticipated needs and events as they unfold, instead of trying to predict events)
- Identify adjustments to success factors and the specific nature of the required changes. (Scan the horizon for early signs of emerging stakeholder requirements, new threats, or opportunities and procedures so that an early onset of the development cycle for an innovative response can occur. Managing stakeholder relations does not mean correctly guiding the details of next year's demand and then tooling up to provide only that service )
- Formalize decisions to implement these changes (Educate stakeholders about capabilities and possibilities they did not realize were feasible)
- Execute changes to achieve the desired results while preserving the human *adaptation capacity* for future changes.

With “processes” in place, the strategy for the facilitator at the edge of chaos is to apply two strategies: To raise adaptation capacity and to reduce adaptation resource demand

- Increasing *adaptation capacity* beyond that needed to negotiate current levels of change is the only way to stay ahead of the demand curve. The optimum time to build a strong *adaptation capacity* is before high levels of dysfunction have been created
- Reducing the unnecessary demands on an organization’s existing *adaptation resources*<sup>200</sup>

Increasing *adaptation “capacity”* in settings where “transition demands” are already high and evidence suggests that more, not less, “ambiguity” and “uncertainty” are in the making, accelerating “adaptation capacity” beyond what is required to negotiate current levels of change is the only way to stay ahead of the “demand curve.” Although reprioritization of existing resources is a vital component to any operation trying to survive, much less prosper in uncertain times, this tactic should not be confused with an increase in overall “capability.” When assets are moved from one category to another, overall “capacity” is not enhanced.

To reduce *adaptation “demands”* a leader facilitates an environment for the direction and commitment necessary for specific change projects to succeed. This is accomplished by stakeholders who:

- Adhere to the limitations of their part of the school/district’s existing *adaptation capacity*
- Require themselves to live up to the tough standards set for the kind of behavior necessary to fulfill critically important initiatives
- Insist that those who hold key positions in the change process are trained and expected to perform in a manner that promotes transition success
- Petition each person or team with implementation responsibilities for key initiatives to include in their plan of action an assessment of human barriers that could impede success and a description of how they plan to address these vulnerabilities

#### 4.13.1 Summary: Cognition Process

In this section, “how” (cognitive component) a leader interacts to facilitate an environment at the edge of chaos has been explored. Several guidelines for beginning the path forward to create this environment were described and are summarized as follows:

##### Organizational Level

- It would execute that, which has not yet even been requested
- It would repeatedly succeed in erratic, competitive environments through fast and effective modification of their operations. It would orchestrate multiple, even simultaneous reconfigurations of their various organizational structures
- It would rapidly redefine and redeploy their human, physical, and financial resources following a disruptive change

##### Leadership Level

- Increasing *adaptation capacity* beyond that needed to negotiate current levels of change is the only way to stay ahead of the demand curve. The optimum time to build a strong adaptation capacity is before high levels of dysfunction have been created
- reducing the unnecessary demands on an organization’s existing *adaptation resources*
- Conditions people, at all levels of the organization, for ongoing upheaval and constantly changing conditions

##### Individual Level

- Adhere to the limitations of their part of the organization’s existing *adaptation capacity*

## 5.0 THE SCIENCE OF EMERGENT STATES OF SYSTEM ORDER

### 5.1 PATTERNS OF BEHAVIOR

The fitness of a system is determined partly by the degree of interactive behavior. Depending on the prevailing environment, the behavior of a natural complex adaptive system fluctuates on a behavior continuum from order to chaos. The system, as a whole, on any point on this behavior continuum will experience periods of stasis in interaction punctuated by periods of substantial exchange of information/energy with its environment. Fluctuations of exchange suggest the system's capacity to adapt to changing environments (Lewin, 1999). Present in biological systems, in industrial economies, and more generally in evolving social systems (Lewin, 1999), the same behavioral continuum reflects fluctuations between degrees of *disequilibrium* on the one hand and disintegration on the other (Caine & Caine, 1997; Conner, 1998; Kauffman, 1995; Stacey, 1995). Within any subsection, and on every level of that social system, there will be similar tensions between stability and change. Consequently, even on a micro-agent level there will be those who are happy doing what they've always done, and there will be those who are frustrated because 'what we've always done' isn't working (Russell & Peters, 1998).

Movement on the order/chaos continuum, as described by Conner, reflects "creative tension" formed when two objectives become critical to success demands (Conner, 1998). The tension (energy) brought to life by the clash of different viewpoints is a necessity if truly creative

alternatives are to result. (For example, members of a group may struggle to reach one state because it looks like the answer for a given endeavor or for a period of time, but usually, before achieved, the circumstances shift and a very different state become more appealing.) Making the right call is possible only through the pressure and strain generated when diverse views collide in an atmosphere of mutual goals and interdependence (Conner, 1998). For instance, the examples in Table 36, below, illustrate possibilities on the space continuum where a system may choose to locate:

**Table 36: States on the behavior continuum**

<u>EXAMPLES ON THE SPACE CONTINUUM</u>	
FROM	TO
Reducing expenses	Increased Quality
Minimizing costly mistakes	Rewarding innovative thinking
Forming cohesive teams	Forming teams with diverse backgrounds
Individual effort	Team work
Discipline	Improvisation
Defined Structure	Fuzzy boundaries
Shared Perspective	Diversity of ideas
Exploit what works as long as possible	Continuous improvement
Trust logic	Rely on intuition
Zero defects	Learn from mistakes
Near-term results	Long-term vision
Tactful feedback	Frank dialogue
Patience	Urgency
Pride in accomplishments	Humility for what is left undone
Insistence on accomplishing important tasks, no matter what	Forgiveness for being human
Managing the segments	Leading the whole
Eject destructive conflict	Attract unorthodox thinking

At a certain point, though, depending on its properties, a complex system eventually settles into a behavior state called an attractor, and the system takes on an *ordered pattern* (White, 2001). It would take a major perturbation to create change and create a new basin of attraction and attractor. (Keeping in mind that a system can have multiple attractors, as in the example of cultural evolution with attractors equivalent to bands, tribes, chiefdoms, and states (Lewin, 1999) Three or four main basins of attraction (realms or patterns), identified and categorized by several prominent authors from differed disciplines in Table 37, below, are possible from change by a system on the behavior continuum between order and chaos (Conner, 1998). Each state is a system’s struggle on a “change continuum” where choice reflects various degrees of jeopardy.

**Table 37. States of Order as Defined by Various Authors**

Stuart Kauffman Biology	Lewin, (1999)	Stephen Wolfram <sup>201</sup> Mathematics	Darryl Conner Social Systems/Business
Ordered State	Static State	Type 1 Order Type 2 Order	- Complacency - Continuous Improvement - Intermediate Movement - Dramatic Movement
Edge of Chaos	Zone of creativity within the edge of chaos	Type 4 Order	Paradigm Shifts
Chaos State	Chaotic State	Type 3 Order	Chaos

### 5.1.1 Left on the Continuum: Predictability

Although the noncompetitive realm of the predictability/instability continuum, shown in Figure 30, below, may initially look attractive, it is filled with stagnant danger. Regardless of their appearance, most major organizational initiatives generate some level of distress (Conner, 1998). Ordered environments are typically more “predictable” and more amenable to being influenced.<sup>202</sup> These strategies may or may not result in favorable outcomes, but as long as predictability is intact, people feel they have some degree of control over their future. Even when the consequences of maintaining the status quo are significant, most people avoid dramatically new, unpredictable circumstances whenever possible. Most people would prefer to maintain the continuity of a negative, even self-destructive, but familiar situation (Conner, 1998).

Leaders who opt for this less stressful, more comfortable environment will find it difficult for their school/district to remain viable among others who compete for families to locate in their districts (Conner, 1998). To keep pace in a fast-moving world, facilitators must drive as much change as possible into their schools/districts without overloading their people with more disruption than they can accommodate.

The chaos realm on the behavior continuum represents the greatest amount of change-related maladjustment a person or group can experience. Chaos is entered into when significant disruptions pile upon people long after they have exceeded their available “adaptation resources.” When larger numbers of subsystems break down, it may take only one more relatively modest problem to make the system unusable or unstable. The final breakdown may be something small. By themselves, none of the small problems would constitute any real jeopardy to the usefulness of the whole, but combined with the other subsystems’ failures, the

system is unusable (Conner, 1998). When “change” continues to be poured into a saturated sponge, the consequences are threefold:

- Morale deteriorates
- The initiatives that are attempted result in only short-term, superficial application of the intended goals
- People stop listening to the leaders, who continue to announce changes that never fully materialize (Conner, 1998)

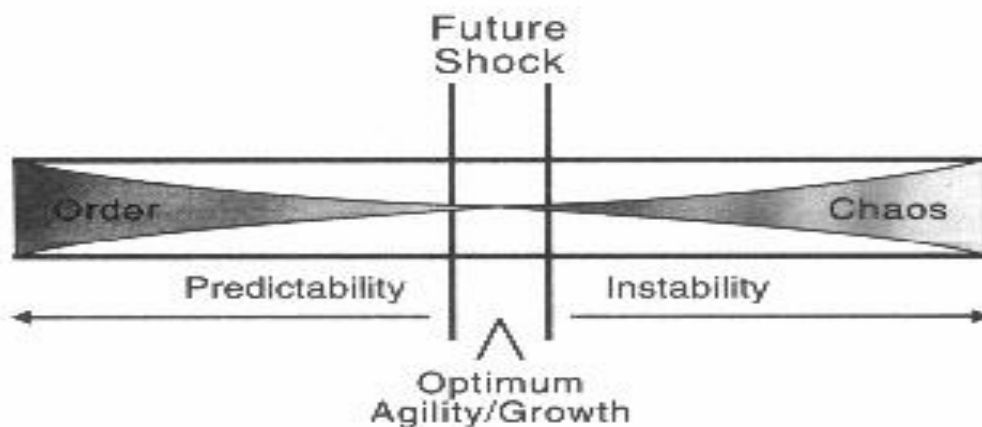
Whether the aftermath of “chaos” proves to be better or worse for those involved is, of course, subjective and immaterial to this dialogue. Once “control” is lost, it cannot be regained. The dynamics of chaos then take over. Therefore when struggling with change, there is no such thing as invulnerability--- only greater or lesser risk and liability (Conner, 1998). From one perspective, the threshold between “order” and “chaos” is crisp and unequivocal; yet, from another standpoint, it has emergent qualities (Conner, 1998). Each end of the behavior continuum represents a separate and powerful influence that balances the impact of the other--- counterweights to each other and inextricably bound together (Conner, 1998). “Chaos” doesn’t explode on the scene, it unfolds (Conner, 1998). Both exactness and vagueness are present at the same time. Once a critical mass of transition (change) magnitude and consequences has formed that exceeds an organization’s available resources, the behavior of chaos suddenly springs forth. The progressive nature of the zone is revealed once “chaos” has clearly taken hold. (For example, within a corporation that has crossed into chaos, dysfunction steadily advances until there is maximum destruction) (Conner, 1998).

How many, and which, subsystems must fail before a primary system slips from “order” to chaos? The critical issue here is determining just where “control” (“order”) leaves off and “chaos” begins (Conner, 1998). Of particular interest is the systems capacity to allow a system to move itself back toward “order” or over to “chaos”. If a system should fall back into a



strained, but still predictable, “orderly” state, it can, at any later time, again shift toward the “chaotic” threshold (Conner, 1998). If, however, the “chaos” boundary is penetrated, it cannot return in any form or version to the kind of control it previously employed (Conner, 1998). This is because resources that previously were present have been absorbed into another existing system or they were used to form a new system (Conner, 1998).

The edge of chaos (future shock) is the behavior state on the continuum that separates predictability (order) and instability (chaos) as shown in Conner’s Figure 4.1 in Table 37, below. The edge of chaos is that behavior state “order” and “chaos” where the factors that contribute to dysfunction are just forming and are only beginning to have an adverse impact on productivity and quality. Although this state is filled with possible danger, systems naturally gravitate toward this region between predictability and instability. The edge of chaos provides the greatest hope for survival and prosperity during turbulent times (times of change) (Conner, 1998). Note that the claim is not that being at the very limit of recoverability is always optimal, but rather that being able to move close to the limit often is adaptive.



**Figure 4.1 Order/chaos continuum.**

**Figure 30. Order continuum from Predictability to Instability (Conner)**

Given the forced-choice nature, the optimum move for a system is to stay within this “future shock” or “edge of chaos” behavioral state. The idea of the edge of chaos may appear contradictory in that it represents a time when the organization is literally poised at the point of dissolution, not formation. Although the edge of chaos occurs when people begin to display significant levels of dysfunctional behavior (when the demands of “change” near or exceed a person’s or group’s “capacity” to absorb the “implications” (in Conner’s Figure 8.1, as shown in Figure 31, below) preceding full-scale chaos, in its early phases, it creates a zone where Conner suggests that “nimbleness”<sup>203</sup> can thrive.

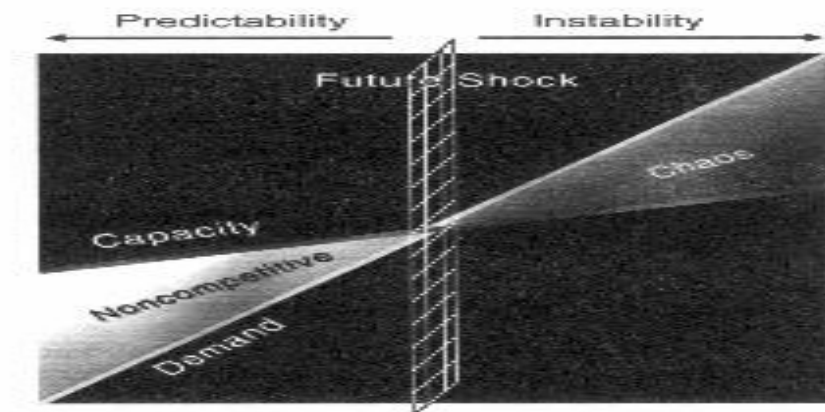


Figure 8.1 Capacity versus demand.

Figure 31. Capacity vs. Demand Continuum (Conner)

Found in the early phases of chaos, when bedlam is just beginning to form, in Conner’s Figure 4.2 “THE ZONE”, as illustrated in Figure 32, below, this system’s optimum agility/growth state on the continuum is referred to as “the edge of chaos” by Stuart Kauffman (theoretical biology); “future shock” by Darryl Conner (Business); and the point of “creative change” by Ralph Stacey (business management); “far from equilibrium” (Prigogine and

Stengers 1984); “the edge of chaos” (Waldrop 1992; Kauffman ); “bounded instability” (Stacey 1992); “living on the edge of possibility” (Caine & Caine, 1997) or “contained instability.”

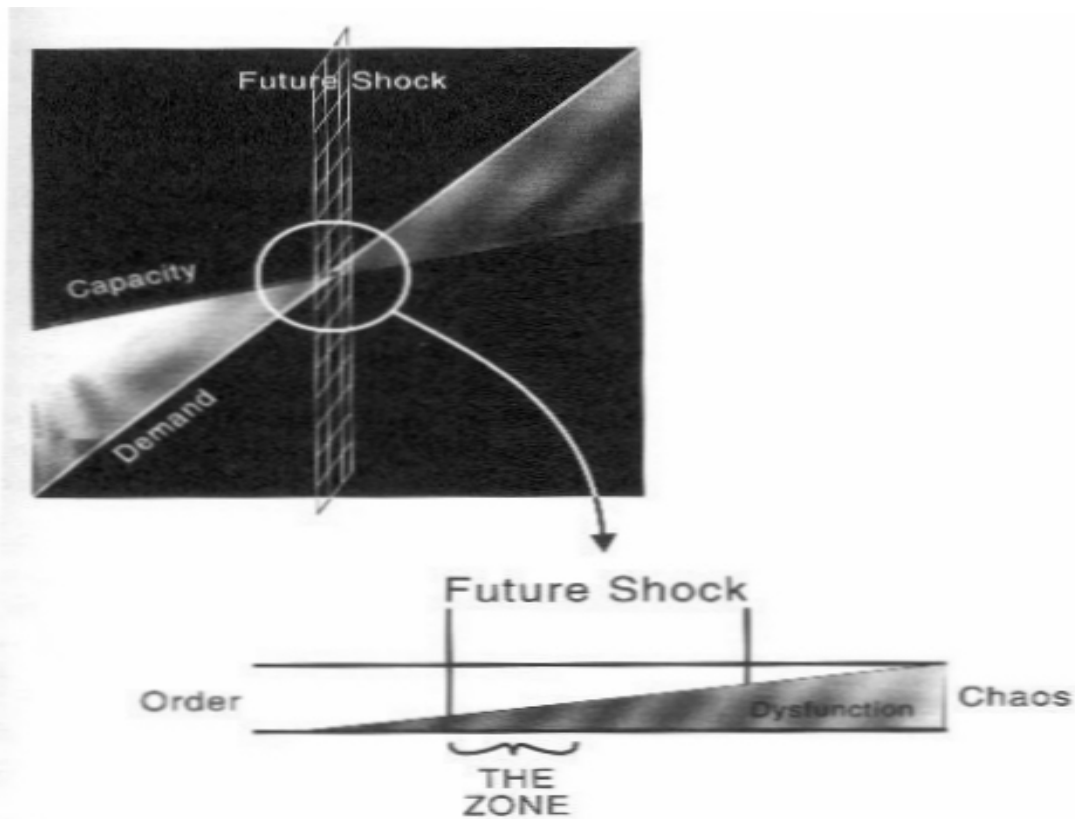


Figure 4.2 The zone.

Figure 32. The Zone

In moderate doses, “future shock” (edge of chaos) accommodates “change” without a significant loss of productivity and quality. In these moderate doses, it can cause insurmountable blockage to an organization’s competitiveness, if not its viability. Yet a lighter measure of the same future shock symptoms, illustrated in Figure 32, above, allows a social system (organization/agency/institution) to stretch, even strain, its ability to adapt to the unexpected, and the price for doing so does not exceed the gains that are achieved. It is at this early stage of

“future shock” that the optimum amount of agility can be attained before the cost of dysfunction becomes too great<sup>204</sup> (Conner, 1998).

### 5.1.2 Cognition at the Edge of Chaos

Systems able to operate close to the edge of chaos zone (where a contained slide is feasible) enjoy the benefit of a faster and more effective *adaptation capability* (cognitive *structural coupling*) compared to their competition. At the edge of chaos (between order and chaos), small cognitive networks exist that are tentatively linked with a limited number of other cognitive networks.<sup>205</sup> Success is dependent on a set of extremely sensitive, accurate, fast-feedback systems that work in concert to create the overall required agility of the system. (Conner, 1998). These cognitive networks are sufficiently ordered to carry information about themselves and accomplish dynamic goals, but close enough to chaos that they experience its tug (Marion, 1999). This “competitive advantage” materializes (not today’s needs) the response to the next generation of needs that are not yet known by the client<sup>206</sup> (Conner, 1998).

“What is in short supply is a provider that can not only do that on a consistent basis, but can also turn on a dime and reconfigure with me what they deliver and how they serve us in order that we can together meet the new, short-fuse requirements given to me by one of my customers” “I need more than current reliability – I also need future capability” “That’s a value-added partner you hang on to” (Conner, 1998).

The *process of adaptation* (cognition) to change in systems that are able to move close to the edge of chaos is relatively “optimal”---new approaches and ideas can be put forward and tried without jeopardizing the integrity of the system. When the cognitive “*adaptation capacity*” of a person or group can be enlarged without destroying the ability to recover and grow stronger, the end results will be elasticity and agility, not affliction and malfunction (Conner, 1998).

## **6.0 GENESIS OF A COMPLEXITY HYBRID THEORY OPERATIONALIZED FOR EDUCATION SYSTEM REFORM**

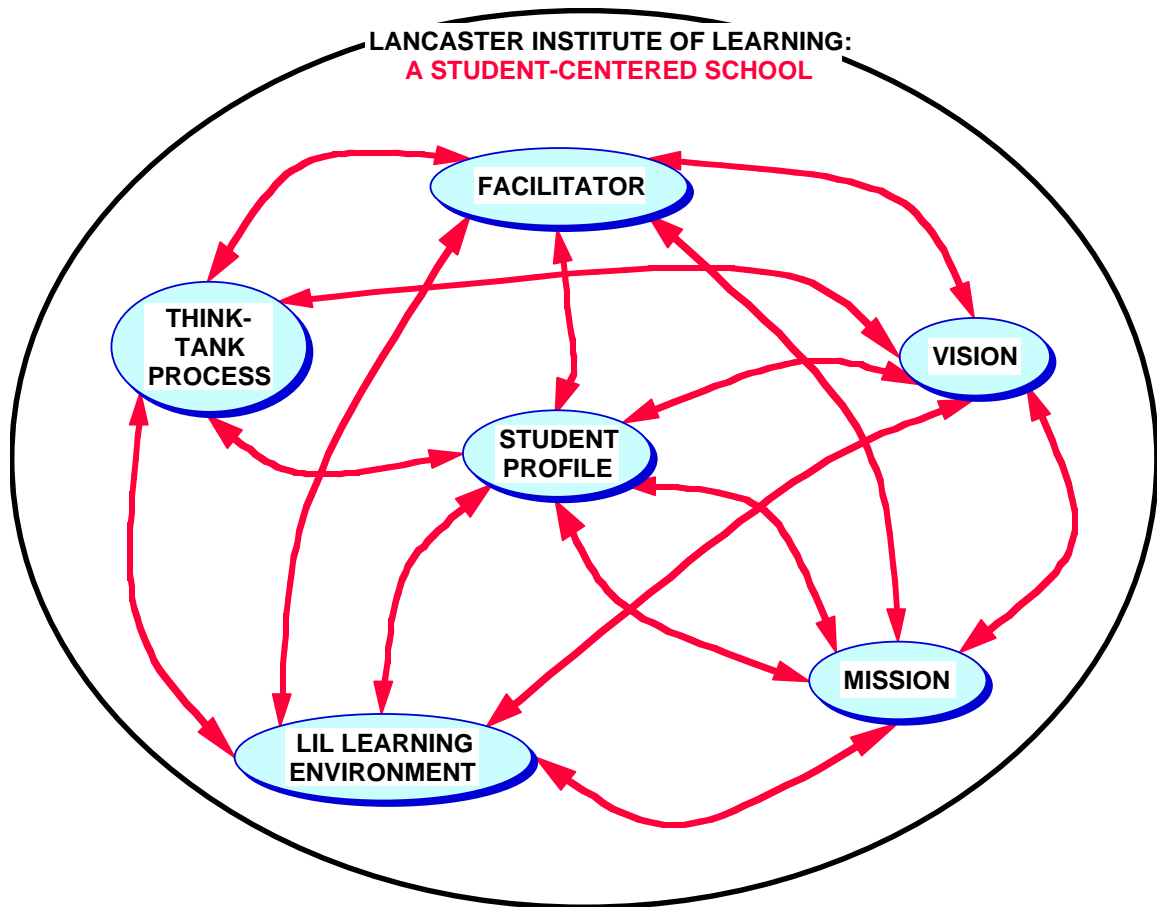
The genesis of the Education Theory Complexity Hybrid (ETCH) is contingent on establishing its credibility. Chapter 6 evaluates that credibility.<sup>207</sup> The goal in establishing ETCH credibility is to create a bridge of understanding between the complexity universalities (reflected in the New Science of Complexity Theory) described in previous chapters and their behavioral indicators present in the Lancaster Institute of Learning education system, described below. In this chapter then, I explore ETCH's ability to account for system behavior (on all structural levels of an educational system, from the autopoiesis of the student to the emergent global level education system). For this complexity Theory Hybrid to be credible, it must prove effective in guiding improved leadership of all parts of the education system. While traditional practitioners must be ready to embrace the paradigm shift that the new theory implies, I do not address the readiness of practitioners in this dissertation. I do consider ETCH's applicability to educational leadership and school system improvement. To account for productive leadership steps taken during the creation and operation of the Lancaster Institute of Learning (LIL) (1994-1998)<sup>208</sup>, a high school in southeastern Pennsylvania,<sup>209</sup> I show how the complexity universals manifested themselves in the LIL education system (part of the social system) and how they explain leadership steps taken at LIL (although the ETCH theory had not yet been developed at the time LIL existed). Specifically, as outlined below, I shall describe an overview of the Lancaster Institute of learning

(LIL) (key LIL components underlined), and use LIL to review and illustrate the following ETCH principles (universals in italics):

1. CONCEIVING THE LANCASTER INSTITUTE OF LEARNING (LIL): An Open Complex Adaptive Living System
  - a. Role of Facilitator
  - b. Role of the Empowered LIL Instructor
  - c. The LIL Think-Tank Processes: *Continual Transformation through Cognitive Structural Coupling Feedback Loop Networking (Interaction) in the LIL Think Tank*
  - d. The Emergent LIL Vision & Mission: *Emergence of an open student-centered learning school system described through the LIL Mission and Vision*
2. LIL DESIGN
  - a. The Student Profile: Identifying behavioral *patterns of organization* through the Student Profile
  - b. The Student-Centered Paradigm: *Self-organizing, autopoietic design* to transform student development in four key areas:
    - i. Psychological Component
    - ii. Social/Environmental Component
    - iii. Academic Component
    - iv. Career/Goal Setting Component
3. PSYCHOLOGICAL & SOCIAL ENVIRONMENTAL COMPONENT: *Facilitating the LIL Learning environment Setting the environment for shaping new attractor patterns for learning by identifying points of bifurcation and change in the student's mental model*
  - a. How *behavioral attractors* were shaped
  - b. "LEVELS": Setting a *self-regulation environment* for new choices of student behavior
4. ACADEMIC COMPONENT
  - a. Establishing *New Attractor Patterns of Learning*
  - b. One-on-One Content Instruction
  - c. Integrate Group Interaction (IGI) & Group:
    - i. *Feedback Loops* in the content and skill learning processes through Integrated Group Interaction (IGI) and *interconnective, collaborative learning, (Group)*
    - ii. *Cognitive Structural coupling* to shape upper-level thinking skill development through "Group"
5. FIELD TRIPS: *Structurally coupling* in student learning environment through field trips
6. CAREER/GOAL SETTING COMPONENT: The student at *phase transition* identified through career exploration, community service, and apprenticeships

## 6.1 CONCEIVING THE LANCASTER INSTITUTE OF LEARNING: AN OPEN COMPLEX ADAPTIVE LIVING SYSTEM

From the viewpoint of ETCH, the Lancaster Institute of Learning was a social system that exhibited an interconnected combination of autopoiesis (self-organizing, internal processes), dissipative structure (its interaction with its environment), and cognitive system processes that could adapt to change,<sup>210</sup> where flexibility was built into the design and the design could adapt for change. Within the design, interconnected, interdependent processes and their underlying universalities, reflected observable behaviors both within and between LIL's organizational/communication levels. From the ETCH perspective, LIL was a self-organizing, emergent, open, nonlinear, structurally coupled, complex adaptive system, where these universal patterns of behavior (complexity universalities that included an interconnected network of interactive self-organizing feedback loops), manifested through the Lancaster Institutes Autopoietic Process to shape the school's design. As shown in Figure 33, below, the organizational/communication feedback loops cycled between the role of the facilitator; the process that *emerged* the vision and mission; the LIL think-tank process; the process that *emerged* the LIL learning environment driven by data from the student profile; and the resultant process that emerged LIL student-centered paradigm. The following LIL description illustrates these LIL feedback loop processes as observed through ETCH application.



**Figure 33: LIL Communication Feedback Loops**

### **6.1.1 The Role of Facilitator**

Unlike the role of the traditional school administrator who envisions a one way linear causal process in which teachers with knowledge and skills package and transfer these like a package to a student, the facilitator in an ETCH system, through the development of “how” processes, will constantly facilitate steps to stretch his/her school’s capacity boundaries, by introducing as many goal-directed changes (aligning with the vision and mission) as possible without overextending available adaptation resources.<sup>211</sup> The role of facilitator requires a dedicated focus to building



and constantly updating processes to stimulate rapid response in how staff thinks, feels, and behaves during the school's continual *adaptation* and evolution.

The LIL school administrator *emerged* as a “facilitator” to network with both the school's stakeholders internal to the school system, and with stakeholders external to the system in the neighboring traditional school systems. Through networking, the LIL facilitator took steps to increase the school's capacity to absorb disruption by framing the processes that encouraged the interaction to empower staff to emerge further processes that led to desired changes in school system program and activity. Simultaneously, through a mutual cognitive *structural coupling* with the environment (including teachers, peers, family, etc), and the interconnected *feedback loop networking process* (the LIL think-tank processes, explained in more detail in next section), the facilitator created an environment for its stakeholders<sup>212</sup> (agents) to continually insure that the vision and mission was vital, relevant, current, and that the enterprise was an “open system” (keeping people and things in an unending growth-and-renewal mode ).

In other words, the vision and eventual emergent strategic plan (which assumes a bottom-up feedback loop structural process), started from the facilitator's mental model---a desire to create an environment where the student could feel safe and find success without watering down curriculum. The LIL facilitator then shaped the contextual environment which evolved from her vision into an emergent mission, through the structural coupling of staff, students, and stakeholders.

Designed to tap the synergy among staff, these processes that were operationalized in the school's environment through the facilitator, adjusted/adapted depending on the nature of the changes and circumstances presented. In other words, the facilitator in an ETCH system was

the conduit for an environment that capitalized on “how” (process)<sup>213</sup> to empower an *open learning school system*---an *open* environment within the school’s day-to-day operations where *creativity* thrives, so that when important initiatives are announced, staff listens, understands the urgency, and executes tasks, usually on time and within budget. Consequently, it is a greater priority for the facilitator to create an environment where a plan emerges to make key decisions, rather than to dictate the specifics of decisions to be addressed.<sup>214</sup> The flexibility and agility offered by this strategy becomes a key asset that, in the long run, proves more dependable for cutting edge sustainability.

### **6.1.2 Role of the Empowered LIL Instructor**

The facilitator specifically created a work environment to help instructors and staff adjust to and absorb change. Complexity theory suggests that this is best done by increasing *adaptation* capacity. The relationships between staff, facilitator, and student in LIL determined the system’s essential characteristics or identity---its *patterns of organization*. The facilitator realized that absence of commitment from key instructors in this school’s working environment would have created unnecessary drain on existing adaptation resources and would have jeopardized the project’s success altogether. Empowerment created a vested interest in the role of LIL instructors. Each instructor’s input, treated with respect, raised the level of commitment, accountability, and responsibility to insure that the system operated at a higher level of performance.

The role instructors played in the school was very different, which meant “change” for most LIL instructors. At LIL the dialogue with the teacher was a goal-action-feedback cycle that interconnected with the student’s learning cycle. The goal was congruence between teacher and

student, wherein each achieves richer insight and learning (Laurillard, 1999).<sup>215</sup> Even a public school tenured teacher or an instructor with a master's degree employed at the Institute was challenged to reevaluate the relationship between student and teacher. Therefore, professional training at LIL became imperative. A three-day, over-night yearly camping retreat was a mandatory component of professional development at LIL. It was necessary for the teachers to understand how to interconnect with the students, how to interconnect with each other; and with the facilitator. Trust built into relationships was imperative as part of the LIL environment.

Distrust among students was very high when they entered the LIL. The facilitator believed that if the trust connection between the teacher and the student was encouraged to develop, the student would then be more willing to lower defense mechanisms and abandon the vulnerable fear-based layering that instilled the inappropriate decision-making. The LIL instruction staff required professional development training, in what evolved into a policy of how to interact with a student whose behavior challenged acceptable behavior. Learning and teaching were not seen as a one way linear causal process in which a teacher with knowledge and skills transfers these like a package, to a student (Merry). Learning and teaching were not seen as linear preplanned processes, with sharply defined, pre-packaged modules designed to be transferred in strict order to the learner (Merry). The teacher's role was also one of a facilitator (not traditional decision maker) who had a counseling relationship with students and who guided their growth and development

- The instructor facilitated an environment where students explored ideas and feelings about themselves, their schoolwork, their relationships, and their future
- The instructor facilitated an environment where students and teachers partnered in the learning process, being open and honest
- The instructor was patient and focused on each immediate benchmark.

- The instructor created an environment of trust so that the student could explore his needs and values to make educational and personal decisions, formulate solutions, evaluate perceptions and feelings, and clarify their ideas.
- Through reflective listening, the instructor empathized with the student's viewpoint to create an atmosphere of dialogue in which the student's self-direction was nurtured and developed.
- Through that created environment of trust, the instructor embraced student's fears of feelings and thoughts perceived to be "wrong."

The *relationship* between student and instructor was seen as a two way *interactive process* (U. Merry). The learner was not a passive receiver but learned through *actively interacting (structurally coupling)* with the teacher, and testing knowledge acquisition through application (U. Merry). The student learned by working on the material and bouncing it against his experience and his internal models (U. Merry).

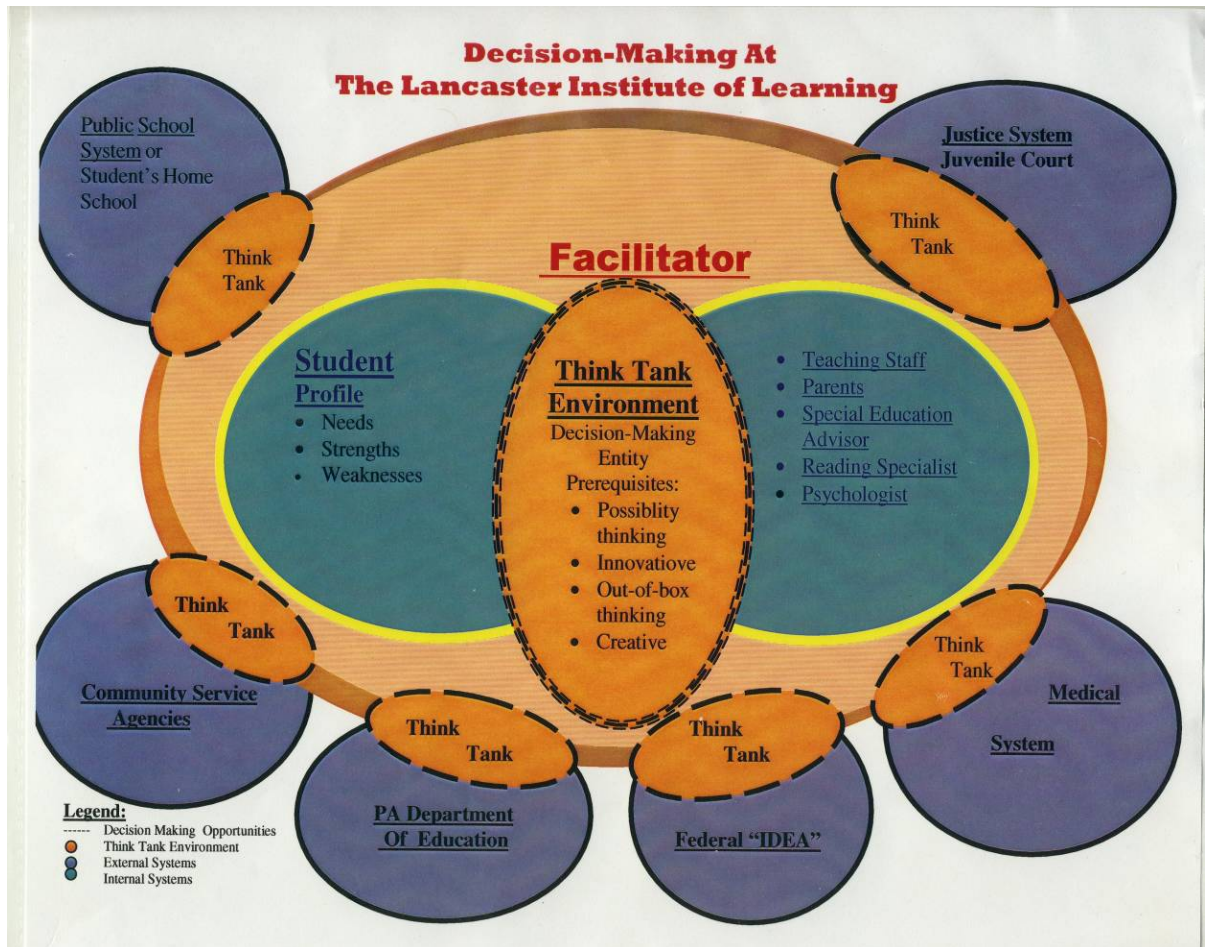
One of the most challenging hurdles to overcome during teacher training sessions at the Lancaster Institute was preparing teachers for the developmental enigmas that surfaced with the students who attended the school. I chose the term "enigmas" because each student's "case" was so different, and each student's case was not as it presented initially.

There was an initial challenge to instill within the instructors that these students did not fit the "logical mold" regarding chronological age or grade verses academic development, and that neither age nor academic development accurately reflected or determined academic aptitude. An example comes to mind where the Institute enrolled a ninth grade young lady who had successfully concealed a big secret. The beauty of one-on-one instruction at the Institute, in this case, was that its process successfully uncovered the accurate reading level for this ninth grader to be at second grade. Obviously, she successfully avoided detection in public schools for a number of years. In six months, the Institute was able to increase her reading level from second

grade to sixth grade. Her developmental stage, the instruction model tailored for progressively more difficult reading levels, and her capabilities in needed skill areas like reading merely needed to be "aligned" for her to succeed.

### **6.1.3 The LIL Think-Tank Processes: Continual Transformation through Cognitive Structural Coupling Feedback Loop Networking (Interaction)**

The LIL working environment was created to empower instructors to identify what variables tailored best as the process that would execute a particular student-centered change.<sup>216</sup> Through the autopoietic emergence universality, a “think-tank”<sup>217</sup> process developed as shown in Figure 34, below. It emerged not for the transmission of information between staff, but as a delicate interplay between the combined processes of structural coupling, far-from-equilibrium, irreversibility, and feedback loops among agents (stakeholders) in a system far from equilibrium. The Think-Tank was a collective, coordinated behavior among living organisms---a synergy that emerged from the interconnected, interrelationship of the system’s parts (instructors, parents, special education instructors, reading specialists, Psychologists, social worker), where individual living systems became part of each other’s worlds as they communicated with one another and coordinated their behavior (Maturana, 1987) for the benefit of each student.



**Figure 34: The Interconnected LIL Communication System**

Through the ETCH lens, for the LIL facilitator to create an environment for LIL to operate at the edge of chaos, empowerment of staff to optimally contribute to the “think tank” team capitalized on the *emergence* process---a bottom-up cyclic process. Operating in an edge of chaos environment suggests that no solution is ever permanent. Rather, mental models of solutions or goals are malleable commodities constantly reworked by the system’s stakeholders to meet changing conditions (Horn & Carr, 2000). At LIL, this meant that through individual and collaborative patterns of interconnections within the school, feedback *loop processes* began with the student’s internal autopoietic-cognitive processes and emerged into the vision and

mission of LIL. In addition to this internal “think tank” process, the facilitator also interconnected with external systems that encouraged adaptations. As shown in Figure 34, above, other public school systems, community service agencies, the Pennsylvania Department of Education, Federal mandates like IDEA, the medical system, and the justice system stimulated and participated in think-tanks with the LIL facilitator to *emerge* a comprehensive learning environment for the student. Such mutual coordination of behavior is the key characteristic of communication of all living organisms, with or without nervous systems. Consequently, rather than setting goals and setting the route to reach them, the LIL facilitator created the conditions that nurtured (rather than stifled) creativity by shaping the process of identifying student needs. The facilitator focused on addressing “how” (the process) the school identified student needs instead of “what” particular needs students had.

#### **6.1.4 The Emergent LIL Vision and Mission: Emergence of an Open Student-Centered Learning School System Described Through the LIL Mission & Vision**

A window into the philosophy, vision, and strategic planning of the Institute illustrates how the *open system, feedback loop process, and structural coupling* patterns of behavior (three of the Complexity Universalities) manifest through the Lancaster Institutes *autopoietic process* to shape the LIL vision and mission.<sup>218</sup> As a critical aspect of school organization, facilitating for a *structural coupling* process that enhances flexibility, creativity, adaptivity, and continual evolution is essential. Through its *cognitive structural coupling process*, the LIL facilitator and empowered staff shaped the contextual environment that guided individual behavior by

articulating the school’s emergent context (vision, mission, strategy) in a way that promoted and reinforced resilience of the whole system.

Through *feedback loop interaction*, the mental models of LIL stakeholders within the system evolved and emerged as Vision and Mission statements that took on a behavioral identity in terms of structure and outcome.<sup>219</sup> Through impromptu staff & facilitator brainstorming about purpose and goals, the mission statement for this private, state-licensed high school emerged and declared:

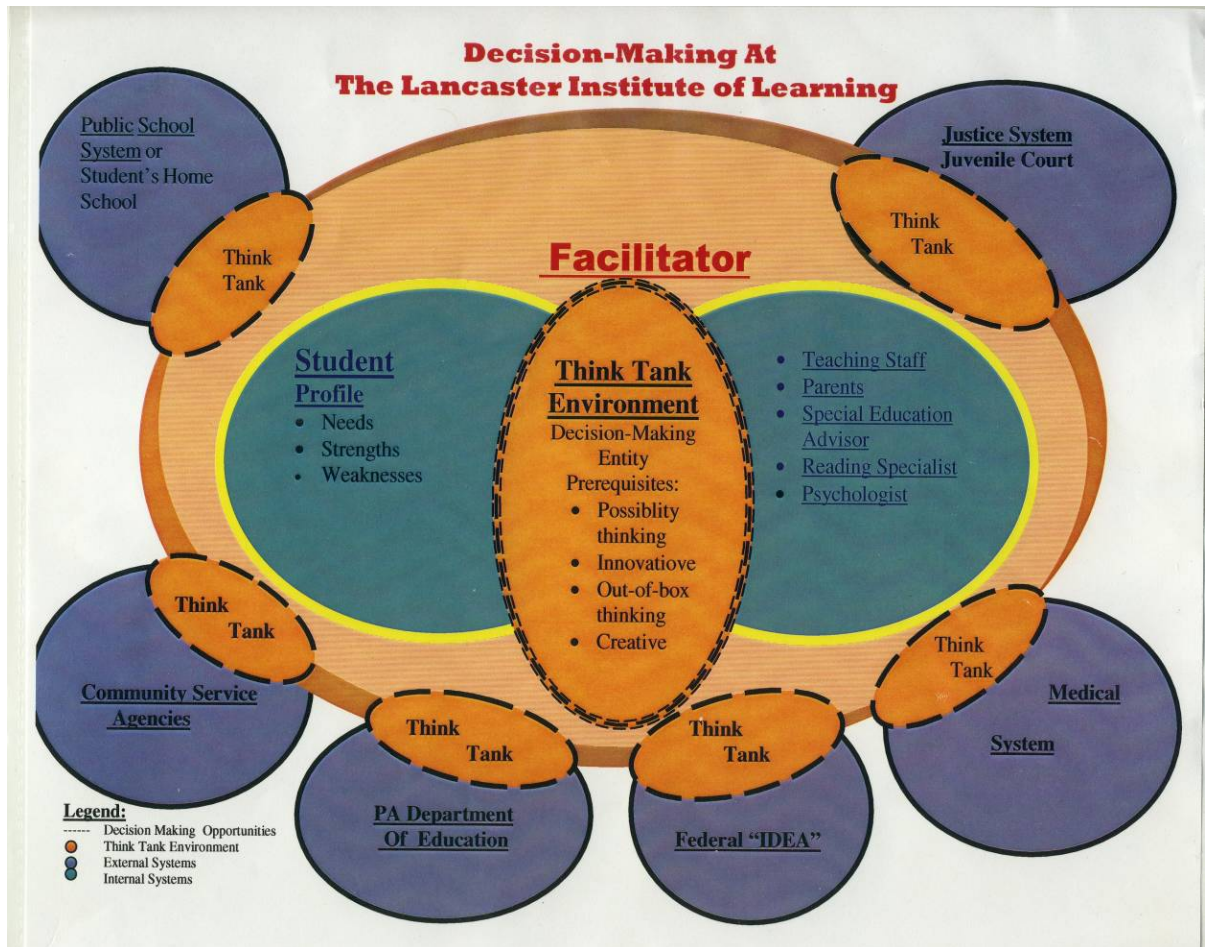
“The Lancaster Institute of Learning, a non-discriminatory school, provides a non-traditional learning environment, committed to creating a community of life long learners able to think critically, work cooperatively, and make successful contributions to the work force and society”

## **6.2 THE LIL DESIGN**

### **6.2.1 The Student Profile: Identifying Behavioral Patterns of Organization through the “Student Profile”**

At the core of the LIL vision or mental model was the ““Student Profile,” shown in Figure 34, below, around which the entire decision-making emerged around the needs of those students.





**FIGURE 34: The Interconnected LIL Communication System**

It was the “Student Profile” that provided the primary vehicle for shaping the needed structural couplings of the open LIL school system. The facilitator created the environment for the process used to profile the student to emerge within the “*think tank*” of the school (This “*think tank*” environment would self-organize spontaneously as the stakeholders adapted to the emergent challenges presented in the student profile) The *facilitator* together with the teaching staff, parents, special education advisor, reading specialist, and psychologist” comprised the think tank and identified, as shown Figure 34, above, the “*needs, strengths, weaknesses*” of the student. Then, developed an operational “student profile” for each student. Embracing the

dynamics of these processes requires understanding the importance of student's history external interactions with his/her environment. The instructors very quickly learned never to accept at face value what "appeared" to be fact. Developmental status did indeed influence, plus or minus, how, and in what degree, the child learned. The key was to correctly identify the holistic profile of the child and successfully choose the teaching methods that would not only unlock the developmental process but stimulate progress. Both Piaget's contribution from Intellectual Development Theory, Kohlberg's contributions in Moral Development, and Gardner's Multiple Intelligences were considered in identifying the developmental levels of students as well as how these developmental levels influenced the construction of thinking. From this regard, the developmental theories were one of the most beneficial pieces of information in the design and structure of the Lancaster Institute, because they crystallized to my staff the pivotal necessity of correctly assessing and adapting to the "developmental level" of the child. These theories suggest a connection between learning and learning styles as the student progresses through developmental levels.<sup>220</sup>

In order to accurately document the academic starting point with every student, a collection of assessments were made of the student when he/she entered the Institute. The purpose and goal of this profile was to align the curriculum with the child's "real" academic developmental level.<sup>221</sup> Appearances could be deceiving. Therefore, in addition to the skills assessment incorporated in the "Group" process, a reading, math, and spelling assessment was also administered. Psychological evaluations were extracted from the student's data that arrived from the home school. The facilitator and staff observed the student in various settings.<sup>222</sup> All of this data was collected and discussed at the think-tank session where all the staff participated. Discussion centered on developing a plan of action based upon the data in the student's profile.

## 6.2.2 The Student-Centered Paradigm: Self-Organizing, Autopoietic Design to Transform Student Development in Four Key Areas

Through the Vision and Mission at the LIL, it was ultimately determined, that for a student to have a chance at success, an individual, student-centered would create an optimal learning environment. The vision and mission in the LIL learning education system, established the autopoietic parameters of a student-centered process designed for optimal performance level learning, where the student was the greatest resource, not the teacher (Jastron, 2005). The paradigm shift from the traditional education paradigm to the complexity hybrid redefined the learner from an absorber of information to one who interacts dynamically with it (Caine & Caine, 1997).

Redefining the learner presented a two-edged sword: How to visualize the school's mission/purpose of a student-centered school by identifying the student's holistic attributes, skills, strengths, weaknesses, and needs, and at the same time avoiding enabling the student's presenting behavior.<sup>223</sup> A student functions simultaneously at many different *scales*; however, traditional evaluation systems are not designed to deal *with self-similarity or radical emergence* that are evident in *scaling* phenomena in a complex adaptive system such as a student. As a system, a child (student) may reflect the tension felt in an entire school, just like a group of students emerge into a dynamical course of events that affect the entire school. Therefore, by realizing that each student is a composite of externally as well as internally influenced processes, the LIL facilitator, provided the phase transition environment enabling the student's choice for the necessary paradigm shift (shift in *attractors*). Within this shift of attractors, through the student's *structural coupling* with the LIL tailored environment, the facilitator provided many *sensual interactions* on fronts that

were both external and internal to the student. As a result, the school's interaction with the student was systemic/holistic. As shown in Figure 35, below, for the student this meant that his/her learning environment had to structurally couple in four pivotal ingredients of the student's life:

1. The student's academic environment (focus on cognitive structural coupling processes as student utilized his senses in the learning process)
2. The student's personal social environment (including peers and family) (focus on dissipative structure processes as the perception of the student interacted, adapted, and ultimately made decisions that impacted his social environment )
3. The student's self-esteem (internal decision-making process) (focus on autopoietic processes as the perception of the student was challenged to reflect and evaluate his/her choices, to make adaptations to align his/her actions with his/her goals)
4. The student's career and goal setting (for both present and future) (focus on cognitive, autopoietic, and dissipative structure processes as the student in phase transition encouraged by his/her learning experiences, challenged decision-making processes, and maturation development to embrace, plan, and adapt for life after LIL ).

Through the LIL think tank, the yellow boxed items in the Figure 35, below, emerged as the means by which the four student-centered components, listed above, were implemented, and in turn lead to the student having a more positive mental model to guide his behavior.

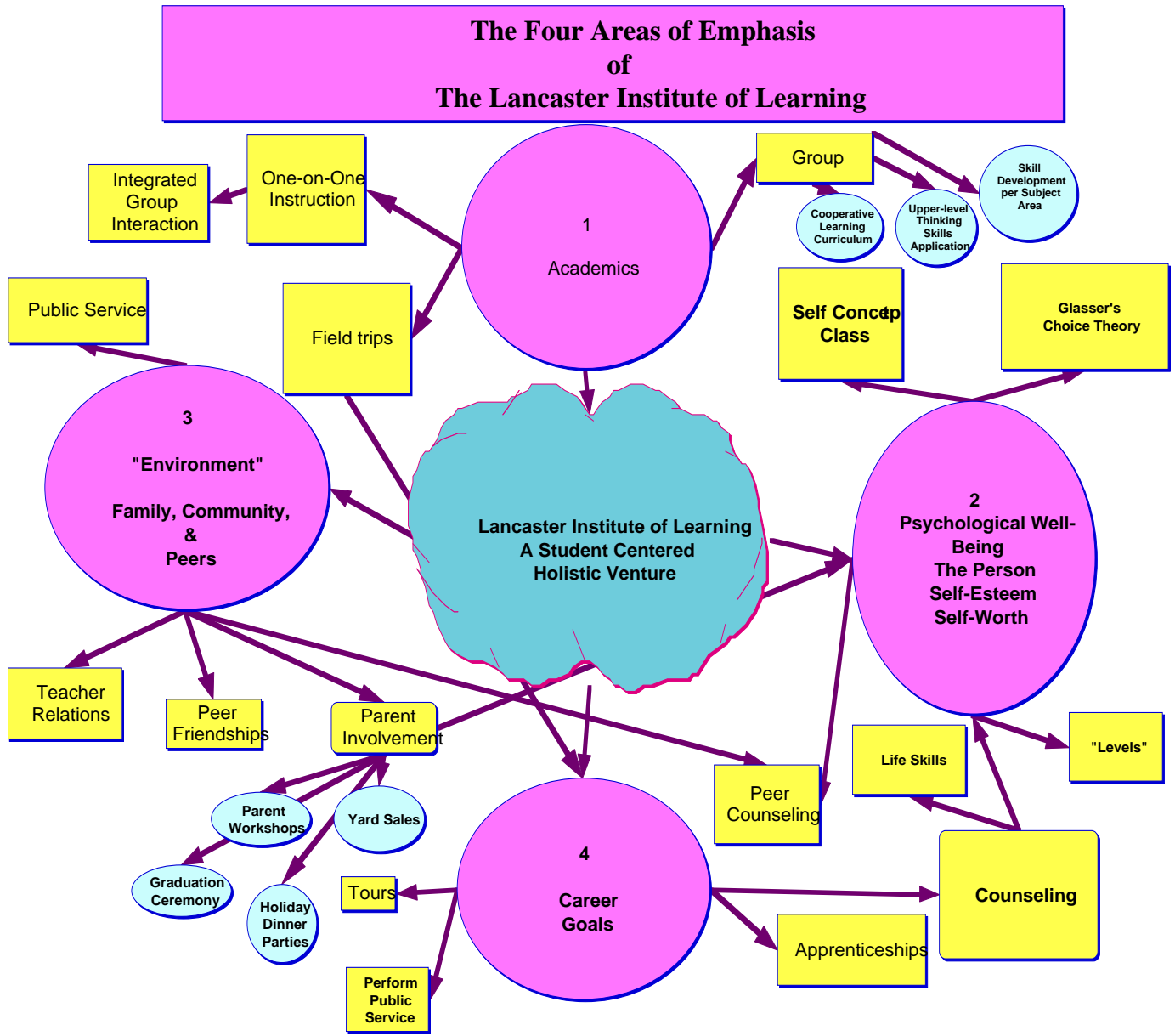
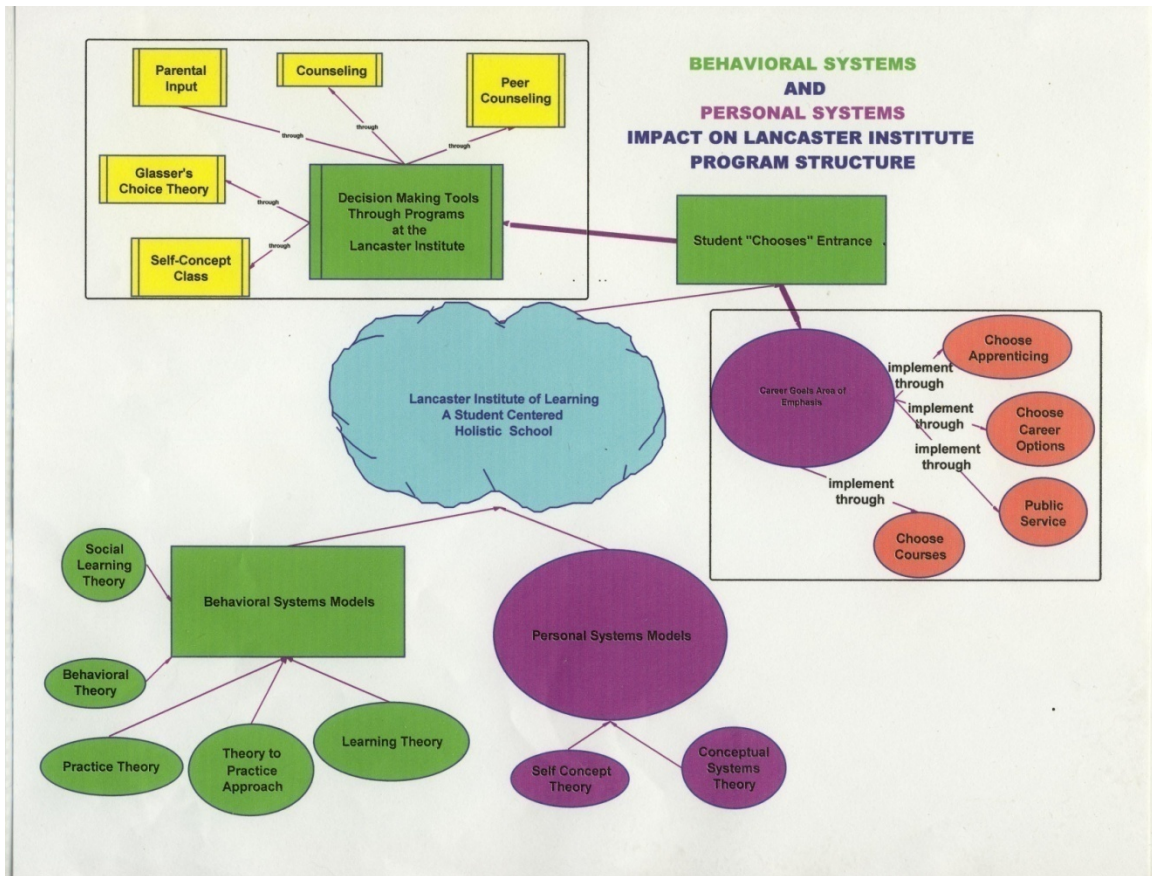


Figure 35: The LIL Student-Centered Paradigm

**6.3 PSYCHOLOGICAL & SOCIAL ENVIRONMENTAL COMPONENT:  
FACILITATING THE LIL LEARNING ENVIRONMENT BY SETTING THE  
ENVIRONMENT FOR SHAPING NEW ATTRACTOR PATTERNS FOR LEARNING  
BY IDENTIFYING POINTS OF BIFURCATION AND CHANGE IN THE STUDENT'S  
MENTAL MODEL**

The LIL facilitator capitalized on creating perturbing environments where necessary bifurcations encouraged a “new state of order” that the student internalized and to which the student made a commitment. The think-tank team applied complexity hybrid universalities by capitalizing on the self-bounded, self-regulated, and self-perpetuated aspects of the student’s autopoietic process. Transformation occurred as structural coupling interactions occurred between the student’s external boundaries and his environment. The learning environment at LIL was developed by weaving together two groupings of interconnected education theories as shown in Figure 36, below. The first group, included the Social Learning Theory, Behavioral Theory, Practice Theory, and Learning Theory. The second group included Self Concept Theory and the Conceptual Systems Theory.



**Figure 36: LIL Interconnected Program Structure**

The internal operating systems of the student, includes his/her structural coupling (cognition), emotion, and perception. These maintain the student's (and the school system's) boundaries and vitality. The think-tank team created an environment that affected these boundaries in the student's autopoietic, cognitive, and dissipative structure. The student continually evolved, organized, and reorganized his mental models based on information gleaned from those he interacted in both the school and additional environments external to the student.

In ETCH language, the think-tank team capitalized on the non-linear effects of the dissipative structure process between the student's autopoietic, dissipative, cognitive processes

and those of his environment. In other words, the Lancaster Institutes' own dissipative structure embraced the student as a dissipative structure. This shaped each LIL student profile and the *LIL nonlinear patterns of behavior of a student-centered school*.

### **6.3.1 How Behavioral Attractors were Shaped at LIL**

Therefore, as a *dissipative structure*, the LIL student was an *open system*\_making him/her *permeable to influence*\_. The LIL students shared a commonality---they were not finding success in the public school environment. Many carried various special education labeling including “gifted” (IQ above 130) AD (attention deficit), ADHD (attention deficit hyperactive disorder), and SED (social emotional disorder) to name a few. When external environmental interaction (by teachers, other students, etc.) with the student resulted in a label of inadequacy, the student, through structural coupling responded and adapted (coped in order to survive) accordingly. As this feedback loop persisted, the student reached a bifurcation point, where the student's behavior/choice of actions was unpredictable. As a *dissipative structure*, the student's response behavior had the potential for disproportionate, exponential, *nonlinear effects*\_. Through feedback loops, the impact of a previous external interaction would become the input for the next encounter. As *iteration* magnified the effects of the nonlinearity, simple causal relationships were virtually impossible to detect, to measure, control, or evaluate. His/Her history of structural coupling (fine or course grained), and various external conditions determined if the student broke down or broke through to a new state of order. For most the Lancaster Institute was the last resort to dropping out of school completely.

With the Student Profile and Think-Tank process in place, in addition to influence on the student as a dissipative structure, creating a paradigm shift within the student *autopoietic*



*processes* meant creating an environment that removed the debilitating stigma of previously attached labeling, and meant a deliberate focus on the concrete in the form of descriptors and action plans that:

1. Concentrated on observable behavior (opened the door for the use of Glasser's Choice Theory to be implemented at the school)
2. Clearly defined tasks and methods for interacting with the student (encouraged one-on-one instruction, accountability, and a concrete tracking structure of updates, progress, setbacks, etc within the school)

Component I of the LIL design: that the school concentrates on observable behavior: As mentioned previously, the student that “chose” to attend the Institute had not found success in the public schools as one of twenty-five students in a class. As the student structurally coupled in his previous public school environment, lack of success/progress had prompted some type of labeling, or placement into a special education program (to provide more services for the student), or retention (to provide another opportunity for the student to acquire the skills and content.<sup>224</sup> Through the intake interview process at LIL, these students shared the effects, both autopoietically and as a dissipative structure to the many years of exposure to non-success (often through no effort of their own), and the resultant impact into every pivotal area of his/her environment both at school and home. The student's interviews disclosed a perpetuating progression of autopoietic coping mechanisms that had materialized in a choice of maladaptive behavior, which then developed into an environment that surrounded the student and continued to encourage the behavior to continue negatively (A true “Catch 22”).<sup>225</sup>

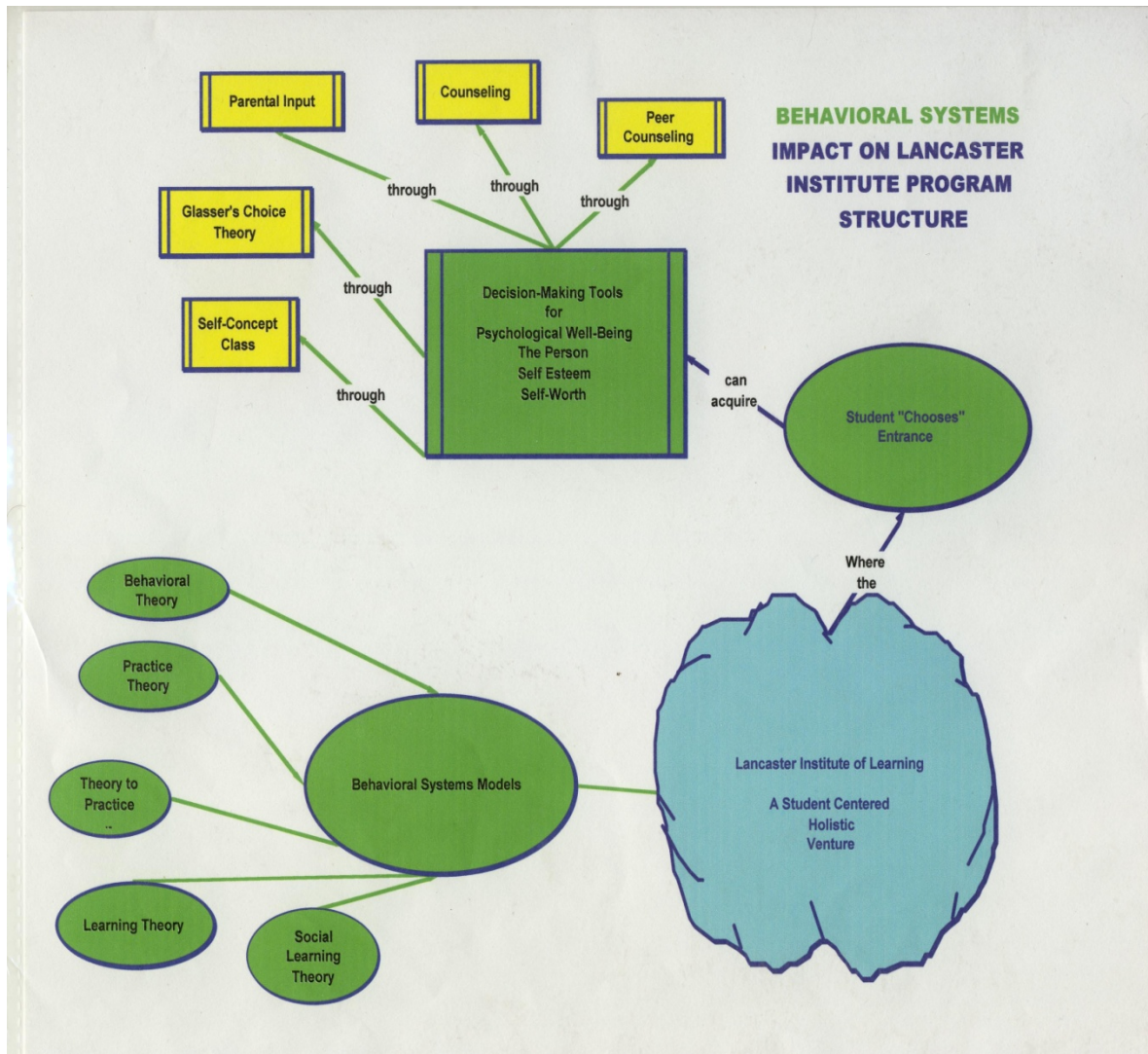
To understand the rationale for the Lancaster Institute's creation meant clearly identifying the observable behavioral profile of the student. By concentrating on observable

behavior with immediate feedback-loops that encouraged adaptive behavior choices, with plenty of devised autopoietic opportunities to reflect on choices and their consequences, the dissipative structure of the student through environmental interaction discovered new attractors for new choices of observable behavior that aligned with his/her choice of goals.

Component II of the LIL design: To clearly define tasks and feedback-loop approaches for interacting with the student (encouraged one-on-one instruction, accountability, and a concrete tracking structure of updates, progress, setbacks, etc within the school) Glasser's model urged clearly defined tasks and methods for interacting with the student. Glasser's method focused energies on mental model perturbations that target needed behavioral bifurcations. Consequently, LIL students were reminded and held accountable for choice of appropriate behavior by establishing their control for choices. The LIL *student* controlled his decision-making process, thereby releasing and redirecting negative placed energy back into productive strides forward. With clearly set boundaries and clearly established consequences for choices, each student holistically empowered appropriate behavior which opened the door to address the academic component.<sup>226</sup>

By creating an environment where the student had control to choose, LIL provided opportunity for the student to reflect and adjust behavior to new *basins of attraction* by peeling at the layers of inappropriate behavioral decision-making, in a safe, nonjudgmental environment. The student could replace inappropriate choices with appropriate ones.<sup>227</sup> As shown in the yellow rectangles in Figure 37, below, safe, nonjudgmental environments to explore choices and consequences included the self-concept class, counseling, peer counseling, parental input, and feedback using Glasser's Choice Theory. Through this combination of decision-making tools, the student was encouraged to embrace alternative options in decision choice<sup>228</sup> that would align

with his short-term and long-term goals As a result of the various LIL efforts, the student's perspective broadened from "living only for today" to implementing long-term self-actualizing objectives.<sup>229</sup>



**Figure 37: Structural Coupling Between Education Theory and LIL Practice - As Tools for Student Counterconditioning**

Operationalized, the student entered the school where he/she had control for decision-making. As shown in Figure 37, above, to establish the environment for "counterconditioning" to occur prospective students were given a tour, provided with the philosophy of the school and provided with three pre-requisites in order to enter the school:

1. Had to be at the school by choice.
2. Had to be willing to give 100% effort.
3. Had to be drug free.

Nothing else mattered ---not a non-successful past, run-ins with the legal system, or time in a psychiatric hospital were of consequence.<sup>230</sup> Through the student/parent/ principal contract (Appendix C), the student had to "choose" to enter the program. The expectations of LIL were clearly delineated, which included a guaranteed two to three hours of homework per night; hard work; lots of hugs and support; and a framework of accountability. Once enrolled the student turned his decision-making to choosing courses, from which the student had a large pool to select. The student was provided with the information to make wise decisions. Course choices and update meetings occurred four times per year and were attended by the student, his/her parents or guardians, the student's teachers, and the facilitator. The meeting environment was designed to encourage open discussion where ALL present provided input, including the student. The final decision in course selections, however, was the student's.

As a result, the student's mental model supported the following goals:

1. To lead the student toward greater mental and emotional health by developing self-confidence and a realistic sense of self and by building empathetic reactions to others
2. To increase the proportion of education that emanates from the needs and aspirations of the students themselves, taking each student as a partner

in determining what he or she will learn and how he or she will learn it

3. To develop specific kinds of qualitative thinking, such as creativity and personal expression" (Models of Teaching (283)

### **6.3.2     “LEVELS”: Setting a Self-Regulation Environment for New choices of Student Behavior**

The at-risk student that attended LIL obviously had more diversified issues that interconnected and impacted many levels of student development and contributed to academic non-success. Recent research suggests that impacted developmental levels include change in the composition of the chemistry in the brain of the student (Miller, 1995). “The “brain’s centers for emotion move the individual to rage or to tears” (Goleman, 1995).)   Constant stress and threat to this degree in students lives rewire emotion circuits (LeDoux, 1994). Debilitating experiences can actually “hard-wire” the brain and induce dysfunctional thinking for life.<sup>231</sup>   A new theory on volume transmission (Adnati, Bjelke, & Fute, 1992) paints an even more complicated picture by hypothesizing that not only does “communication” occur between neurons and axons but information also passes through the extra cellular space. In the notion of “downshifting,” the response to a threat accompanied by a sense of helplessness or fatigue, can be hard-wired into the mind/brain so that the brain remains on high alert.

The at-risk manifested behavioral school issues had often prevented the LIL student from successful academic experiences in the school system from which he/she arrived. When the at-risk student reached a bifurcation point, pressured by these issues, that bifurcation was unpredictable. The student could give up, or worse. The student’s history of *structural coupling*

(*fine and course grained*), and various external conditions determined if the student's structure broke down or broke through to a new state of order.

Under certain conditions the system (student) could choose to re-structure focus or energies to *new attractors* that benefited the system (him/her) as a whole. Consequently, the challenge at LIL was to create a student-centered environment that by its structure, encouraged holistic growth that affected a "counterconditioning"<sup>232</sup> in all parts of the student's environment. (Appendix D) The LIL think-tank team, facilitating a student-centered environment, was instrumental in establishing conditions for this counter-conditioning *phase transition* of energy flow within the student and also throughout the school system as the student-body interacted with each other. The concept of "counterconditioning" aligned with establishing a student-centered environment where *perturbations* created a *bifurcation* that lead to a *phase transition* which encouraged holistic growth.

The think-tank team recognized that because their students were so vulnerable to any input, and because downshifting could be very debilitating, safety, security, and relationship were indispensable ingredients of the LIL model. Therefore, a new orchestrated environment provided feedback loops that reinforced choices and actions that guided the student toward optimal level of healthy performance. It provided an environment that prompted individual structural coupling that resulted in new behaviors where patterns of reinforcement capitalized on reinforcing desired behaviors. Those conditions provided a new attractor for the student's energy flow (ambitions, goals, direction).

To create an environment that provided these type of *feedback loops*, was certainly at the heart of a student-centered vision and mission. Moreover, the LIL facilitator recognized that experience in one domain (choices in acceptable behavior) could easily impact the *capacity of*

*change* of a child in other domains (such as spatial ability and intelligence) (Boettcher, Hahn, & Shaw, 1994); (Rauscher, Shaw, Ky, & Wright, 1995). Therefore, a balance in experiential learning required the learner's interaction with the environment to be rich in stimulation, and yet imbued with orderliness and care (Caine & Caine, 1997).<sup>233</sup>

Consequently, the next step was to empower the student with the tools to make healthy decisions. Glasser's "Choice Theory" provided the framework to individualize a reflective decision making process for each student.<sup>234</sup> Glasser's process empowered the student to make self-corrections in behavior and outline a strategy for implementing corrective measures. Each student, as you may well expect, entered LIL at a different maturation for academic readiness. As that student searched for meaning and determined purposes, his/her capacity for change ascribed a level of *intentionality* or organized focus that was inseparable from the student as a whole. Three aspects of intentionality are critical because they make the mind the executing function or intelligent organizer and receiver of brain activity (Freeman, 1995). These three aspects of intentionality included:

- To stretch forth and modify (adapt) the self in conformance with the world.
- To seek wholeness in growth
- To maintain the unity of self (Freeman, 1995)

The beauty of the LIL approach was the opportunity to embrace the student at the self-control level with which he entered the school and create a strategy that worked for that student.<sup>235</sup> (Appendix E) The think-tank team created an environment that capitalized on how the attractor and feedback loop universalities operated autopoietically, cognitively, and as a dissipative structure. The think-tank team recognized that the body, brain, and mind are shaped by "experience," and are inextricably interconnected on many levels. (Diamond, 1988). They

recognized that the student entered LIL and presented a behavioral “level”--- a *pattern of behavior* or *predominant attractor* that through interactions had emerged into a self-fulfilling prophecy. For students exhibiting dysfunctional social behavior, the facilitating think-tank created environments where feedback loops provided options for *alternative basins of attraction and attractors* to develop through “levels”, counseling, peer counseling, and parental input, as shown in Figure 37, below.

The creation and application of “Levels,” as a reflective tool for appropriate behavior, shown in Figure 37, below, emerged in response to Glasser's Choice Theory, and provided the opportunity to begin with the student's current behavioral awareness and maturation and broaden the awareness and intrinsic behavioral motivation.<sup>236</sup> Application of Glasser's Choice Theory provided on an individual basis a more constructive decision-making environment for the student. The "Levels" identified stages of school social growth by focusing on "Attitude", "Behavior" "Preparedness", and "Cooperation", all necessary in healthy school social interaction.<sup>237</sup> (Appendix E) The use of "levels" focused on encouraging the student to self-reflect, self-organize, and progress behaviorally from one behavioral "level" to another.

*Self-regulation* of a student’s entire system (including choices) is a consequence of the *feedback loop*, where the first link (input) is affected by the last (output) – where the initial effect is modified each time it traveled around the *feedback cycle*. *Self-regulation* includes the ability to create new structure and new modes of behavior in the *self-organizing process* that involves development, learning, and evolution ability. The self-regulation universality provided an environment where the student could choose to stretch his expectations of appropriate behavior. The more advanced the "level", the higher the expectations of appropriate behavior, and resultant assumption that the less adult supervision was required.<sup>238</sup> (Appendix E)



Levels accomplished two goals. First they identified for the student a progressive developmental scale of appropriate interaction with others and himself. Second students could control their movement from one level to another. Throughout the day/week each student could practice and implement behavior chosen from a particular "level." The feedback was immediate, on a per class basis. A synopsis of a week's behavioral choices was provided on a weekly basis.<sup>239</sup> (Appendix F) If the choices for the week reflected a pattern that suggested mastery, the student's choices enabled him to emerge to a higher level empowered with his new behavioral skills.

The LEVELS capitalized on the student's ability to choose and learn socially interactive skills that allowed him/her to successfully assimilate into our community. The students who graduated from the Lancaster Institute went to college, art school, military, and cooking school. Some students, with diploma in hand, were in a better position to provide for their offspring. Others, still not of graduation age were able to return to the public school system without being labeled as "a behavior problem," "learning disabled," "ADD," or other labels with negative connotation.

## **6.4 ACADEMIC COMPONENT**

### **6.4.1 Establishing New Attractor Patterns of Learning: The Student's Learning Epiphany**

The facilitator with expertise in complexity hybrid universalities, will create a learning environment by capitalizing on the emergent universality of the autopoiesis process on several

levels of a learning system. The present education system acknowledges the need for additional exploration in the cognitive development model of older children requires additional exploration,

"Nearly all-current research is with relatively young children. Improving the cognitive development model of older children has not been explored fully, but we feel that older, generally more able learners will probably profit even more than younger children from developmentally appropriate teaching" (Joyce, 2000) Chapter 14

LIL provided one option. Once the curriculum was matched to the plan of action emerged from the empowered think-tank, the goal was to raise the child's academic level to grade level.<sup>240</sup> Generally, through the *emergence process* new patterns of learning and behavior were generated by the *interactive structural coupling* of the agents (students) with the environment through the cognition process. Specifically, because the child chose to attend the Institute knowing the commitment that was required of him/her, the initial hurdle was met. The child entered with an "I want to do this" attitude. The staff, trained to tap into this attitude, coupled the think-tank findings which tailored instruction in a one-on-one setting. New structures were established at *bifurcation*, and old ones disappear. The next step was to watch for the epiphany (the bifurcation) within the child and "pounce." At bifurcation points, the changes in a student's mental model are sufficiently extreme that the resulting change in behaviors and apparent capabilities can be substantial (Lesgold, 2006). These structural changes are not designed and imposed by some force outside of the system, but *self-organize* over time as the internal dynamics of the student system.

"As the teachers learned to use several models of teaching designed to increase cooperative activity, teach concepts, teach students to work, the learning rates of the students began to improve dramatically" (Joyce, 2000) Chapter 15. And improve "dramatically" they did. Although varying slightly from child to child, invariably a major breakthrough occurred in about the second week of school. The staff knew to watch for it. "Instruction designed to accelerate

intellectual development, made it occur more rapidly than if teaching did not take place " (Joyce, 2000) Chapter 14. What took the child nearly an hour to complete, all of a sudden, now took about twenty minutes. The thinking pattern changed and the student, as if by instinct, desired additional depth to his/her instruction. At this juncture, the self-esteem took a major leap as well. An internalizing of belief within the child that "I'm not stupid" and "Hey, I'm smart" manifested and became visible in performance and confidence. The socialization and feeling of acceptance also turned the corner.<sup>241</sup>

The challenge for the teacher was far from over, however. Now that the student had reached this threshold, a major regrouping of instruction approach was imperative. To the forefront came a tailored instruction process to accelerate the upper-level thinking skills as well as opportunities to apply those upper-level thinking skills.<sup>242</sup> (Appendix J) Unfortunately, "many programs for students deemed to be at risk academically have emphasized step-by-step learning of lower-order information and skills, although it appears that the complex, inquiry oriented models would have much more positive effect " (Joyce, 2000) Chapter 15.<sup>243</sup> Hands-on application provided the student with plenty of opportunities for further exploration of a topic which continued as a feedback loop to escalate the academic developmental process.

#### **6.4.2 One-on-One Instruction**

Living systems do not passively encounter the world; rather, they actively generate meaning through sensory *structural coupling* with their environment in accordance with a chosen focus. Students in a learning environment are no exception. Complexity views human beings as active, dynamic, self-organizing systems with a mind self-capable of self-reflection, continuous growth, change, and interaction with the environment through a "perceptual" world (how things seem

from his/her point of view). This sensory structural coupling extends to how the brain, mind, and body function.<sup>244</sup> Each student's brain is holistic and interdependent. It is a complex adaptive system that continually self-organizes, adapts and changes as it *structurally couples* with its "outer" and "inner" world (Caine & Caine, 1997; Kelso, 1995).<sup>245</sup>

In the *self-organizing process*, an understood fundamental brain feature, the student (organisms) is not fully determined through the student's genes (Mainzer, 1994). *Self-organization* replaces the view that the brain can be controlled by simple, direct, cause-and-effect mechanisms and procedures, with an ETCH paradigm where the regions of the brain are both separate and connected to a larger whole. Conventional ideas about the learning process are challenged by the complexity hybrid universalities,<sup>246</sup> which provide an alternate structural form to the learning process. This alternative view of the learning process emphasizes the importance of interconnections on several major *cyclic levels* that joins "practice" and "discussion" on one level, with the activities of "adaptation" and "reflection" (symbolized by a "Goal-Action-Feedback-Modified Action" Cycle), in a teacher-student constructed environment (content learning, fieldtrip or application/experiment (Laurillard, 1999).<sup>247</sup> The *structural coupling process* and this *feedback cycle* prompts the individual to change his/her action in the light of experience (in exchange with their environment), and to articulate his/her perception of the interaction in a form that is understandable to the teacher. Every part of this cyclic structure is necessary.

"Reflection" on action is key to this cyclic learning process. Without it the attempt to reach convergence of meaning creates voids in the feedback loop or learning cycle (Laurillard, 1999). Reflecting on an experience at the discursive level, in dialogue with the teacher, both

articulates the theoretical representation of that particular action, in order to generalize, and enhances their further actions (Laurillard, 1999).

Therefore, if learning was to take place a *feedback cycle* had to take place between the autopoietic and dissipative structure of the student's internal and external structurally coupling. *Feedback Loops* in the learning process continually contributed to the student's ability to revise and adapt. Feedback from the structural coupling with his/her environment modified the student's response, which in turn lead to a more favorable environment (Segell, 2000).

Feedback was the primary means of "control" in LIL, therefore as a complex adaptive system, the design of feedback processes within a school system were critical to adaptation and effective functioning. The autopoietic, internalized conversation interacted and interconnected with the dissipative structure of the student as he interconnected with his environment. The internal autopoietic component adapted and changed the student's mental model of the world and his place in it.<sup>248</sup> (Laurillard, 1999).

In retrospect, it is no surprise that one-on-one instruction with a heavy dose of a hands-on environment allowed the greatest amount of progress in the shortest amount of time and still permitted the student to set the pace of his learning. (Appendix G) One-on-one instruction permitted an immediate feedback loop on understanding of skills and content<sup>249</sup> where the student could adapt and adjust to new *attractors*

The beauty of one-on-one instruction, as part of the "Academic" area of emphasis in the LIL structure (see previous diagram), was its ability to tailor activity and interactions for the child at both his/her current maturation level, the level dictated by any special needs, and his/her current academic level of performance. If the child was labeled gifted and attention deficit, one-on-one instruction addressed both needs in the instruction process. The student's specific "think

tank" team, made up of specific credentialed instructors and professionals was tailored to the child's needs, able to evaluate thoroughly the current levels of the students' instructional readiness and current knowledge acquisition levels. In addition, the teacher then, was able to adapt instructional methods used, without sacrificing instructional content, to create an environment for the student to thrive, as shown in Figure 38.

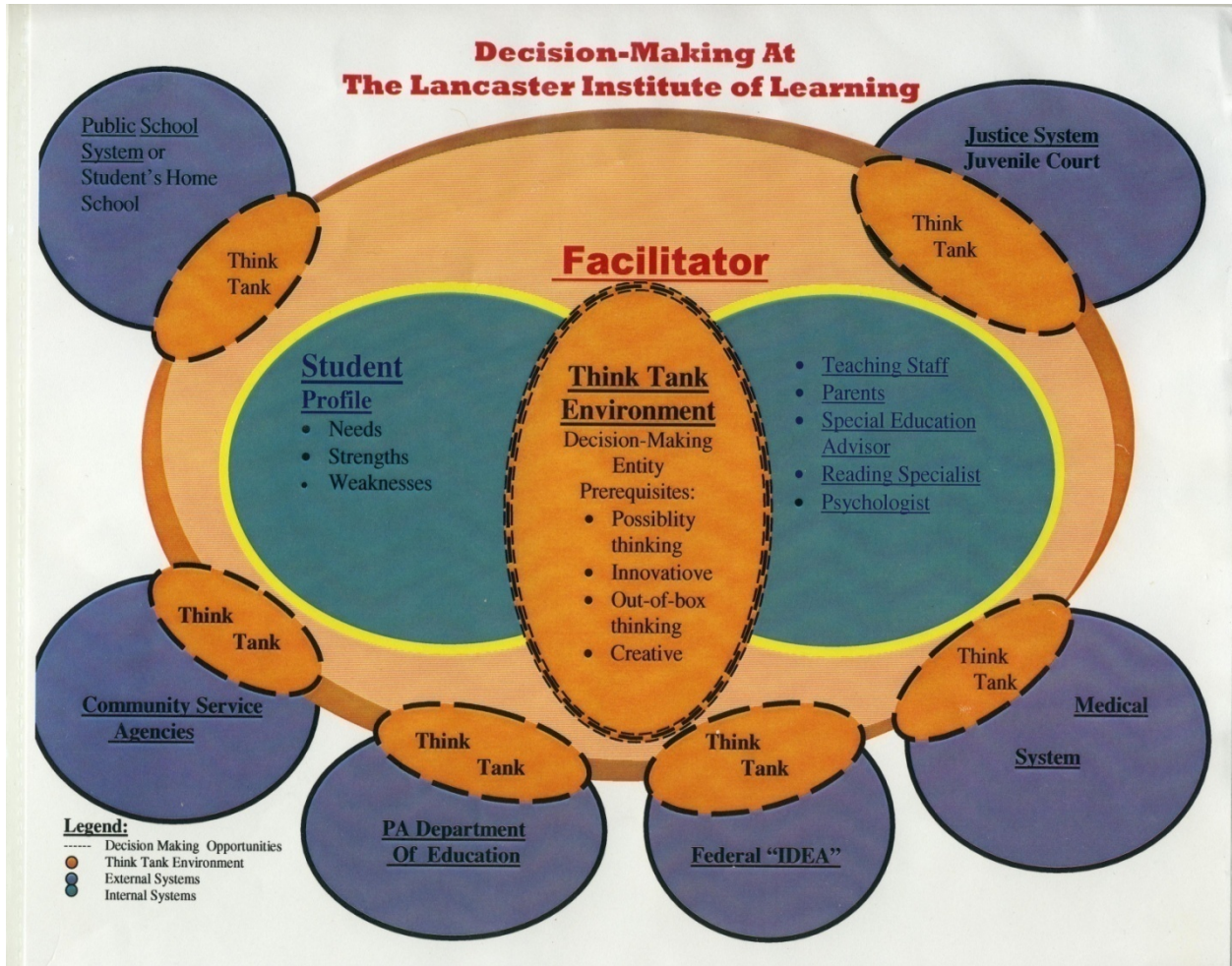


Figure 38: The LIL Think-Tank Process

### **6.4.3 Integrate Group Interaction (IGI): THE ROLE OF SKILL AND CONTENT REINFORCEMENT AT LIL: Feedback Loops in the Learning Process**

The LIL facilitator created an environment that capitalized on the feedback loop universality, and Integrated Group Interaction (“IGI”) emerged as a key process in the Lancaster Institute. "Integrated Group Interaction" (IGI) followed the one-on-one instruction and accomplished a twofold purpose: 1. It provided immediate reinforcement for the class just completed and 2. It provided an opportunity for the student to interact with his peers in a positive, healthy environment. Many of these students had difficulty remaining focused with peers in the same room.<sup>250</sup> "IGI" was structured so that each student arriving from his one-on-one instruction had a reinforcing assignment to complete that was based on his previous' class instruction. (Appendix H) The assignment was structured (chunked) to accommodate the amount of reinforcement each child required. Some students required more drill and practice, <sup>251</sup> while others benefited from computer reinforcement software, and still others gained from hands-on experimentation. The assignment was immediately checked for accuracy and thoroughness. The completion of the assignment needed to occur in a manner that would not disturb the other students present.

The "Mastery Learning" model designed by John Carroll and adapted by Bloom, suggested that aptitude is the "amount of time it takes someone to learn any given material" (Joyce, 2000). The key variable appears to be the adaptation of the "amount of time" needed to acquire the skill or material. One-on-one instruction coupled with "IGI" created the Mastery Model to which Carroll and Bloom refer. "The reinforcement the learner derives from knowledge of his or her correctness both makes the achievement enduring and propels the

learner toward new tasks. This is one reason why highly sequenced ‘programmed’ materials often work well with students who previously experienced little success”(Joyce, 2000, p. 321).

## **6.5 “GROUP” INTERCONNECTION AND COLLABORATIVE LEARNING AS PART OF THE DISSIPATIVE STRUCTURE LEARNING SYSTEM**

Once one-on-one instruction and "IGI" (reinforcement) were in place and creating an environment where the instructional methods were tailored for the learner, and Glasser's Choice Theory provided the student with the internal decision making tools, the next component of focus was changing the basin of attraction of nonproductive student behavior within group interaction and community acceptance that in many cases were characteristic for this type of child. "Group" was designed to have five to seven students interact together in an instructional setting. Group had three interlocking objectives:

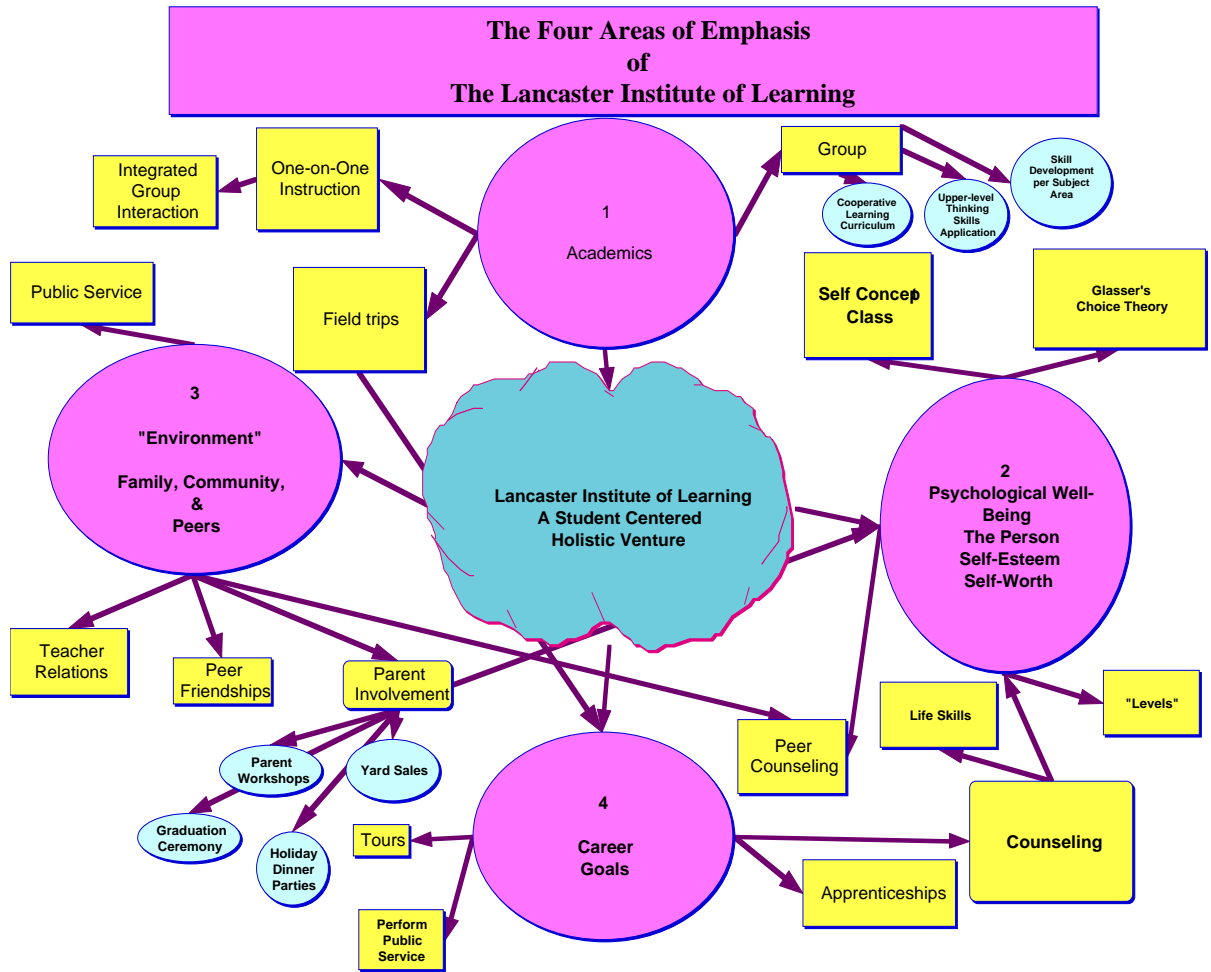
- 1) Skill development per subject area
- 2) Cooperative learning curriculum
- 3) Upper-level thinking skills application

Through “Group” (so named by its purpose —“group interactional instruction”) the *interconnective* universality manifested on several levels. Connection, cooperation, and building mutually beneficial networks demonstrated *the interconnected, interdependent* influence of “how” individual variables (individuals, groups, institutions) are transformed and transforming in their interactions. *Evolution* and even *co-evolution* of the variables alters both the organism (student) and the manner in which the student (organism) interconnects. The facilitator capitalized on these universalities to create an environment where the student *structurally*



*coupled* with his environment to naturally learn and *adapt* as an *autopoietic, cognitive, dissipative structure*.

"Group," IGI, "Field Trips," Career Development, and Apprenticeships (explored later in this section) in the school specifically addressed the "interaction component." This component emerged from the "Academic" area of emphasis as shown in Figure 36, below.



**FIGURE #35 THE LIL STUDENT-CENTERED PARADIGM**

### 6.5.1 GROUP - SKILL DEVELOPMENT: How Context Dependent Skill Development Was Shaped at LIL

"Group" was designed to utilize cooperative learning in a problem-solving environment that focused on "skill development," with or without content present. (i.e.: use your chemistry and physics background to provide the reasons for the corrosion in a piece of equipment presented, and determine three solutions for the problem) Some "Group" activities were indoors; some, like navigating the Conestoga Creek, occurred outdoors. Students were required to support each other in mastering the skill assigned and were evaluated on cooperation, participation, etc.

Each week the student encountered a new "Group" experience that required him to apply the skill and content he learned throughout the week. Each complex adaptive system (student) is unique, therefore *context dependent*. A facilitator with expertise in complexity hybrid universalities capitalizes on the *context dependent* universality, by remembering that the student (a CAS) is intimately related to and connected to its environment. Each "Group" learning opportunity created an option for change and adaptation. As such, the student's learning occurs as a part of changes in his internal dynamics, and is dependent on changes in the environmental context in which he interacts.

The first objective of group -- Skill development in each subject area— identification of the skills per subject each student needed to be successful in a particular subject area. (Appendix G) The rationale for "skill" development focus derived from the rationale for the Social family Models - that of "Preparing citizens in a productive democratic social order." The determination of which skills to be chosen as the focus of the "group" was determined by the pre-test of skill acquisition each student attempted when he/she entered the school.<sup>252</sup> The evaluation of each skill tested on three levels:<sup>253</sup>

- 1) The ability to recognize the skill when presented
- 2) The ability to pick out the skill among other skills
- 3) The ability to apply the skill in a contextual setting

The instruction for Group then focused on the skill or skills and the level of skill complexity identified by the collective group of five to seven students in the group.<sup>254</sup> As a skill's level was mastered additional identified skills were added to the mix.<sup>255</sup> The more the group as a whole acquired higher skill levels the more streamlined became their social interaction.<sup>256</sup>

#### **6.5.2 GROUP - COOPERATIVE LEARNING: How the Establishment of new Attractors was Shaped at LIL**

The second objective in "Group" was the use of Cooperative Learning Curriculum during skill instruction. (Appendix I) The LIL facilitator capitalized on the attractor universality by creating an environment where the student interacted with his environment; chose his behavior (actions) and its subsequent attractor. Patterns of behavior emerged from the interaction of the parts, but those patterns also acted to constrain the behavior of the parts. In this way, the attractor becomes a self-fulfilling prophecy. Through Cooperative Learning, the students were exposed to instruction and implementation simultaneously and learned how to engage in healthy, appropriate, constructive group interaction. At least that was the goal. Resistance to change is also really attraction. The staff very quickly discovered that the most difficult challenge in instruction of this group was not in teaching content, but rather in guiding a constructive

environment when the students interacted. Keep in mind that "disruption" was the name of the game in their previous schools.<sup>257</sup>

Quantitative feedback for skill application counters possible resistance (effects of a counter-productive attractor). Studies of system maturity and creativity indicate that as systems mature, they tend to move from one attractor to another, beginning with random and moving through periodic, strange, and point attractors in sequence. The facilitator will capitalize on this attractor sequence and provide an environment where the student can explore his skill options

At first the teacher's role provided direction and a strict structure of roles for the students to emulate, which took patience on the teacher's part and lots of practice with the students. (It was extremely beneficial that the teachers had been exposed to training on how to conduct "cooperative learning" in the classroom. Some, at first, imagined cooperative learning as directing the students to "go and work together.")<sup>258</sup>

As the students became familiar with the expectations and the self-direction of the group, the teacher's role became that of a facilitator. This environment was very different from what the students were familiar. Previously student energies collaborated on how to "beat the system," now collaboration focused on how to "build a flotation devise that would support their weight, and could only be built with corrugation and adhesive", as an example. A percentage of total grade was divided between mastery of Application, Cooperative Learning and Social Development Skills. Records of performance and accountability for each student were cumulated on a distribution worksheet, shown below available to the student's team.

**Group Grades Distribution Worksheet**

Topic \_\_\_\_\_ Subject \_\_\_\_\_ Date \_\_\_\_\_

Teacher \_\_\_\_\_

Student	Application of skill 60%	Coop. Learning Skills 20%	Social Dev Skills 20%	Total 100%	Cum total	Teacher

"As they become more familiar with the model, we simply loosen the structure, turning increasing amounts of control over to the learners" (Johnson & Johnson, 1999)

**6.5.3 GROUP – UPPER-LEVEL THINKING SKILL DEVELOPMENT:**

**How Structural Coupling for a Learning System was Shaped at LIL**

By capitalizing on the *cognitive structural coupling universality*, the facilitator created an environment that enabled processes of *recurrent interactions*, not only with its environment but also to itself, and thus brought forth not only an *external* but also an *inner structural change* in the system. This meant creating an environment where the instructors could also create environments (scenarios) which tested the upper-level thinking skill application proficiency of each student as well as their collective emergent problem solving capability. The third objective in "Group" was the elevation of instruction to the use of upper-level thinking skills as the norm. (Appendix K) This required instructors to have a developed understanding of skill development scope and sequence. Since many teachers coming from public school settings rarely implement upper-level thinking skills, collaborative training in this area was often required.

To accomplish this objective two additional challenges had to be addressed. First, the teachers had to understand their role in the process of "how to raise the bar" in instruction that required upper level thinking skills from the students. The second challenge was for the students to have instruction (training) in the skills necessary to "think" in upper level thinking skills. "Group" provided enumerable opportunities for students to stretch their upper level thinking skill development. As part of each other's worlds, through the *structural coupling process*, each student *communicated and coordinated as well as adapted to emerge* as a joint group behavior to problem-solve the task presented during a specific coordinated "group" encounter.

In the first challenge, the teachers, who in many cases were only familiar with lower level direct instruction, knew very well how to have the students "label", "identify", and "define". How would instruction change when the objective was "document", "propose", "design", "analyze", and "theorize"? In what ways would the students have to be prepared to participate in this type of instruction?<sup>259</sup>

The second challenge addressed the students' perspective. Keeping in mind that the majority of instruction that this student was exposed to was lower-level direct instruction, what did it mean to the student to "think" in upper level thinking skills? What were the supportive "skills" needed for the student to utilize the ability to "theorize" effectively?<sup>260</sup>

## **6.6 FIELD TRIPS AS A COMPONENT OF THE LEARNING SYSTEM: HOW STRUCTURAL COUPLING BETWEEN THE STUDENT AND LEARNING ENVIRONMENT WAS SHAPED AT LIL**

Learning is an active process in which meaning is developed on the basis of experience (Duffy, 1992). The process never ends. The richer the experience, the deeper the processing; and the more those authentic purposes and meanings are engaged, the more profound and continuous is the learning. Therefore learning is a nonlinear iterative process, in which each stage of the learning process develops from the results of the former stage (Merry). The learning mode often grows in an organic way with certain understandings and experiences being the basis for further advances. At other times it is a change process with sudden discontinuous transformative jumps to qualitatively different levels of understanding. (Merry) In fact, in Caine & Caine's experience, the learning process acquires a dynamic of its own. It becomes intrinsically fulfilling and is accompanied by the constant urge to go deeper. Knowledge is thus generated in ways that is coherent, meaningful, and purposeful for the person who is creating the meaning and in the social contexts in which the person functions (Benson, 1992). It therefore becomes a process that thrives on possibility and that induces the pursuit of excellences, not as a dictated and mechanical outcome, but as a natural and joyful consequence of meaningful learning (Caine & Caine, 1997).

The LIL facilitator capitalized on this experiential learning process, which intuitively worked in accord with the *structural coupling* universality of cognition. Through this experiential constructivist learning process there was recognition that the brain both perceived and generated patterns (Caine & Caine, 1997). Through these patterns of behavior (attractors), the student determined essential characteristics/identity.

LIL was able to create a tight accountability structure for the student to re-align his energies and behavior back into academic endeavors. One-on-one instruction sessions encouraged concentrated periods of instruction and learning, thereby creating an opportunity for the student to gain significant ground in a shorten period of time. The purpose of "Field trips" capitalized on a richer learning experience and tailored for the students to see first hand what they were learning about all week. For each trip the students had to design interview questions, take notes, create resultant tables/charts for the data, make and record observations and draw conclusions. (Appendix L) They toured manufacturing plants of various types depending on the tie-in to the content. Museums, libraries, universities, community colleges, technology schools, art schools broadened perspectives and created career options. Service organizations, small businesses, and various agencies provided insight into the networking of our community.

## **6.7 CAREER EXPLORATION---SETTING GOALS: HOW THE EVOLUTION OF CO-EVOLUTION WAS SHAPED AT LIL:**

To review: With instructors returning from the training retreat in August, the students "and" teachers embraced the beginning of the school year with a three-day, overnight camping trip that encouraged staff to interact with the students on a very "personal" basis. The three day event was a concentrated pursuit of trust building that included everything from a student/teacher ropes course; to teacher/student night hikes; blind leading; encapsulated in campfire building, cooking, and scary stories; personal disclosures; and an assortment of activities geared to breaking down barriers and creating "bonding." Carl Rogers' "The nondirective strategy" looked to three sources of student problems



1. Present feelings
2. Distorted perceptions
3. Alternatives that have been unexplored because of an emotional reaction to them (Joyce, 2000)Chapter 16

Once back in the school building after the retreat, with students' "choices of courses" completed, the one-on-one instruction component was scheduled and implemented. As the one-on-one instruction and "integrated group interaction" paired to provide the content foundation, the next layer of the school's programming, the short and long term goals and career decisions became the priority.<sup>261</sup>

The LIL student interacted as a cognitive, dissipative structure with his wider environment and affected his long-range sustainability. Self-Regulation and interconnection of the co-evolution process are universalities and are powerful aspects of biological evolution. The *evolution of co-evolution* prefers an intermediate position near the phase transition where adapting systems interconnect. Through these *interconnections* agents are transformed and transforming as they interact (Eoyang, 1993). Apprenticeships and Fieldtrips, as shown in Figure 39 and Figure 40, below, were scheduled to explore post-graduation institutions and embrace the student's need to evolve as the environment with which the student interconnected did similarly. The goal of this Career component was to reinforce, build, develop, and expand the rationale of LIL's program structure.

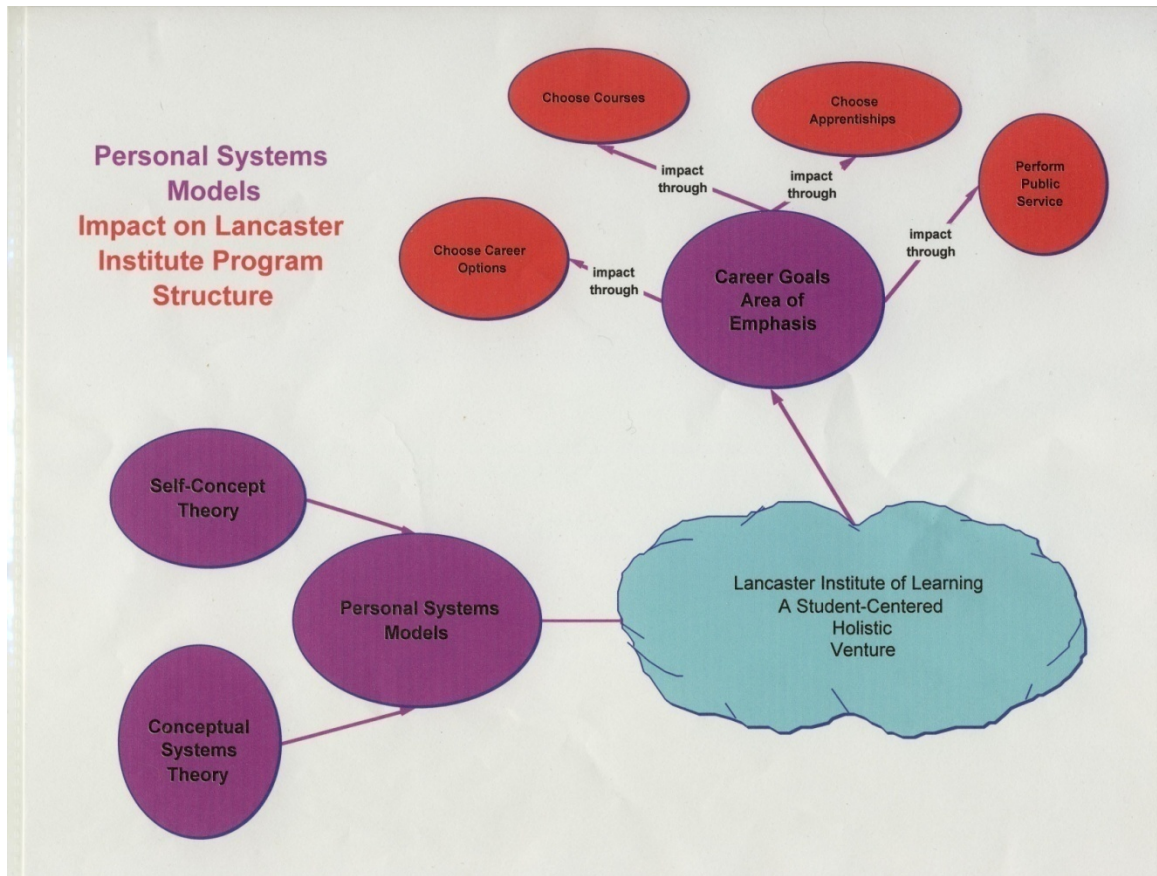
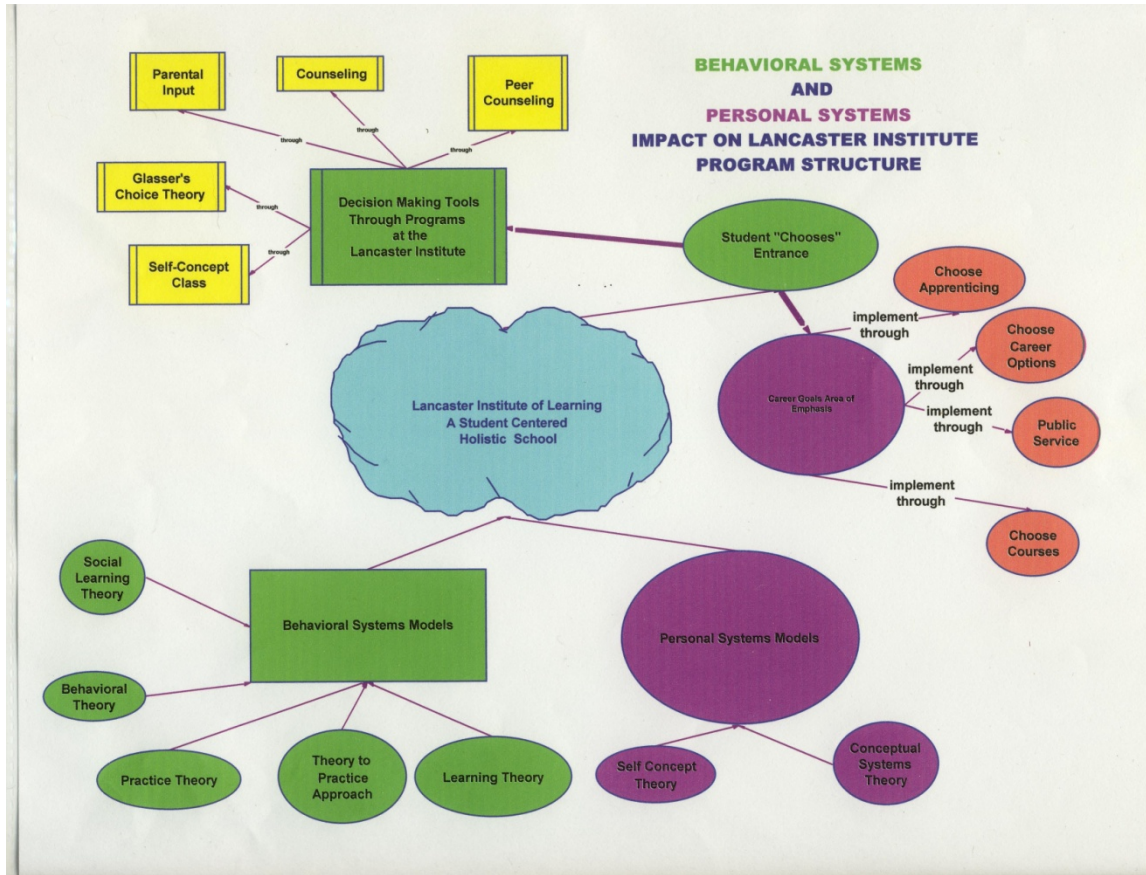


Figure 39: The LIL Career & Long-Term Goal Model

### 6.7.1 How the student at phase transition Open and Far-From Equilibrium was shaped at LIL

As is shown in the diagram below, students had the opportunity in eleventh and twelfth grade to choose apprenticeships in their career area of interest (not to be confused with McDonald's internships). Assignments resulted from the experience that tied directly to their one-on-one instruction. Seventh through twelfth grades were exposed, through tours, to an assortment of local schools. Technical schools, trades schools, universities, community colleges, art schools,

designing schools, and drafting schools had something to offer for everyone. In addition, the branches of the service conducted a career day at the school providing choices for the armed forces. Local political leaders provided a different slant for those students who were more demonstrative.



**Figure 40: Career Goals Areas of Emphasis**

Other student exposure experiences into the community were in the form of public service scheduled once a month. The students could read to elementary students, visit the aging, participate in crafts at the hospital for senior day visitors, fill shelves at the food bank, and serve food to the homeless, to name just a few. The facilitator realized that the more the student

interacted within his own system through structural coupling and a continual flow of information, that his state of disorder was increased. The student was experiencing a phase transition at the point of bifurcation. He/she could begin to renew his/her own structure, and hopefully result in action or coping strategies. As an open system, the LIL student interacted and networked within a larger open system (LIL) and the outer Career environment. As such all were always in some stage of development. The facilitator capitalized on the open as well as the far-from-equilibrium universalities.

David Hunts' "Conceptual Systems Theory" outlined the amount of structure the student needed to be productive, and focuses on the learner's cognitive complexity of his or her information-processing system. It is the social theorists belief that education's central role is "to prepare citizens to enhance personal and social life and to ensure a productive democratic social order," and is accomplished by combining productive social behavior and academic skills and knowledge. Through "cooperative enterprise," these theorists rationalize that "inherently the quality of life will be enhanced." All of which is instructionally designed to "increase and decrease their structure to fit the level at which the student operated best" and emphasized "how students learned social behavior, and how social interaction enhanced academic learning."

Conclusion: The Behavioral and Personal systems were instrumental in connecting the four areas of emphasis at the Institute as shown in Figure 36, above. These two systems provided a conduit for staff, student, parent, and the facilitator to unify collectively for the betterment of the child.

## 7.0 CONCLUSION

What does this dissertation tell about ETCH, its universals, and influences on future school systems? It depends on what system we are exploring. LIL was a living, breathing example of how ETCH can be applied to an educational system. ETCH was LIL's baby. The learning experiences at Lancaster Institute of Learning (LIL) - the practice, the day to day activities, and interaction with instructors, students and parents put life into ETCH. The initial LIL experiences using feel-by-instinct, and trial-and-error implementations were a creative art form that unknowingly distilled the principles of ETCH, and culminated in a viable blueprint for innovative educational administration.

Some say predictions about future ETCH school systems is difficult because forces shaping the future do not add up in a simple, system wide manner. Their effects include nonlinear interactions among the components of the system. However, prediction difficulty in complex adaptive systems like school systems does not make the situation hopeless. It does require a large shift in conceptual tactics to thought about the major driving forces. ETCH challenges perceptions about fear of change, and exchanges them with opportunities for improvement. Open communication replaces damage control for resolving problems. An empowered, self-organized bottom-up organizational structure replaces the present hierarchical structure. School systems are a complicated network of interrelations among the individuals (agents) replacing schools where teachers and administration are autonomous. In the LIL

context, ETCH and the complexity universals provide a blueprint for interconnection, and adaptation through communication. The Autopoietic Processes, Dissipative Structure, and Cognitive Processes at each level of the education system interconnect on various levels and include universals which operate in all living systems.

There is no cookie-print of ETCH since interconnective, adaptive sets of agents in unique environments emerge unique schools, or district environments. However, ETCH application does establish a framework for dialogue. It explores present linear, mechanistic, reductionistic paradigms in education systems that reflect both the status-quo inducing qualities of current structure and practice in the field and the unanticipated change pressures. ETCH application is a paradigm shift from superficial 1st order education system change to a 3rd order system redesign where leadership facilitates an environment where employees self-organize to address the impact of change. ETCH introduces a new generation of theory drawn from several emerging fields of study associated with the Science of Complexity, evolutionary sciences, Mathematics, Physics, Biology, and Chemistry.

For complexity theorists looking across many disciplines, there is a common universal thread that manifests in observable patterns of behavior. It permeates all living systems (both traditional and those that reflect the complexity hybrid), and provides a tool to facilitators of all school types. ETCH demonstrates the likely application of the new theory to the field of education in a scenario of optimal learning environments. It explores how leadership roles facilitate the emergence of those optimal learning environments.

The hopeful intent of my research is to inspire the emergence of leadership that would interact as a catalyst -- facilitating, (not directing) -- a school district through a transition to emerge operating at optimal level ( not maintenance level) within a regime of behavior, referred

to as the edge of chaos (not merely at or below average level). The facilitator of an ETCH school system develops an environment through processes that create an empowered, open learning school system. When important initiatives are announced, staff listens, understands the urgency, and executes tasks on time and within budget. The facilitator creates the conditions that nurture creativity, moving the system to the phase transition at the edge of chaos. In other words, the role of facilitator requires a dedicated focus to building and constantly updating the processes to reflect rapid response in how staff thinks, feels and behaves during the school's continual adaptation and evolution.

The Lancaster Institute was successful before knowledge of ETCH principles existed. LIL was the education laboratory that solidified a concrete concept. It was a think tank for educational reform and gave rise to the possibilities of using principles that already prevail in business and government. Nonetheless LIL illustrates many of the ETCH ideas. It shows that the principles of ETCH can be applied to education. LIL implemented the principles before the theory. However, through LIL's experiences, ETCH solidified those principles into an education complexity hybrid theory.

The basic ETCH universals are listed below, after which each is illustrated with a reference to the material presented in the previous chapter about LIL. In some cases, a complexity universal is simply applied to label a phenomenon, while in other cases, the universal led to an important reconceptualization of how a school should operate.

ETCH/COMPLEXITY UNIVERSALS	
Self-organization	Nonlinearity
Auto & Cross Catalytic Cycles	Far-From Equilibrium
Interactiveness	Perturbation and Bifurcation
Emergent Pattern Formation and Pattern of Organization	Interconnectedness
Feedback Loops	Adaptation
Self-Regulation & Self-Perpetuation	Scaling/ fine and coarse graining
Emergence	Structural Coupling
Open systems	Attractors
System History	Context Dependent
	Self-Generation
	Trajectory Development
	Evolution of Co-Evolution

UNIVERSALS APPLICATION TO LIL SCHOOL DESIGN

1. Self-Organization: is the spontaneous emergence of order that results from the interrelationships from the system’s parts. A constant flow of energy and matter through the system is necessary for self-organization to take place.

- On the Student level self-organization was exemplified through the interaction between the student’s autopoietic internalized, decision-making process, and the structural coupling of the LIL environment, as he/she adjusted choices and accepted the consequences of those choices.



- Among the instructors, self-organization was exemplified in the emergence of the “student profile” at the time of student enrollment, where instructors exchanged and deliberated options for the student’s optimal learning environment
- In LIL as a whole, self-organization was exemplified through the emergence of the “student-centered learning” environment resulting from the interactions of individual instructor’s input creating feedback loops that precipitated its unique qualities.

2. .Auto & Cross Catalytic Cycles – Appear in the self-organization process as interlocking closed loops, where one cycle acts as the catalyst in subsequent cycles, having the ability to self-balance and self-organize.

- At the student level at least two sets of auto and cross catalytic cycles influenced the behavioral adjustment process in the autopoietic student process. In the first closed catalytic cycle, as the student was presented with and explained the alternative behavioral choices, he/she reflected and chose to adapt or resist. The observable behavioral indicators of those choices structurally coupled with the LIL closed catalytic cycle environment to provide immediate feedback and consequences to the student.
- Among the Instructors instrumental in emerging the “student profile,” the closed catalytic cycle evolved from the discourse in input from instructors of different disciplines (reading specialist, special education instructor teacher, high school content instructor, and elementary teacher) as they exchanged options on how to provide an optimal learning environment for the student.

- In LIL as a whole catalytic cycles resulted from the interactions of individual instructor's input during the student profile, staffing, department meetings, and think-tank stages which emerged into student-centered learning.

3. Interactiveness is the energy and matter exchange between systems or system components generating a system that is always changing. Patterns of behavior emerge from the interaction of the system's components (students, instructors, facilitators, and stakeholders). Learning how those patterns of behavior arise is the key to identifying the system as whole. Interactions among interdependent agents of complex adaptive systems (CAS) transform and are transforming. Because CAS are open systems, transformation occurs across the system's external boundaries.

- At the student level cycles between Integrated Group Interaction (IGI) and one-on-one instruction; "Group" and Choices of Actions (Levels); Field Trips and application of subject content; and Career goal setting, were interactive program examples of interactions between the student and him/her environment that generated change within the system (student).
- Among the instructors, weekly "staffings" provided interactive feedback on the success of teaching methods and outlined adjustments in instructional approach for the following week.
- In LIL as a whole, through internal interactions there emerged a student-centered learning environment that structurally coupled with the feedback cycles of the student's home schools, social agencies, government agencies, their programs, and community.

4. Emergent Pattern Formation and Pattern of Organization – *The configuration of relationships determine the system's characteristics or identity or patterns of organization. Over time, systems exhibit certain patterns of behavior or attractors. If the pattern is destroyed then the organism will die. If the system is an autopoietic network the system lives. If the system is non-autopoietic, the system is not living.*

- On the student level the challenge at LIL was to create a bifurcation to provide alternate options for the student in both behavior and academics. The student was very vulnerable at the bifurcation point and could behaviorally/academically spin off into chaos (quit) or choose a new alternative (graduate). Often the student's reputation/behavior or academic standing was so intertwined with the student's self-image that staff had to be extremely sensitive at point of bifurcation to make available alternative behavioral options to fill the void.
- Among the Instructors an example of an emerging pattern of organization occurred during the training/camping teacher retreat in August. By the end of the retreat, instructors that arrived with an autonomous, reductionistic, mechanistic, and linear frame of reference created interdependent trust – building relationships among themselves - and could identify the ultimate pattern of organization expected from the LIL student.
- In LIL as a whole, through the exchanges/interaction, relationship building among staff, and staff and student, the emergent pattern of organization reinforced the mission and vision for a student-centered school.

5. Feedback Loops is the tendency of a system to use its own output to make adjustments in its inputs and/or processes. These loops carry resources (material information and energy) from one agent to another. These transforming feedback loops serve to give both stability and changeability to the complex adaptive system (CAS). Feedback is the primary means of control in a CAS, so the design of feedback systems within an organization are critical to adaptation and effective functioning.

- At the Student level developmental status initiated the feedback loop process which influenced the degree to which the child learned. The key was to correctly identify the holistic profile of the child and successfully choose the teaching methods that would not only unlock the developmental process but stimulate progress.
- Among the Instructors: At each weekly “staffing,” each student’s established growth pattern was reviewed to see if the student raised a step, to determine if there was movement academically, socially, affectively. There had to be progress each week in each area. If there was no growth, a series of steps were taken through evaluation, adaptation, implementation, and reassessment.
- In LIL, as a whole, through feedback loop interaction in the form of impromptu staff and facilitator brainstorming about purpose and goals, the vision and mission took on a behavioral identity in terms of structure and outcome.

6. Self-Regulation & Self-Perpetuation of the entire system is a consequence of the feedback loop (the first link, input, is affected by the last, output). The initial effect is modified each time it travels around the cycle.

- At the student level, distrust was very high at point of entry into LIL. As the trust connection between the instructor and the student developed, the student was more willing to lower defense mechanisms and abandon the vulnerable fear-based layering that instilled the inappropriate decision-making. “Levels” was the setting for a self-regulating environment for new choices of student behavior.
- Among Instructors, the most challenging hurdles to overcome during teacher training sessions was preparing instructors for the developmental enigmas that surfaced with the student who attended the school. When an accurate developmental stage and an instruction model tailored for progressively more difficult upper-level thinking skills were combined, the capabilities in skill deficit areas aligned for success.
- In LIL, as a whole, the think-tank process and weekly staffings was a delicate interplay to empower instructors to identify which variables tailored best for the particular student-centered change and to continue to adjust instruction methods to student’s progress.

7. *Emergence is a process that materializes through the self-organizing interactions of the agents within the system. The emergence process spontaneously materializes a whole in the form of collective properties such as life, thought, or purpose that the agents might never have possessed individually.*

- At the student level new patterns of learning and behavior were generated by the interactive structural coupling of the students with the environment

through the cognition process. Generally taking about two weeks, the student experienced an epiphany in his learning process.

- Among Instructors trained to tap into the emergent “I want to do this” attitude of the student, the think-tank findings which tailored instruction, were coupled into a one-on-one setting. New student dissipative structures emerged at bifurcation. Instruction designed to accelerate intellectual development, made the epiphany occur more rapidly than if instruction had not occurred.
- In LIL as a whole, from discussions about composition of pivotal learning environments, emerged four ingredients of the student’s life that became the framework of the LIL instructional program.

8. *Open systems are systems in a state of complex stability, whose boundaries permit interaction with its environment in a constant flow of energy and matter through the system. As a result, the system is always in some stage of development and transformation. The more diversity imbedded in the organizational components, the less it is likely the organization will shut out information and the more sensitive and adaptive the organization is to the nature of change.*

- At the Student Level each teen at LIL was considered permeable and malleable and open to direction. And since these teens, between ages 14 & 21, were at the age of all-knowing wisdom, the challenge for the LIL think-tank was to increase the flow of resources through the teen by saturating the educational program with challenging options for wiser choices regarding behavior, academic commitment, and long-range planning.

- Among Instructors the open system was applicable especially during the teacher retreat in August during which the agenda was filled with exercises geared for bonding and trust building, with alternative teaching methods, with simulations that challenged status-quo, with opportunities for creative brainstorming and problem solving, and with cooperative interdisciplinary lesson plan design.
- In LIL as a whole, most important was open channels of communication without restraint. The crucial element was communication. Without transparent communication neither LIL nor ETCH would work. The communication flowed back and forth between the instructors and the facilitator. Suggestions were open, encouraged, whether on computer, in person, over lunch, at think-tank meetings, with the family ---back and forth --  
- in feedback loops, -with each student taken into consideration. Every suggestion from the instructor was acknowledged and treated with respect.

9. *A System's History is the organism's record of its previous structural changes at any point in the system's development. Its history of structural coupling will determine the new pathways available for that system.*

- At the Student Level, the LIL students shared a commonality – they were not finding success in the public school environment. Many were gifted, on some form of medication, and were labeled. Most succumbed to the self-fulfilling prophecies of failure, not fitting into one of twenty-five in a class in a public school system. In order to impact the history of structural coupling, the LIL

learning environment had to contain a rich environment with reflective mental model options for change to a new basic of attraction.

- Among Instructors the facilitator realized that public school teaching experience was inadequate for an instructor at LIL. Most were challenged to re-evaluate the relationship between student and teacher, teaching methods adapted to learning styles, feedback loop adjustments in instruction, and empowered, think-tank contribution.
- In LIL as a whole, the LIL facilitator understood the limitation of traditional public school practice and created an environment saturated with processes that encouraged cutting-edge approaches to illuminate hurdles in each student's learning process.

10. *Nonlinearity is the potential for disproportionate or exponential relationship between variables, where small changes in one variable may produce highly disproportionate effects in variables systemically connected to the changed variable. This pattern is exacerbated because CAS depend on iterative processes. They repeat the same processes over and over again. The output of a previous process becomes the input of the next one. Iteration magnifies the effects of the nonlinearity, so that simple causal relationships are virtually impossible to detect, to measure, control, or evaluate.*

- At the Student Level, the student's response behavior had the potential for disproportionate, exponential, nonlinear effects. Through feedback loops, the impact of a previous external interaction became the input for the next encounter. Creating a paradigm shift within the student's autopoietic processes meant creating an environment that removed the debilitating stigma of previously



attached labeling, and meant a deliberate focus on the concrete in the form of descriptors and actions plans.

- Among Instructors, who learned to use several models of teaching designed to increase cooperative activity, high level skill development, in a socially functional setting, witnessed a major breakthrough occur in about the second week of school. It was suspected that instruction designed to accelerate intellectual development changed the thinking pattern requiring additional depth to the student's instruction level.
- In LIL as a whole, learning was an active process in which meaning was developed on the basis of experience. The process never ended. The richer the experience, the deeper the processing, and the more those authentic purposes and meanings engaged, the more profound and continuous was the learning. Therefore learning was a nonlinear process, in which each stage of the learning process developed from the results of the former stage.

11. *Far-From- Equilibrium is a state of system where energy and information are drawn in to keep the system in a state of ongoing flux. As information and interaction is brought into the system from its environment, it becomes more active and unpredictable. The system begins to renew its own structure, hopefully resulting in strategies for collective action or the emergence of subgroups developing a coping strategy. Far-From- equilibrium systems do not evolve smoothly and continuously over time, but do so in sudden leaps, which intersperse over relatively extended periods of stasis.*

- At the Student Level, being and interacting in a far-from-equilibrium student-centered system placed him/her in the center of control for decision-making. The

structure of a student-centered environment encouraged holistic growth that affected a counterconditioning in all parts of the student's environment. Prospective students were given a tour provided with the philosophy of the school and provided with three pre-requisites in order to enter the school- there by choice; committed to 100% efforts; and was drug free.

- Among Instructors, the facilitator realized that empowering a cutting-edge school setting meant creating a work environment to help instructors and staff adjust to and absorb change that existed in an open system far-from equilibrium. The relationships between staff, facilitator, and student determined LIL's pattern of organization, and absence of instructor commitment would have created unnecessary drain on existing adaptation resources and would have jeopardized the project's success altogether.
- In LIL as a whole, the facilitator realized that the more the student interacted within his own system through structural coupling and a continual flow of information, his state of disorder was increased. The student was experiencing a phase transition at the point of bifurcations. The student could begin to renew his own structure, and hopefully result in action or coping strategies. As an open system, the LIL student interacted and networked within a larger open system (LIL) and the outer Career environment. As such all were always in some stage of development. The facilitator capitalized on processes that utilized both the open as well as the far-from-equilibrium universals.

12. *An increased amount of perturbations in a system increases its points of instability to the point of crucial destabilization or bifurcation. A bifurcation is a*

*threshold of instability perturbated to a point of phase transition and a new pathway, at which the dissipative structure may choose from among several possible paths, or states. When the system reaches the bifurcation point it is unpredictable. Its history of structural coupling (fine and course grained), and various external conditions determine if the structure breaks down or breaks through to a new state of order. Bifurcations are the foundation of organizational change and learning.*

- At the Student Level, bifurcation issues could be very debilitating. The student's interviews disclosed a perpetuating progression of autopoietic coping mechanisms that had materialized in a choice of maladaptive behavior, which then developed into an environment that surrounded the student and continued to encourage the behavior to continue negatively. Therefore, a new orchestrated environment provided feedback loops that reinforced choices and actions guided the student toward optimal level of healthy performance. The LIL environment prompted individual structural coupling that resulted in new behaviors where patterns of reinforcement capitalized on reinforcing desired behaviors. Those conditions provided a new attractor for the student's energy flow (ambitions, goals direction).
- Among Instructors, the facilitator designed an environment to tap the synergy among staff and capitalize on empowered open learning environment where creativity thrived. For instructors coming out of the public school setting, with an expectation of being told what to do and when to do it, the LIL experience drove some to the point of bifurcation. Thinking creatively in instruction design was extremely foreign and threatening to them.

- In LIL as a whole, the facilitator constantly developed and refined ‘how’ processes to stretch LIL’s capacity boundaries without driving the school into chaos, by introducing as many goal-directed changes as possible without overextending available adaptation resources. This was a dedicated focus to building and constantly updating processes to stimulate rapid response in how staff thought, felt, and behaved, during the school’s continual adaptation and evolution.

13. *Interdependence & Interconnectedness are variables that drive many CAS. As key agents in a system (individuals, groups, institution) relate to each other, and influence each other’s behavior in complicated and unpredictable ways – known as coupling, the complex interdependencies and interconnectedness of these variables are transformed and transforming in their interactions, and emerge into new and unexpected system-wide behaviors.*

- At the Student Level, the body, brain, and mind are shaped by experience, and are inextricably interconnected on many levels. Through the use of behavioral “levels,” the student reflected, self-organized, and progressed behaviorally from one “level” to another.
- Among Instructors, through interconnectedness, trust was built on respect where each staff member was empowered to dialogue with the facilitator. It was okay to challenge the facilitator’s assessment with questions. “How is it not going to work? What will make it work? What is the alternative?” The instructor/facilitator relationship was based on integrity, respect, appreciation, and acknowledgment.

- In LIL as a whole, through Group Interactional Instruction (Group), the interconnective universal manifested on several levels. Connection, cooperation, and building mutually beneficial networks demonstrated the interconnected, interdependent influence of how individual variables (individuals, groups, institutions) are transformed and transforming in their interactions.

14. *Adaptation is a process that involves attempting to turn interactions to system improvement according to some measure of success. A system that contains agents that seek to adapt is referred to as a complex adaptive system (CAS). Although it is difficult for an agent to predict the consequences of its actions and therefore to choose the best course of action, the implication is that they have learned and discovered various ways of positioning itself in its context.*

- At the Student Level, as a complex adaptive system, the student self-organizes, adapts, and changes as he/she structurally couples with his/her outer and inner world. Interviews with the student revealed the cost of labeling in public schools where the child feels defeat even before he/she matures. As the stigma of the labeling was removed at LIL, the student adapted to a new interactive environment with the freedom to interconnect, expand, and grow.
- Among Instructors, the first challenge for them in GROUP was limited experience in skill development curriculum. Most were only familiar with lower level direct instruction, where they knew very well how to have the students “label”, “identify”, and “define”. Instruction had to change drastically when the objective became to document, to propose, to design, to

analyze, and to theorize. In what ways would the students have to be prepared to participate in this upper-level thinking skill type of instruction?

- In LIL as a whole, a student-centered environment prepared the student to postpone immediate gratification, expect and embrace graduation, and embrace adaptation into a his/her place as a member of community/society as a life-long learner.

15. *Scaling/ fine and coarse graining is the ability to view a system on different levels (scaling). Individual agents take relatively independent actions; various groupings of agents emerge in the dynamical course of events; and the system as a whole exhibits identifiable behaviors – behaviors that in each level/domain are both similar to and different from behaviors of the other levels. An individual child may reflect the tension felt in an entire school, groups or gangs may form in response to this tension, and rumors may move through the faculty in response to specific incidents. Each of these domains is intimately associated with the others and exhibits both similarities and differences from them.*

- At the Student Level, the student functioned and learned simultaneously at many different scales. Each student was a composite of external and internal influenced processes and pressures operating neurologically, anatomically, physiologically, emotionally, and socially.
- Among Instructors, the scaling universal presented most vividly as they designed instruction for the holistic student. The LIL learning process emphasized the importance of interconnections on several major cyclic levels

that joined practice and discussion on one level, with the activities of adaptation and reflection in a teacher-student constructed environment.

- In LIL as a whole, the learning environment had to structurally couple in four pivotal ingredients of the student's life: Academic environment, personal/social environment/the student's self-esteem, and career and goal setting. Through this four component student-centered approach, the LIL environment shaped new attractor patterns for learning by identifying point of bifurcation and change in the student's mental model.

16. A Structurally Coupled system is a living, cognitive, leaning system. *Structural changes are acts of cognition, development and learning, and are expressions of structural coupling. This coupling produces the self or ego. Through mutual structural coupling, individual living systems are part of each other's worlds as they communicate with one another and coordinate their behavior. Through mutual structural coupling, communication is not a transmission of information, but is a coordination of behavior among living organisms. Such mutual coordination of behavior is the key characteristic of communication of all living organisms, with or without nervous systems, and it becomes more and more subtle and elaborate with nervous system of increasing complexity. Two parts of a system are said to be tightly coupled if they have a great influence on each other. Parts are loosely coupled if the influence is present, but not extreme. They are uncoupled when neither influences the other. The level of coupling in a system affects the amount of time required to propagate a change from one part of the system to the other. In an organization, coupling affects the speed of information transfer and the effectiveness of efforts to encourage change.*

- At the Student Level, structural coupling interactions occurred between the student's external boundaries and his environment resulting in internal transformation. The student continually evolved, organized, and reorganized his mental models based on information gleaned from those he interacted in both LIL and additional environments external to the student.
- Among Instructors, through the structural coupling process, each student was part of and affected each other's worlds and learning. Instructors designed scenarios where each student communicated and coordinated as well as adapted to emerge as a joint group behavior to problem-solve the task present during a specific coordinated "group" encounter.
- In LIL as a whole, the think-tank capitalized on the experiential learning process, which intuitively worked in accord with the structural coupling universal of cognition. There was recognition that the brain both perceived and generated patterns, and through these patterns of behavior (attractors), the student determined essential characteristics/identity.

*17. An Attractor describes the predominant pattern of behavior in a CAS and insures that a system is stable. The pattern emerges from the interaction of the parts, but it also constrains the behavior of the parts. It is a trajectory to which motion gravitates. Resistance to change is really attraction. External activity causes a system to jump from one attractor to another. Whenever an agent enters the system, it will move toward the established pattern of behavior, the predominant attractor regime.*

- At the Student Level, for those exhibiting dysfunctional social behavior, the facilitating think-tank created environment where feedback loops provided



options for alternative basins of attraction and attractors to develop through “Levels”, counseling, peer counseling, and parental input.

- Among Instructors, capitalizing on the attractor universal meant creating during “GROUP” an instructional environment where the student interacted with his environment chose his behavior, and its subsequent attractor. Patterns of behavior emerged from the interaction of the students, but those patterns also acted to constrain the behavior of the parts. In this way, the attractor became a self-fulfilling prophecy. The most difficult challenge in instruction was not in teaching content, but rather in guiding a constructive interactive environment during a cooperative learning problem solving exercise.
- In LIL as a whole, one-on-one instruction permitted an immediate feedback loop on understanding of skills and content where the student could adapt and adjust to new attractors. The beauty of one-on-one instruction, as part of the academic area of emphasis in the LIL structure was its ability to tailor activity and interactions for the child at both his current maturation level, the level dictated by any special needs, and his current academic level of performance. The teacher then was able to adapt instructional method, without sacrificing instructional content, to create an environment for the student to thrive.

18. Context Dependent: *Complex Adaptive Systems (CAS) are unique in that their behavior is context dependent. CAS are intimately related to their environments, and depend on changes in the context, as much as on changes that are arbitrarily considered a part of the system’s internal dynamics.*

- At the Student Level, the public school context from which the student arrived created a self-fulfilling prophecy of downshifting progress and performance to non-existent levels.
- Among Instructors, curriculum was designed around the developmental level of the student instead of grade level or chronological age of the student.
- In LIL as a whole, “Group” focused on context dependent skill development. It was designed for the student to apply the skill and content he learned throughout the week. Since each student was unique, therefore context dependent, he was intimately related to and connected to his environment. Each “Group” learning opportunity created an option for change and adaptation. As such, the student’s learning occurred as a part of changes in his internal dynamics, and was dependent on changes in the environmental context in which he interacted.

*19. Self-Generation means that all components including those of the boundary are produced by processes within the network. This includes the ability to create new structure and new modes of self-organizing behavior that involve development, learning, and evolution. Over time the production processes continue so that all components are continually replaced by the system’s processes of transformation*

- At the Student Level, the LIL student controlled his decision-making process, thereby releasing and redirecting negative placed energy back into productive strides forward. With clearly set boundaries and clearly established consequences for choices, each student holistically empowered appropriate behavior which opened the door to address the academic component.

- Among Instructors, the student's self-regeneration processes meant tailoring the instructional design with feedback loops that reinforced choices and actions that guided the student into choosing new behaviors and toward optimal level of healthy performance.
- In LIL as a whole, creating an environment where the student had control to choose, LIL provided opportunity for the student to reflect and adjust behavior to new basins of attraction by peeling at the layers of inappropriate behavior decision-making, in a safe, nonjudgmental environment. The student could replace inappropriate choices with appropriate ones. In so doing the student's perspective broadened from living only for today to implementing long-term self-actualizing objectives.

20. *Trajectory Development is the process that nonlinear systems use to identify solutions (trajectories). Dependent on the initial state, or pattern over time, a system would pass repeatedly through a sequence of states cycles (attractors). Eventually the system hits a state it has previously encountered and eventually will repeatedly cycle around a recurrent loop of states called a state cycle attractor. Different trajectories may all converge on the same state cycle, like water draining into a lake. If the system falls into a small state cycle, it will behave in an orderly manner. But if the state cycle is too vast, the system will behave in a manner that is essentially unpredictable.*

- At the Student Level, each student entered LIL at a different maturation for academic readiness. As that student searched for meaning and determined purposes, his capacity for change ascribed a level of intentionality or organized focus that was inseparable from the student as a whole.

- Among Instructors, the application of “levels” was a reflective tool for appropriate behavior and provided the opportunity to begin with the student’s current behavioral awareness and maturation and broaden the awareness and intrinsic behavioral motivation. The use of levels focused on encouraging the student to self-reflect, self-organize, and progress behaviorally from one behavioral level to another.
- In LIL as a whole, the beauty of the LIL approach was the opportunity to embrace the student at the self-control level with which he entered the school and create a strategy that worked for that student. The LIL approach capitalized on how the attractor and feedback loop universals operated on the student’s autopoietic, cognitive, and dissipative structure.

21. *Evolution of Co-Evolution prefers as intermediate position near the phase transition where adapting systems interconnect. Through these interconnections agents are transformed and transforming as they interact.*

- At the Student Level, Apprenticeships and Fieldtrips were scheduled to explore post-graduation institutions and embrace the student’s need to evolve as the environment with which the student interconnected did similarly. The goal of this Career component was to reinforce, build, develop, and expand the rationale of LIL’s program structure.
- Among Instructors, assignments for eleventh and twelfth grade students who chose apprenticeships in their career area of interest resulted from the experience that tied directly to their one-on-one instruction. Seventh through twelfth grades were exposed, through tours, to an assortment of local schools.

Technical schools, trades schools universities, community colleges, art schools, designing schools, and drafting schools had something to offer for everyone. In addition, the branches of the service conducted a career day at LIL providing choices for armed forces. Local political leaders provided a different slant for those students who were more demonstrative.

- In LIL as a whole, evolution and even co-evolution of the variables alters both the student and the manner in which the student interconnects. The facilitator capitalized on these universals to create an environment where the student structurally coupled to naturally learn and adapt. “Group,” “IGI,” “Field Trips,” Career Development, and Apprenticeships at LIL specifically addressed the “interaction component.”

#### What was Accomplished?

My initial LIL experiences using instinct and trial-and-error led to a search for answers, for a better way to create an optimal learning environment, and culminated in this viable blueprint for innovative educational administration. The overall goal of this dissertation has been to construct a more encompassing Education Theory Complexity Hybrid (ETCH) targeted for the educational system that introduces concepts of complex adaptive systems that hopefully will inspire educational policy and practice. I believed that knowledge of the basic principles of complexity theory-the complexity universals – could drive a new style of leadership that is more effective than the current styles, and which I believe are grounded in a traditional view that is too mechanistic, reductionistic, and linear to stimulate the kinds of facilitation that seem most effective in shaping stronger learning institutions.

The rationale for constructing an educational theory complexity hybrid, therefore, is to inspire a paradigm shift from a traditional to complexity model of education, thereby prompting an alternative theoretical frame of reference which in-turn could provide the potential to enhance the effectiveness of education in preparing our students for 21<sup>st</sup> century demands. In addition the educational theory complexity hybrid can provide a roadmap for future preparation and practices of educational leaders, a variety of educational programs, interventions, and diagnostic tools.

In this dissertation, I have explored the ways in which educational systems behave as complex adaptive systems and the ways in which educational leaders might be more effective if they identify schools and school districts as complex systems. I also have illustrated how one school that was quite effective in helping each child learn had a set of practices highly consistent with the complexity view that I have presented. There remain, of course, a number of next steps that could make the ideas I have presented more useful and more credible.

First, since experience has taught me that not all leaders are ready to think in complexity terms, it would be worthwhile to assess the readiness of current and potential school leadership to identify the degree of intervention needed to develop a comfort level around the complex adaptive system model. Second, since the experiences presented from the Lancaster Institute of Learning in this dissertation are retrospective in nature, it will be important to apply complexity principles to the leadership of some additional schools and to study in depth whether the approach results in fundamental improvement.

Finally, my own experience, based upon difficulties encountered in leading LIL, suggests that the following issues are likely to require further study and development. By far, funding

was the most significant administrative hurdle throughout the school's existence---a situation that presently would not occur in a local, state, and federal funded public school environment. Otherwise known as revenue, its continual flow through the school's dissipative structure was obviously crucial for the school's sustainability. Disrupt the flow (resources) and the system ceases to exist, according to complexity theory. The original school, TUTOR-US Learning Center took its first breath, with no collateral and a four thousand dollar bank loan given to a single entrepreneurial woman with two school-age children. Obviously, the bank was cautious since the TUTOR-US concept was an original, providing no external options to determine its marketability. (By contrast, the charter school initiative that followed years later would be provided with both "seed-money" and start-up state funding often exceeding a hundred thousand in capital investment.)

The TUTOR-US Learning Center four thousand dollar start-up funds were pitted against two major operating expenses: site rent (\$1,000/month) and free-lance expenses for thirteen part-time teachers receiving 1099s. The merger of TUTOR-US services into the Lancaster Institute of Learning four years later, created opportunities while exacerbating a tenuous financial feedback loop. The school's financial structure changed in a number of ways. Most importantly, the status of the school changed from a profit to non-profit organization; the Lancaster Institute relocated to a new site; and most significantly, the physical move increased both major operating expenses to include a new site rent at \$4,000/month and a new payroll for thirty-two staff (some full and some part-time) that included payroll tax deductions. Since revenue for the Lancaster Institute was solely created by student tuition (no additional state or federal funding was available at the time), it was imperative that the

student flow was maintained at building capacity within the guidelines of state and federal regulations.

This tenuous financial status flowed through the school's dissipative structure in a feedback loop that required continual counter measures to balance its negative influences. Its impact on human capital was just one example. LIL could not match public school salaries which affected the availability pool for quality instructors. The teachers that were attracted to LIL were the visionaries who responded to the altruistic LIL mental model. In spite of the tenuous financial situation, the impetus to continue for eight years was visible in the dramatic growth (emotional, academic, and behavioral) of the children---the same children who had been the incorrigible outcasts of the public school system. Even with the perpetual financial tentacles, every day the visible changes presented in the children's behavior and growth created impetus to fight to continue.

An additional huge hurdle involved the student and the influences external to the school setting. Had LIL remained open, steps toward a residential campus environment would have received front-burner attention. Unfortunately, at the end of the school day, some students would return to a dysfunctional home environment, whose influences all too often regressed progress made during the school day. Replacing the dysfunctional home environment would have facilitated an environment that reinforced Glasser's Choice Theory and provided a home structure with self-correcting feedback loops. As it stood, parents in denial, for example, with their child's confirmed drug use (confirmed through school blood testing) availed few options, since a condition of school membership was a drug-free status.

Simultaneously, positive feedback from external forces was a significant motivating force that kept my energy level ready to embrace the next eighty hour week. And I was committed



to continue. Over the eight years various parents, guardians, and grandparents would call, write, visit and describe the noticeable difference in their offspring during the student's enrollment and the follow up of the student's journey after graduation. Some of the comments I treasure most include: "He turned down going out with his friends to make sure his homework was complete." "She went and did her homework without being told. She never did that before." "He is showing a confidence about what he has learned that he hasn't shown for a long time." "Before LIL, graduating did not seem to be an option." In their eyes, LIL was truly a holistic approach to learning (Appendix M).

## APPENDIX A: COMPLEX ADAPTIVE SYSTEM TERMS

PG 56

1. Self-organization	10. Nonlinearity
2. Auto & Cross Catalytic Cycles	11. Far-From Equilibrium
3. Interactiveness	12. Perturbation and Bifurcation
4. Emergent Pattern Formation and Pattern of Organization	13. Interconnectedness
5. Feedback Loops	14. Adaptation
6. Self-Regulation & Self-Perpetuation	15. Scaling/ fine and coarse graining
7. Emergence	16. Structural Coupling
8. Open systems	17. Attractors
9. System History	18. Context Dependent
	19. Self-Generation
	20. Trajectory Development
	21. Evolution of Co-Evolution

1. Self-Organization: is the spontaneous emergence of order that results from the interrelationships from the system's parts. A constant flow of energy and matter through the system is necessary for self-organization to take place.
2. Auto & Cross Catalytic Cycles – Appear in the self-organization process as interlocking closed loops, where one cycle acts as the catalyst in subsequent cycles, having the ability to self-balance and self-organize.
3. Interactiveness is the energy and matter exchange between systems or system components generating a system that is always changing. Patterns of behavior emerge from the interaction of the system's components (students, instructors, facilitators, and stakeholders). Learning how those patterns of behavior arise is the key to identifying the system as whole. Interactions among interdependent agents of complex adaptive systems (CAS) transform and are transforming. Because CAS are open systems, transformation occurs across the system's external boundaries.
4. Emergent Pattern Formation and Pattern of Organization – The configuration of relationships determine the system's characteristics or identity or patterns of organization. Over time systems exhibit certain patterns of behavior or attractors. If the pattern is destroyed then the organism will die. If the system is an autopoietic network the system lives. If the system is non-autopoietic, the system is not living.
5. Feedback Loops is the tendency of a system to use its own output to make adjustments in its inputs and/or processes. These loops carry resources (material information and energy) from one agent to another. These transforming feedback loops serve to give both stability and changeability to the complex adaptive system (CAS). Feedback is the primary means of

control in a CAS, so the design or feedback systems within an organization are critical to adaptation and effective functioning.

6. Self-Regulation & Self-Perpetuation of the entire system is a consequence of the feedback loop (the first link-input- is affected by the last – output). The initial effect is modified each time it travels around the cycle.
7. Emergence is a process that materializes through the self-organizing interactions of the agents within the system. The emergence process spontaneously materializes a whole in the form of collective properties such as life, thought, or purpose that the agents might never have possessed individually.
8. Open systems are systems in a state of complex stability, whose boundaries permit interaction with its environment in a constant flow of energy and matter through the system. As a result, the system is always in some stage of development and transformation. The more diversity imbedded in the organizational components, the less it is likely the organization will shut out information and the more sensitive and adaptive the organization is to the nature of change.
9. A System's History is the organism's record of its previous structural changes at any point in the system's development. Its history of structural coupling will determine the new pathways available for that system.
10. Nonlinearity is the potential for disproportionate or exponential relationship between variables, where small changes in one variable may produce highly disproportionate effects in variables systemically connected to the changed variable. This pattern is exacerbated because CAS depend on iterative processes. They repeat the same processes over and over again. The output of a previous process becomes the input of the next one. Iteration

magnifies the effects of the nonlinearity, so that simple causal relationships are virtually impossible to detect, to measure, control, or evaluate.

11. Far-From Equilibrium is a state of system where energy and information are drawn in to keep the system in a state of ongoing flux. As information and interaction is brought into the system from its environment, it becomes more active and unpredictable. The system begins to renew its own structure, hopefully resulting in strategies for collective action or the emergence of subgroups developing a coping strategy. Far-From equilibrium systems do not evolve smoothly and continuously over time, but do so in sudden leaps, which intersperse over relatively extended periods of stasis.
12. An increased amount of perturbations in a system increase its points of instability to the point of crucial destabilization or bifurcation. A bifurcation is a threshold of instability perturbated to a point of phase transition and a new pathway, at which the dissipative structure may choose from among several possible paths, or states. When the system reaches the bifurcation point it is unpredictable. Its history of structural coupling (fine and course grained), and various external conditions determine if the structure breaks down or breaks through to a new state of order. Bifurcations are the foundation of organizational change and learning.
13. Interdependence & Interconnectedness are variables that drive many CAS. As key agents in a system (individuals, groups, institution) relate to each other, and influence each other's behavior in complicated and unpredictable ways – known as coupling, the complex interdependencies and interconnectiveness of these variables are transformed and transforming in their interactions, and emerge into new and unexpected system-wide behaviors.

14. Adaptation is a process that involves attempting to turn interactions to system improvement according to some measure of success. A system that contains agents that seek to adapt is referred to as a complex adaptive system (CAS). Although it is difficult for an agent to predict the consequences of its actions and therefore to choose the best course of action, the implication is that they have learned and discovered various ways of positioning itself in its context.
15. Scaling/ fine and coarse graining is the ability to view a system on different levels (scaling). Individual agents take relatively independent actions; various groupings of agents emerge in the dynamical course of events; and the system as a whole exhibits identifiable behaviors – behaviors that in each level/domain are both similar to and different from behaviors of the other levels. An individual child may reflect the tension felt in an entire school, groups or gangs may form in response to this tension, and rumors may move through the faculty in response to specific incidents. Each of these domains is intimately associated with the others and exhibits both similarities and differences from them.
16. A Structurally Coupled system is a living, cognitive, leaning system. Structural changes are acts of cognition, development and learning, and are expressions of structural coupling. This coupling produces the self or ego. Through mutual structural coupling, individual living systems are part of each other's worlds as they communicate with one another and coordinate their behavior. Through mutual structural coupling, communication is not a transmission of information, but is a coordination of behavior among living organisms. Such mutual coordination of behavior is the key characteristic of communication of all living organisms, with or without nervous systems, and it becomes more and more subtle and elaborate with nervous system of increasing complexity. Two parts of a system are said to be tightly

coupled if they have a great influence on each other. Parts are loosely coupled if the influence is present, but not extreme. They are uncoupled when neither influences the other. The level of coupling in a system affects the amount of time required to propagate a change from one part of the system to the other. In an organization, coupling affects the speed of information transfer and the effectiveness of efforts to encourage change.

17. An Attractor describes the predominant pattern of behavior in a CAS and insures that a system is stable. The pattern emerges from the interaction of the parts, but it also constrains the behavior of the parts. It is a trajectory to which motion gravitates. Resistance to change is really attraction. External activity causes a system to jump from one attractor to another. Whenever an agent enters the system, it will move toward the established pattern of behavior, the predominant attractor regime.
18. Context Dependent: Complex Adaptive Systems (CAS) are unique in that their behavior is context dependent. CAS are intimately related to their environments, and depend on changes in the context, as much as on changes that are arbitrarily considered a part of the system's internal dynamics.
19. Self-Generation means that all components including those of the boundary are produced by processes within the network. This includes the ability to create new structure and new modes of behavior- self-organizing- that involve development, learning, and evolution. Over time the production processes continue so that all components are continually replaced by the system's processes of transformation
20. Trajectory Development is the process that nonlinear systems use to identify solutions (trajectories). Dependent on the initial state, or pattern over time, a system would pass repeatedly through a sequence of states cycles (attractors). Eventually the system hits a state

it has previously encountered and eventually will repeatedly cycle around a recurrent loop of states called a state cycle attractor. Different trajectories may all converge on the same state cycle, like water draining into a lake. If the system falls into a small state cycle, it will behave in an orderly manner. But if the state cycle is too vast, the system will behave in a manner that is essentially unpredictable.

21. Evolution of Co-Evolution prefers an intermediate position near the phase transition where adapting systems interconnect. Through these interconnections agents are transformed and transforming as they interact.



## APPENDIX B: TERMINOLOGY

TERMINOLOGY	
<u>System</u>	<ul style="list-style-type: none"> <li>• “A pattern of elements in mutual interaction, where the boundaries that delimit it are dependent on the activity under consideration” (Krippner, 1998) That pattern of mutual interaction cannot be described in a shorter way than by describing it as a whole (Casti, 1996).</li> <li>•</li> </ul>
<u>Systemic change</u>	<ul style="list-style-type: none"> <li>• Is an approach to change that: 1) recognizes the interrelationships and interdependencies among the parts of the educational system, with the consequence that desired changes in one part of the system must be accompanied by changes in other parts that are necessary to support those desired changes and 2) recognizes the interrelationships and interdependencies between the educational system and its community, including parents, employers, social service agencies, religious organizations and much more, with the consequence that all those stakeholders are given active ownerships over the change effort[Jenlink, 1998 #95]</li> </ul>
<u>Organization</u>	<ul style="list-style-type: none"> <li>• A set of relations among its components that characterize the system as belonging to a particular class (such as a bacterium, a sunflower, a cat, or a human brain). A system’s organization is independent of the properties of its components, so that a given organization can be embodied in many different manners by many different kinds of components. The description of that organization is an abstract description of relationships and does not identify the components.</li> </ul>
<u>Organizational level</u>	<p>Describes the hierarchy of organizational structure within a human organization. (For example: concept, team, institution, community)</p> <ul style="list-style-type: none"> <li>• <u>Conceptual level</u>: involves development of mental models as they are held and/or documented by individuals or groups of individuals working together.</li> <li>• <u>Team level</u> is defined as a group of persons working together within an institution toward a shared purpose or common task. Sometimes teams are established by forma or permanent processes, and sometimes they are informal or temporary</li> <li>• <u>Institutional level</u> is defined as a functional organizational or business unit. Institutions included in the study are for-profit, not-for-profit, governmental,</li> </ul>

	<p>and religious institutions.</p> <ul style="list-style-type: none"> <li>• <u>Community level</u> involves a variety of individuals or institutions that come together to solve common problems across institutional lines.</li> </ul>
<u>Complex Systems</u>	<ul style="list-style-type: none"> <li>• Complex systems oscillate on a behavior continuum between order and disorder where they appear alive to observers who may perceive them as capable of keeping order and chaos in a special kind of intricate and lively balance. This property – their ability to keep balance - is therefore described as ‘life at the edge of order and chaos’(Research). Complex systems are typically organizations made of many heterogeneous independent parts or agents (often relatively simple) self-organizing locally in the absence of a centralized control to show emergent and complex properties not exhibited by the individual elements (White, 2001). Complex systems are difficult to understand because the behavior of a complex system includes not only the behavior of the parts but how they act together to form the behavior of the whole. Unlike simple systems, complex systems do not show the orderliness, certainty, continuous change and ability to return to their former state that typify the linear, isolate systems, inherited from Newton, and Descartes (U. Merry). In addition, simple systems will give rise to complex behavior or complex systems will give rise to simple behavior(Gleick, 1987). Therefore, complex systems are structurally nonlinear rather than linear (Song, 2002), where predictability is limited and therefore, also, is the ability to plan and control events (U. Merry). Complex Systems also adapt to their changing environment by trying to turn whatever happens to their advantage. The implication is that the complex system (organization) has learned and discovered various ways of positioning itself in its context. (White, 2001) Learning here implies the capacity to sort out information within a context. (White, 2001).</li> </ul>
<u>Complex</u>	<ul style="list-style-type: none"> <li>• Consisting of interconnected or interwoven parts</li> </ul>
<u>Complex Adaptive Systems (CAS)</u>	<p>Complex Adaptive Systems identifies the relationships (network of connections) in the patterns of complex systems. It seeks out the minimum ingredients necessary (in terms of fitness and interaction) to explain the adaptive mechanism buried in a system’s inner workings. Sometimes referred to as “self-renewing systems” or “living systems,” these types of systems have become better known as “complex adaptive systems” (CAS). (Capra, 1996) A “Complex Adaptive System”, therefore is a system of semi-independent agents that interact more or less randomly to influence each other’s behavior. Sustainable systems (CAS) have the ability to change themselves and interact with their context as they change. The economy, the brain, cellular metabolism, or the Los Angeles traffic basin --- each of these cases involves a complex, self-organizing, adaptive “system” possessed of a kind of humanism that makes them qualitatively different from static objects such as computer chips or snowflakes. (Song, 2002)</p> <p>Social Systems, actually any biological system, differ from the Physical Systems in that they are adaptive and they carry information about their environment and their past. Social and biological systems learn from their experiences and adjust their behaviors accordingly. They have the ability to anticipate their future and to attempt to manipulate that future(Marion, 1999)</p>
<u>Learning Organization as a CAS</u>	<p>A learning organization is ‘continually expanding its capacity to create its future...adaptive learning must be jointed by generative learning – learning that enhances our capacity to create (Senge, 1990). “With the academic playing this kind of role, problematising their teaching, and agreeing to play their part in learning from the student, then universities can be “learning organizations” at the departmental level, as well” (Laurillard, 1999).</p>
<u>Optimal Learning</u>	<p>On the behavioral continuum, found within the phase transition, and identified as the edge of chaos, by Kauffman, or future shock, by Conner. Is an emergent context-</p>

<u>Environment</u>	specific interactive environment whose behavior adapts and evolves to position itself for the most efficient level of learning performance? Optimal learning environments result from the interaction of key variables, that through their context-oriented choices, the system as a whole moves to the most efficient fitness level of performance
<u>Learning Society</u>	For the learning society, the process of reflection/adaptation of the society's behavior can be interpreted as policy for the management of its agencies, as the society develops its policies and values, informed both by reports from those agencies and by the outputs of university teaching and research in the form of a national debate. The society will only learn from a university sector that addresses its concerns (Laurillard, 1999). Interestingly, at even higher level of description of society as a whole, an argument can be made that the university's role in society is precisely to enable it to learn and understand itself and its environment. It does this via research to gain that understanding, and via teaching to disseminate it. The university sector has a vital role as the engine of progress for the community. The more it addresses the concerns of society in its research, and the more it widens access to all members of society to benefit from the fruits of that research, the more it supports a genuine "learning society" (Laurillard, 1999)
<u>Systems theory</u>	Embraces the importance of global perspective account for myriad components and interconnections in an educational system. In addition, the recognition that change in one part of a system necessarily alters the rest of the system is a cornerstone of systems theory (Jenlink, 1998 #95).
<u>Systems Thinking</u>	A type of thinking process that suggests that a system is "a collection of parts which interact with each other to function as a whole and that the whole is greater than the sum of its parts" (Kauffman 1980, pp1-2). In systemic thinking no solutions are ever permanent due to the continuously changing relationships between the variables – the dynamic nature of systems. Therefore, solutions must be malleable commodities constantly reworked by the stakeholders to meet changing conditions. (Horn & Carr, 2000)  In addition, systems thinking differentiates between systemic (holistic) and complexity science (ecological). "Holistic," by itself, is less appropriate to describe the New Complexity Science/CAS paradigm. To see a holistic bicycle, for instance, means to see the bicycle as a functional whole and to understand the interdependence of its parts accordingly. (Capra, 1996) An "ecological" view of the bicycle includes the "holistic" concept; however, it adds the perception of how the bicycle is embedded in its natural and social environment where the raw materials that went into it came from, how it was manufactured, how its use affects the natural environment and the community by which it is used, and so on.(Capra, 1996)
<u>Context</u>	Systemic change and systems design is context dependent for effecting change. Context is not only the cultural systems of values and beliefs, assumptions, and artifacts, but also includes the climate or perceived wellness of the setting as well as the existing structures of the system [Jenlink, 1998 #95].
<u>Process</u>	Is the "how." How the vision or design for a system is created. Within process lies the journey not the destination of the system [Jenlink, 1998 #95]. Focus on the process brings about the evolution of mindsets that are fundamental to successful systemic change [Jenlink, 1998 #95]
<u>Agents</u>	Elements of a system that are "connected" to some, but usually not all, of the others. The connections are through relations, and there is tremendous variety across fields in what those relations are and how they work (for example, magnetic attraction, organizational authority, electrical stimulation, sexual affinity, chemical inhibition, geographical proximity, or ethnic hostility). Each element in one of these complex

	systems has “patterns of actions” that affect those connected to it, and where each agent realizes when their interactions have left them better or worse off according to a fitness criterion.
<u>Closed or Fixed Thermodynamic Systems</u>	<p>Closed systems neither import nor export energy, information, or material (Kelly &amp; Allison, 1999). According to Mark Michaels 1994, have a lot of movement, but the input and the output are totally predictable. An assembly line and an engine of a motor vehicle are examples. They are also relatively closed in that they do not interact much with their environment, nor are they sensitive to it. Machines, from this point of view, are dynamic systems (Caine &amp; Caine, 1997). Many business systems seem only partially open (shut out certain kinds of information or information that matches the ways in which they already see the world) (Kelly &amp; Allison, 1999).</p> <p>In a “fixed system”, various components have not been developed or in any way functionally advanced. A fixed-system organization is one that is not growing its people, resources, or competitive advantages. The boundaries of a fixed system do not fluctuate much, aside from change occurrences and plus/minus marginal errors (Conner, 1998).</p>
<u>The Study of Complexity</u>	<p>Uses computers to search for patterns and commonalities in complex systems. Complexity arises through connectivity and the interrelationships of a system’s constituent elements, e.g. through multi-agency arrangement (White, 2001). It is possible to describe social and organizational complexity as being associated with the intricate interrelationships of individuals, of individuals with artifacts, and with the effects of interactions within the organization and between organizations and their “environment” which includes related organizations (R Stacey, 1995). Thus even more integrated and sophisticated grouping and communities can emerge and evolve groups that are then equipped to handle the more complex situations.</p>
<u>Complexity Science</u>	<p>Is the name commonly used to describe this set of interdisciplinary studies that share the idea that all things tend to self-organize into systems. Physics, Biology, Chemistry, Chaos Theory, Cybernetics, Synergetics, and nonlinear dynamics are among the many fields that are a part of the complexity tradition (Kelly &amp; Allison, 1999). The Science of Complexity, within the New Sciences, is an attempt to establish a linking unifying paradigm for all sciences that study life in its various forms and appearances that culminate in establishing the Laws of Complexity or universals. The Science of Complexity has encouraged the belief that deeper insight into human systems is possible from what has been learned from other complex system in the world, whether “natural,” such as ecosystems, or “artificial,” such as computer simulations (Lewin, 1999).</p>
<u>Complexity Theory</u>	<p>Complexity Theory searches for “behavior” over time of complex systems that will unravel a set of rules that govern the behavior of complex systems. Complexity theory affects any group of things that are interacting with each other and have the ability to make themselves more fit for survival (U. Merry). Complexity Theory describes complex systems as exhibiting circularity where “the properties of the parts are not intrinsic properties, but can be understood only within the context of the larger whole” (Capra 1996), although the whole, of course, consists of its parts --- Referred to as a “complementarity” structure between the whole and parts. Indeed, such complementarity is extended to that between a group of symbols, rules, syntax and that of image, behavior, or semantics (Kaneko, 1998). Although most of the vocabulary of Complexity Theory was spawned in Science, this new way of thinking has great implications for the Social Sciences, and for just about every field, including the field of Education, and specifically instruction.</p>
<u>Equilibrium</u>	<p>Traditionally referred to as the ecological “Balance of Nature” in which ecosystems were seen to rest at “equilibrium” until they were disturbed. They then found a new equilibrium. “Ecologists didn’t deny that complex dynamics existed in nature, claimed Stuart Pimm, but were explained as the result of genuinely unpredictable</p>

	<p>factors in the external world, such as fluctuations in climate for example. One essential factor was whether the system was stable or perturbed. More technically, there was a strongly ordered, stable state, in which the flow of activity continued, but nothing much changed (Bryson, 1988; Caine &amp; Caine, 1997).</p> <p>In reality a system rarely comes to rest, as it responds to perpetual shifts in its environment, and further responds to the fluctuating dynamics of the system itself, as is seen in simulations of complex adaptive systems and is observed in nature. What Prigogine and others found was that a system could be at equilibrium and when confronted with change, would fall apart, but it would fall apart so that it could reorganize itself (Wheatley 1995). Fossil history points out this evolutionary pattern throughout time. (Kelly &amp; Allison, 1999)</p> <p>What has been happening with education is that for many years, it has been stable, dwelling quite comfortably in an ordered state. However, over the past several years, there has been more and more interaction with the environment – more intensive media coverage, more concern from political and religious groups, more demands from business, more special needs to accommodate, and more impact from technology. All of these have perturbed the system. Thus, it is moving out of stability and into disequilibrium. (Caine &amp; Caine, 1997; Kiel, 1997)</p>
<u>Physical Sciences</u>	The Physical Sciences teach that most living systems increase in complexity and interdependence as they evolve. Our species is maturing Quantum Theory states that all matter is actually restless and the appearance of stability is only the result of a dynamic balancing act
<u>Punctuated Equilibrium</u>	Means that a system seems to function in a “stable” mode for some period – then, at a point in time, gathers itself together and restructures in a significant way to meet the accumulated changes in its environment (Kelly & Allison, 1999).
<u>Observer</u>	An observer is a system which, through interactions, retains a representation of another system (the observed system) within it. The observer and system are in a relationship. An observer is a person who makes measurements (observations) on a system to gain information about it. This information can be communicated to other people in the form of a description. Our concept of an observer is based on considering a person with senses seeing, hearing, feeling or smelling something. The traditional view of an observer is one that is objective and independent of both the system being observed and the rest of the environment. This influence is solely one-way through the effect of measurements that provide the observer with information about the system. Scientific theories do not describe the properties of the observer; however, through the act of observation, there is an influence between the system and the observer. (Bar-Yam, 2001)
<u>Universals</u>	Also referred to as universal laws, is one of the original concepts of science--- the idea that all matter and all scientific endeavor is formed out of the same building blocks creating a commonality among systems in science. In physics, universals complement the universality found in mechanical laws (classical or quantum) and govern their motion. In biology, the common molecular and cellular mechanisms of a large variety of organisms form the basis of these universals and their processes. NECSI PDF Article.



**APPENDIX C: LIL STUDENT CONTRACT**

The following is an agreement between the Lancaster Institute of Learning and \_\_\_\_\_ (student).

This agreement is set forth for the purpose of enabling the student to successfully complete an academic school year.

I agree to give 100% effort toward my studies.

I agree to complete all assignments neatly and on time.

I agree to cooperate with students and teachers.

\_\_\_\_\_  
(student's signature)

I agree to support \_\_\_\_\_ in her/his studies.

\_\_\_\_\_  
(parent's signature)

I agree to oversee \_\_\_\_\_ studies for his/her optimal benefit.

\_\_\_\_\_  
(director's signature)



**APPENDIX D: COUNTER-CONDITIONING FROM LEVELS**

PG 245



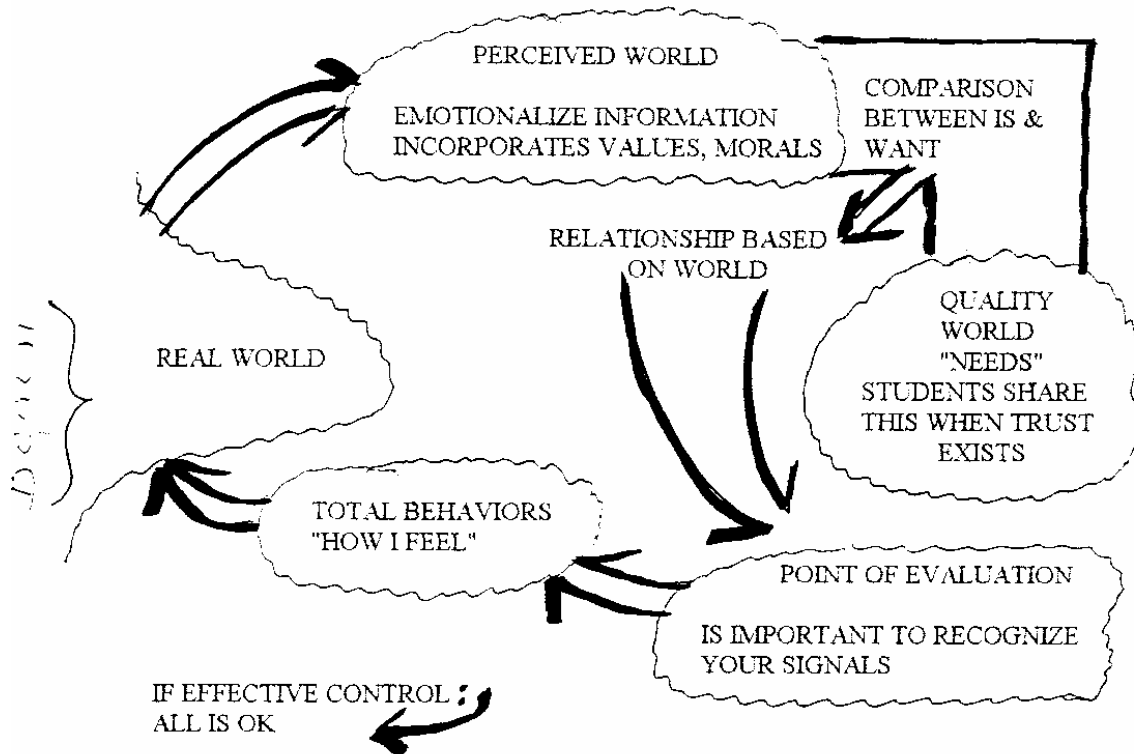
## What is Choice Theory?



- Choice Theory is a biological theory which explains both the psychological and physiological behavior of all living creatures.
  
- It contends that all we can do is behave, and in contrast to stimulus-response theory, which claims that all of our behavior is externally motivated, choice theory explains that all behavior is internally motivated.
  
- Specifically, all of our behavior is our best attempt to satisfy one or more of five basic needs built into our genetic structure.
  
- Choice Theory contends that the only person's behavior we can control is our own. By using Choice Theory, we help people learn that what we do is not determined by external causes, but instead by what goes on inside of us.

CHOICE THEORY - SELF CONTROL THEORY

- \* A PROCESS OF CREATING ENVIRONMENT
- \* ALL BEHAVIOR IS PURPOSEFUL
- \* CONCEPT BASED ON INTRINSIC MOTIVATION




---

1. IS POSSIBLE THROUGH EDUCATION ONE CAN LEAD AN INDIVIDUAL OUT OF DESTRUCTIVE BEHAVIOR

LEARNING STOPS WITH JUDGMENT

---

2.. TAKING OWNERSHIP OF CHOICE OF ACTION  
 DO BECOME WHAT YOU THINK AND SAY  
 PEOPLE OWN WHAT THEY CREATE  
 PEOPLE RENT WHAT YOU CREATE

## APPENDIX E: THE LIL BEHAVIORAL LEVELS

PG 247

	Attitude	Behavior	Preparedness	Cooperation
Level 1	<ul style="list-style-type: none"> <li>• shows no interest</li> <li>• antagonistic</li> <li>• shows no respect for teacher or other students</li> </ul>	<ul style="list-style-type: none"> <li>• shows no eye contact</li> <li>• gives inappropriate answers to questions</li> <li>• does not answer questions</li> <li>• slouches</li> <li>• uses inappropriate language</li> </ul>	<ul style="list-style-type: none"> <li>• homework is incomplete</li> <li>• no notebook and or assignment book</li> <li>• arrives to class late</li> <li>• has no text, paper, or writing utensil</li> </ul>	<ul style="list-style-type: none"> <li>• does not follow directions or is slow to follow directions</li> <li>• argues</li> <li>• lacks focus</li> <li>• fails to listen</li> </ul>
Level 2	<ul style="list-style-type: none"> <li>• shows interest in material</li> <li>• apathetic</li> <li>• shows respect for teachers and students</li> <li>• actions and voice tone show respect for authority</li> </ul>	<ul style="list-style-type: none"> <li>• has eye contact</li> <li>• answers questions</li> <li>• sits up</li> <li>• uses appropriate language</li> </ul>	<ul style="list-style-type: none"> <li>• homework is complete</li> <li>• has assignment book and note book</li> <li>• arrives on time</li> <li>• has text, paper, writing utensil</li> </ul>	<ul style="list-style-type: none"> <li>• follows directions</li> <li>• practices good listening skills</li> <li>• focuses with direction</li> <li>• cooperates with teacher to accomplish given tasks</li> </ul>
Level 3	<ul style="list-style-type: none"> <li>• shows eagerness to learn</li> <li>• shows interest</li> <li>• shows respect for teacher, students, and self</li> </ul>	<ul style="list-style-type: none"> <li>• uses good eye contact</li> <li>• asks good questions</li> <li>• participates actively in a positive way</li> <li>• uses appropriate language</li> <li>• uses good posture</li> </ul>	<ul style="list-style-type: none"> <li>• homework is complete and meets expectations</li> <li>• notebook is neat and in order</li> <li>• assignment book is completely filled in and finished work is crossed out</li> <li>• arrives on time and gets materials ready without prompting</li> </ul>	<ul style="list-style-type: none"> <li>• follows directions</li> <li>• practices good listening skills</li> <li>• is actively focused</li> <li>• helps other to focus</li> </ul>

- Level 1
  - 15 minutes of lunch secluded for study
  - mandatory homework center
- Level 2
  - regular lunch
  - homework center if name is on board
- Level 3
  - open lunch
  - homework center if name is on board
  - earns a free homework pass for three consecutive weeks on level 3 (can not duplicate subject per marking period)

- To advance a level:
  - Must be passing every class
  - No discipline referrals
  - Always on time for school
  - Level 2 requires 238 points for a week
  - Level 3 requires 357 points for a week
  - You cannot jump 2 levels at once
  - If you are absent for more than one day per week you cannot advance to the next level
- To drop a level:
  - Not passing every class
  - Discipline referrals
  - Late for school
  - Less than 238 or 357 points respectively
- If you are on level 2 and you earn at least 357 points, you can stay on level 2 if you have only one item from the drop list.

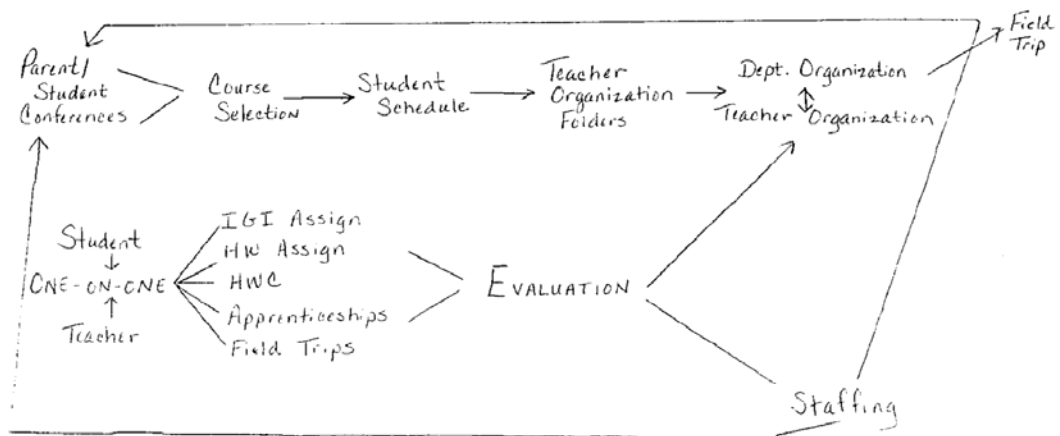
**APPENDIX F: WEEKLY BEHAVIOR FEEDBACK FORM**

PG 248

	Monday	Tuesday	Wednesday	Thursday	Friday
<b>Attitude</b>	Group	Group	Group	Group	Group
	Group	Group	Group	Group	Group
	per 1	Chorus	per 1	per 1	FT
	per 2	per 1	per 2	per 2	FT
	per 3	per 2	per 3	per 3	FT
	per 4	per 3	per 4	per 4	FT
	per 5	per 4	per 5	per 5	FT
		per 5	Group	Chorus	
		Group	Phys Ed		
total	total	total	total	total	
<b>Behavior</b>	Group	Group	Group	Group	Group
	Group	Group	Group	Group	Group
	per 1	Chorus	per 1	per 1	FT
	per 2	per 1	per 2	per 2	FT
	per 3	per 2	per 3	per 3	FT
	per 4	per 3	per 4	per 4	FT
	per 5	per 4	per 5	per 5	FT
		per 5	Group	Chorus	
		Group	Phys Ed		
total	total	total	total	total	
<b>Preparedness</b>	Group	Group	Group	Group	Group
	Group	Group	Group	Group	Group
	per 1	Chorus	per 1	per 1	FT
	per 2	per 1	per 2	per 2	FT
	per 3	per 2	per 3	per 3	FT
	per 4	per 3	per 4	per 4	FT
	per 5	per 4	per 5	per 5	FT
		per 5	Group	Chorus	
		Group	Phys Ed		
total	total	total	total	total	
<b>Cooperation</b>	Group	Group	Group	Group	Group
	Group	Group	Group	Group	Group
	per 1	Chorus	per 1	per 1	FT
	per 2	per 1	per 2	per 2	FT
	per 3	per 2	per 3	per 3	FT
	per 4	per 3	per 4	per 4	FT
	per 5	per 4	per 5	per 5	FT
		per 5	Group	Chorus	
		Group	Phys Ed		
total	total	total	total	total	
total	total	total	total	total	

## APPENDIX G: ONE-ON-ONE PROCEDURE

PG 252



ONE-ON-ONE PROCESS  
SYSTEM



## A. One-on-One Instruction

### 1. Topic Selection

- a) Prior to each marking period there will be a parent/teacher/student conference to determine the student's topics and areas of interests for the marking period.
- b) Each subject teacher should coordinate with his counterpart (for example, English and Social Studies) to team teach where appropriate.
- c) Chosen topics are on file in the director's office for reference. Please update any changes.

### 2. Paperwork

- a) Write learning objectives for each session.
- b) Keep tests/quizzes/papers.
- c) Keep accurate and current grades sheets.

### 3. Grades

- a) The individual grade counts as 80% of a marking period grade.
  - (1) Assignments count as 15% of the individual grade.
  - (2) Class Participation counts as 5% of the individual grade.
  - (3) Test/Quizzes/Projects count as 80% of the individual grade.
- b) Grades should be calculated weekly.
- c) The individual grade is averaged with the group and field trip grades to arrive at a total grade as detailed below

**APPENDIX H: LIL INTEGRATED GROUP INTERACTION (IGI) PROCEDURE**

pg 254

## IGI Procedures

### At the beginning of the day:

- Get IGI chart and all tests and IGI work from the IGI box. (All sheets are filed according to date.)
- Sort tests according to what period that need to be taken. (Students take test during the IGI period for that class.)
- Indicate on IGI sheet when each student is to take a test. (preferably in red.)

### When student arrives at beginning of period:

- Have student initial sheet in appropriate box, and indicate the specific assignment he will be completing. Students must work on the subject that is indicated on the IGI sheet.
  - If the student claims to have no work for an IGI period, first check student's assignment book. Next, ask to see any completed assignment to verify that it is complete.
  - If there is no assignment, or if it seems to be completed, verify with the teacher.
  - If a student indeed does not have work for that class, or if he finished assignment given, correctly, before the period is over, the student may choose which assignment from another class to work on.
- Student should pick-up test or IGI work when they arrive.
- Bathroom is to be used before arriving for IGI.
- Students may have drinks, but No food in IGI. Drinks must be brought to IGI at the beginning of the period.
- After a student arrives and signs in he should find a seat and begin work. Seats may be changed or assigned at the discretion of the teacher. (It is best to avoid potential problems by changing seating arrangements before problems arise.)
- Shortly after the beginning of the period, make sure all students are present. Check sign-in sheet, take a head count, indicate students absent from school for the day. If someone is in school, and not in IGI, make a quick search, notify the office or Irene.

### Throughout the IGI period, the teacher in charge should:

- Maintain a quiet study atmosphere.
- Monitor students for:
  - Completing assigned work. Making sure the student is working on the correct subject as stated on the sign in sheet.
  - Assisting students as needed to complete assignments.
  - Checking completed work and tests for compliance with LII standards.
- Secure any needed supplies for a student, either from the IGI closet or from the office. **Students should not leave IGI.**
- Use IGI sheet to document progress (or lack of it) during any period. IGI sheet can also be used to document any problems or concerns that arise during a period.

- If need be, feel free to contact Irene or the office for special problems and concerns.
- If a student request to meet with a teacher during an IGI period, check the teacher's schedule to determine if they are free or teaching. If they are not teaching, the student may see a teacher at the discretion of the IGI instructor.
- If a student desires to meet with Irene, check with the office as to her availability and schedule an appointment during that period or another IGI. (You may allow the student to do this at your discretion.)

**Computers:**

- Computers in the computer room are reserved for students taking computer class. The Packard Bell Computer has its own schedule and students should not expect to use it except before, after school, or during an assigned computer IGI. Computer students have first priority on this computer because all computer assignments must be completed on it.
- The computers in the media center are for students use during IGI, to type necessary papers. Any work done on the computer must pertain to the designated subject for that IGI period.
- Students are responsible to have and print their work before the end of the period. They also need to clear the screen before leaving.

**At the end of the period:**

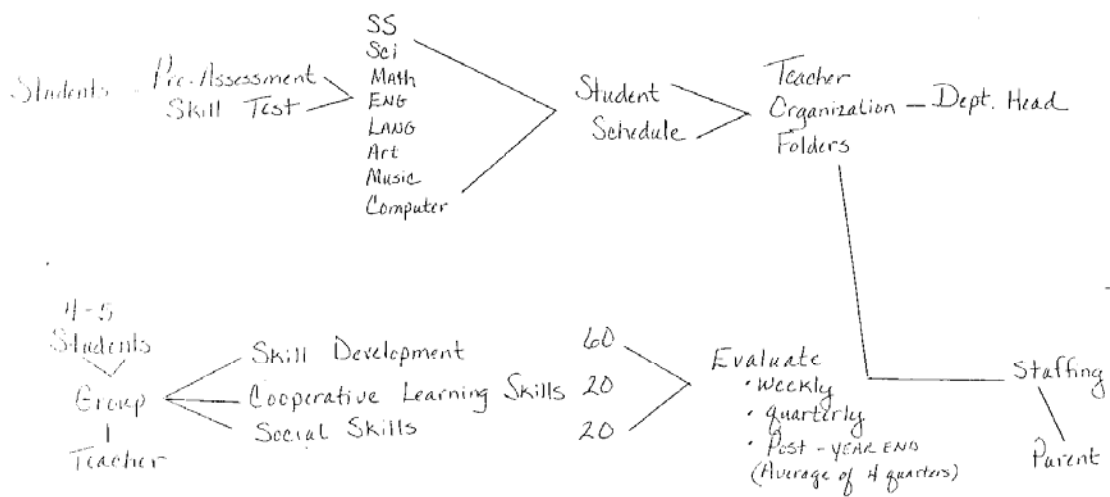
- Be sure to collect all tests and assigned IGI work.
- Place all completed work in completed test folder. (Be sure teacher's name and student name appears on the paper.)
- Any unfinished IGI work or test automatically and immediately goes on the Homework Center Board for that day, unless otherwise noted by the subject teacher. (Please inform the student of assignments placed on HWC board.)
- Students need to clean area before leaving at the end of the period. Nothing is to remain in or on the study carols or tables. Students have assigned spaces on shelves at the bottom of the steps for items they do not wish to carry around.
- All books and encyclopedias need to be returned to their proper places before the end of the period.

**At the end of the day:**

- Make sure the media center is in proper order, with all material returned to their proper place.
- Take all completed tests and IGI work and place in appropriate teacher mail box.
- Place completed IGI sheet in box in completed sheet file.

## APPENDIX I: LIL GROUP PROCEDURE

PG 257



Group Process System

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## Lancaster Institute of Learning Group Procedures

- Goal
  - To develop and reinforce basic skills specific to your subject area.
  - To implement basic social and cooperation skills needed in society.
  - To encourage critical thinking.
- Skills
  - Skills to be covered during the school year are chosen by the assessment tests administered at the beginning of the school year.
  - Within each department skills are evaluated and prioritized for the school year (sometimes quarterly).
  - Components of skills (subject, social, cooperative)
    - Each skill needs to be explained (taught, reviewed).
    - Hands-on activities as application of the skill in daily life.
    - Social and cooperative skills are introduced on a gradual basis (perhaps 2 per week)
      - evaluated by teacher
      - students evaluate selves
- Grading
  - All assignments should be completed in class.
  - Application of skill           60%
  - Social Skills                   20%
  - Cooperative Skills           20%
- Documentation
  - Lesson Plan and completed grade sheet are handed to the director.
  - A copy of the grade sheet is needed for each student. These sheets are then distributed to the teacher with the student's work attached.
  - Paperwork should be completed weekly.

## APPENDIX J: LIL COOPERATIVE LEARNING CURRICULUM

PG 258

### COOPERATIVE LEARNING: METHODS AND RESEARCH

#### Introduction

How can teachers motivate all their students to learn and to help each other learn? How can they structure classroom activities so that students will discuss, debate, and wrestle with ideas, concepts, and skills until they thoroughly understand them? How can they harness the enormous social energy students of all ages bring to class and direct it toward productive learning activities? How can they organize classrooms so that students care about each other, take responsibility for each other, and learn to appreciate each other regardless of ethnicity, performance level, or disability?

The answer is *cooperative learning*. Cooperative learning refers to a set of instructional methods in which students work in small, mixed-ability learning teams. The students in each team are responsible not only for learning the material themselves, but also for helping their teammates learn. Cooperative learning methods are practical classroom techniques teachers can use **every day** to help students learn any objective, from basic skills to complex problem solving. In cooperative learning, students work in small teams to help each other learn. The teams consist of high, average, and low achievers; boys and girls; students who represent any ethnic groups in the class; and any students with disabilities. Teams stay together for several weeks, so teammates can learn to work well together.

Cooperative learning methods are creating a classroom revolution. No longer is a quiet class thought to be a learning class; we know now that learning is often best achieved in conversation among students. Teachers all over the world are breaking up the rows in which students have sat for so long, and are creating classroom environments in which students routinely help each other master academic material.

## TEACHERS ON TEACHING

*Cooperative learning methods have been very effective as a means of mainstreaming students with academic handicaps. What kinds of experiences have you had in using cooperative learning with mainstreamed students, and what specific strategies have you used to help integrate these students?*

Handicapped students typically have poor group skills. At the beginning of each year I devote an entire unit to communication skills (participation, turn-taking, manners, body language, inflection, multi-meaning vocabulary, humor, assertive terms versus aggressive terms, pragmatics, and so on), using a TGT format.

It is not uncommon for the severely handicapped student to have a talent which isn't overly useful in isolation. For example, one of my Down's syndrome thirteen-year-olds has excellent fine motor skills and pretty printing. Her team works on the blackboard while she records the work that is turned in and graded. This child is in demand by other mildly handicapped students who hate to write. She was recruited to help with student council posters.

Another student has excellent auditory memory, discrimination, closure, and sequencing. Comprehension is a problem, but he can sound out any new vocabulary word. His talent is appreciated by the visual learners with poor phonics skills.

I've found that the more severely students are handicapped, the more they need the security of a set routine. I keep groups together for the entire year and rotate TAL, STAD, and TGT for review and evaluation. Some form of cooperative learning is done in fifteen-to-twenty minute blocks each day. Monday, Tuesday, and Wednesday are for instruction and practice, Thursday is for review, and Friday is for evaluation. After Friday's test, it is the students' choice to continue a cooperative learning procedure for extra-credit points. I've had to design the tests to be quick, because they are disappointed if we run out of time.

Mary Beth Ames  
Special Education Teacher  
Laredo Middle School  
Aurora, CO



## STUDENT TEAM LEARNING

This book describes **Student Team Learning**, a set of practical cooperative learning techniques that involve students in cooperative activities built around the learning of school subjects. These techniques, developed and researched at Johns Hopkins University, are not one-time activities designed to liven up the classroom from time to time. They are alternatives to traditional instruction that can be used as permanent means of organizing the classroom to effectively teach a wide variety of subjects at any grade level from two through college.

Student Team Learning methods are not the only cooperative learning techniques in widespread use. They share with other cooperative learning methods the idea that students work together to learn and are responsible for their teammates' learning as well as their own. However, Student Team Learning methods emphasize the use of team goals and team success which can be achieved only if all members of the team learn the objectives being taught. That is, in Student Team Learning the students' tasks are not to **do** something as a team but to **learn** something as a team. The team's work is not finished until all team members have mastered the material being taught.

Three concepts are central to all Student Team Learning methods: **team recognition**, **individual accountability**, and **equal opportunities for success**.

◆ **Team Recognition.** In all Student Team Learning techniques, teams may earn certificates or other team rewards if they achieve at or above a designated criterion. The teams are not in competition to earn scarce rewards; all of the teams may achieve the criterion in a given week and be equally recognized.

◆ **Individual Accountability.** The team's success depends on the individual learning of all team members. The team members focus on helping one another learn and making sure that everyone on the team is ready for a quiz or other assessment which students take without teammate help.

◆ **Equal Opportunities for Success.** Students contribute to their teams by improving over their own past performance. This ensures that high, average, and low achievers are equally challenged to do their best, and that contributions of all team members are valued.

Research on cooperative learning methods has indicated that team recognition and individual accountability are essential elements for producing basic skills achievement. It is not enough to simply tell students to work together; they must have a reason to take one another's achievement seriously. Research further indicates that students who are rewarded for exceeding their own past performance will be more motivated to achieve than if they are rewarded based on their performance in comparison to others; rewards for improvement make success neither too difficult nor too easy for students to achieve.

**APPENDIX K: LIL UPPER LEVEL THINKING SKILLS SCOPE & SEQUENCE**

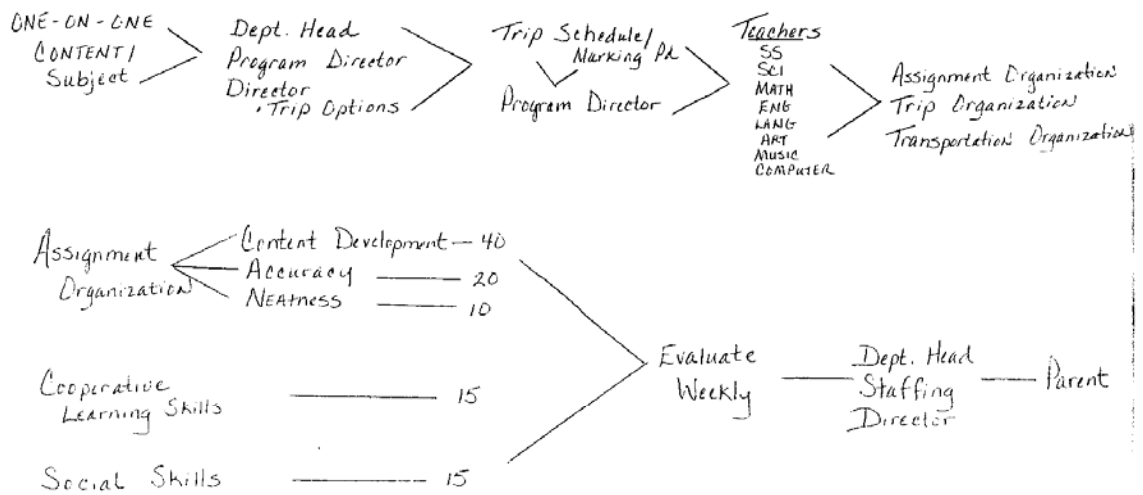
PG 259

## Verb Useful in Writing Learning Objectives

Knowledge	to graph
to define	to prove
to select	to solve
to list	to translate
to identify	to expand
to recall	Analysis
to recognize	to judge
to label	to argue
to locate	to assess
to name	to interpret
Comprehension	to differentiate between
to give in own words	to form generalizations
to read	to infer
to change	to conclude
to restate	to analyze
to reorder	to compare and contrast
to explain	to debate
to estimate	to organize
to add	Synthesis
to calculate	to combine and organize
to divide	to synthesize
to factor	to design
to predict	to devise
to write	to develop
to tell	to produce
to modify	to perform (in public)
to document	to write (an original composition)
to classify	Evaluation
to describe	to choose
to measure	to decide
to put in order	to evaluate
to simplify	to judge
to summarize	to make a decision
Application	
to propose	
to plan	
to classify	
to apply	
to investigate	
to construct	
to convert	
to draw	
to discuss	
to make	
to illustrate	

## APPENDIX L: LIL FIELD TRIPS PROCEDURE

PG 263



FIELD TRIP PROCESS  
System

## Lancaster Institute of Learning Field Trip Procedures

- Who is responsible on the field trip?
  - At least two chaperones must accompany students on all trips.
  - Arrangements are confirmed on week in advance
  - Conflicts in schedule must be resolved in advance
  - All drivers must have valid driver's license and carry insurance. The Lancaster Institute van is covered by insurance as if it were a taxi
- Before the Trip
  - Itinerary/Instructor Checklist
    - Must have typed schedule/agenda (time-table used as a handout with enough copies for all teachers/students)
    - A copy of the itinerary should be left with phone numbers at office
    - Follow-up call the day before the field trip to verify the trip
    - Items to take with you on the trip
      - first aid kit
      - medications
      - clip boards
      - notes
      - brochures/flyers about high school
      - lunches
      - quarters for phone
      - accurate wristwatch
    - Review with Students
      - appropriate behavior on site
      - appropriate behavior in route
      - cue for students to regroup on field trip site
      - review grading for field trip
      - reminder of assignment
      - reminder to bring pencil/pen, notes
  - Student Assignment
    - The assignment must be an applicative evaluation of the skills learned
    - The assignment must be an applicative evaluation of the content learned
    - The assignment must include the criteria (as hand out) for student with detailed expectations of how, when, where, and under what conditions the assignment is to be completed.
    - The assignment must contain the grade percentage distribution
    - The field trip grade should be calculated in the following manner:
      - 40% content development
      - 20% accuracy
      - 5% neatness
      - 15% cooperative skills
      - 15% social etiquette skills

- The grades should be filled out on the relevant grades sheet. One copy is sent to the appropriate one-on-one teacher, and one copy is given to the director.
- Learning Objectives
  - An outline with copy to the director
    - should include the skills to be stressed
    - should include the content to be stressed
  - state objective of field trip to students
  - Students should be kept on task with "sponge"/filler activity that must be completed by trip's close
  - extra/alternate activities could be arranged to prevent "slow time"
- Transportation
  - The van should be equipped with jumper cables, flares, spare tire, blanket
  - If more than one car, each car should have proper directions and phone numbers.
  - Each driver must keep an account of students in each car - no visitors
  - The van must have current registration and insurance.
- Supplies/Equipment/Handouts
  - Submit, in advance, any supplies/equipment needed using the proper "supply request form"
  - Make enough copies of all hand-outs for students, teachers, and director.
- During the Field Trip
  - Car Safety Procedure
    - Seat belts worn by all including driver
    - Cars travel at predetermined safe speed with lights on, and close following distance.
    - have specific direction, maps if necessary
    - follow specific route
  - At Destination Procedure/Student Expectations
    - stay together
    - pay attention
  - Emergency Procedure
    - have phone numbers and contact person at destination
    - If separated call Lancaster Institute. All drivers should call to give status.
    - Have quarters ready for pay phones or call the school collect.
- After the Field Trip
  - prepare and send certificate
  - prepare and send thank you note
  - distribute grades to the appropriate teachers and the director

**APPENDIX M: LIL PARENT FEEDBACK**

Dear Irene:

So sad to hear about the Hancock Institute closing! We desperately need more schools like yours in this country NOT less! Your teaching concept combined with "Tough Love" has saved so many children who are worth their weight in gold & can now be productive citizens instead of "throwaways."

I (we) want to thank you for all you did for Jason. You came through for him when everyone else in the education field turned their backs. He really thrived at the Hancock Institute & only, regrettably, returned to Manheim Twp. for the sports & socialization (plus pressure from his friends).

He was just in the school play & will probably be attending Temple U. or Pitt. to major in psychology. He also formed a band and they are becoming quite popular. He still talks about the Hancock Institute though. What a positive experience he had at such a traumatic time in his life.

Happy Holidays

Well, I hope you & your daughter & staff can make the best out of such a tough time & try to have a Merry Christmas.

Kathie Brooks



404 Indian Head Road  
Columbia, PA 17512

July 3, 1997

Irene Conrad  
Lancaster Institute of Learning  
175 S. West End Avenue  
Lancaster, PA 17603

Dear Irene:

It is with sincere appreciation and thanks that I write this letter. As you are well aware, Sean has been to several other schools, both public and private over the last couple years. It was very frustrating as a parent to see him underachieve and lose direction. Since he began at Lancaster Institute last winter we have seen a great difference in his motivation, which carried over to much better grades and enthusiasm for science projects and graphic arts. He seems to be back on track and starting to consider continuing his education.

There is no doubt in my mind that the individual attention which Sean has received at your school has made all the difference. He was able to ask questions on a one-to-one basis without embarrassment and proceed at a faster rate in the subjects in which he excelled. Your entire staff are dedicated and very special people. They go out of their way to reach each student and it shows. The special concert and week of camping were very impressive and unlike any experience he has had at other schools.

There is no way that I can thank you enough or reward you adequately for all the extra efforts and time you spend in reaching out to some very bright and talented youngsters that get lost in the shuffle of a regular classroom. You should know that you make a difference in the lives of many families who feel they have run out of options. I know it has in our home and with Sean's future and we are grateful.

Fondly,

*Sandy Mullin*

Sandy Mullin, parent  
of Sean Weston



*Mrs.*  
*Pennsylvania*

INTERNATIONAL PAGEANT

855 Chestnut St.  
Columbia, Pa 17512  
(717) 684-5171

June 14, 1997

To all the students, Staff and Faculty of the Lancaster Institute of Learning;

I am sorry for having been delayed in writing you, my life seems to be getting more and more hectic, and less and less time in a given day.

Even though a couple of months have passed, I can honestly say that I cannot get your school and all the students out of my mind. Their complete honesty, integrity, intelligence and attentiveness was remarkable and made me feel special and very much at ease. I often get very nervous speaking in front of students, but these kids made feel important and very relaxed. What an awesome place!!!! You all should be very proud of what you have accomplished. The students were so genuine it totally amazed me. I found that this was by far the easiest group to speak with and I found myself telling them things about my self at their age that I never say to other groups. I truly felt like these students were my friends, more than my "audience".

I would also like to take the time to thank all the students who helped to prepare the "Cinderella castle" backdrop for my school's performance of Cinderella. It was so beautiful and very detailed. I know how much time and effort you put into this project and I want you to know how much all the kids appreciated it. You should be proud of your beautiful work. The play was a huge hit this year, and next year we are planning on doing "Beauty and the Beast" with a modern twist or two!

In closing, I just want to express my sincere thanks to all of you at the Lancaster Institute of Learning. You have one terrific school and some pretty amazing students, and you should be very proud of all you have accomplished. I hope to get back and visit very soon. I was so impressed by all of you. Thank you for letting me come and be a part of a very special environment.

Always

Anne Schober, Mrs. Pennsylvania 1996-1997

## ENDNOTES

- <sup>1</sup> Information Source: Horn, R. A. J. a. C., Alison. (2000). Providing Systemic Change for Schools: Towards Professional Development through Moral Conversation. *Systems Research and Behavioral Science*, 17, 255-272. Diagram Formulation: Conrad, I. (2004) Reform at the Edge of Chaos: Framing a nonlinear education theory. Unpublished doctoral dissertation, University of Pittsburgh, Pennsylvania
- <sup>2</sup> Ironically, after an enormous amount of consultation and study, what is needed is less ‘control,’ not more control, and more faith in the ability of the people in the organization, with appropriately more investment in staff development (Ison, 1999).
- <sup>3</sup> “No problem can be solved from the same consciousness that created it... we must learn to see the world anew”  
Einstein
- <sup>4</sup> Business, for instance share dynamics of complex adaptive systems and are complex and largely unpredictable. Accepting businesses as such systems requires a mindset different from that associated with long-established business models. Managers and executives cannot control their organizations to the degree that the “mechanistic” perspective implies, but they can influence where their company is going, and how it evolves (Lewin, 1999).
- <sup>5</sup> Information Source: Horn, R. A. J. a. C., Alison. 2000). Providing Systemic Change for Schools: Towards Professional Development through Moral Conversation. *Systems Research and Behavioral Science*, 17, 255-272. Diagram Formulation: Conrad, I. (2004) Reform at the Edge of Chaos: Framing a nonlinear education theory. Unpublished doctoral dissertation, University of Pittsburgh, Pennsylvania
- <sup>6</sup> Information Source: Horn, R. A. J. a. C., Alison. 2000). Providing Systemic Change for Schools: Towards Professional Development through Moral Conversation. *Systems Research and Behavioral Science*, 17, 255-272. Diagram Formulation: Conrad, I. (2004) Reform at the Edge of Chaos: Framing a nonlinear education theory. Unpublished doctoral dissertation, University of Pittsburgh, Pennsylvania
- <sup>7</sup> The edge of chaos is a concept coined by Stuart Kauffman, a theoretical biologist, Chris Langton, Packard, and others to identify the point on the system change continuum where system operate at optimal functional level. This concept will be unpacked later in this dissertation paper.
- <sup>8</sup> Ginsberg (1997) describes the current educational system structure in terms of “schools, classrooms, and learning,” boldly stating that they are “based on faulty notions about how our world and the individuals that inhabit it actually work” (Ginsberg, 1997), p.2
- <sup>9</sup> Triangulating the roots of these central paradigms both horizontally (along the timeline from classical science through modern science, knowledge era and information age; see addendum), and vertically (across disciplines from science, social sciences, to business organization; see addendum), and also with current

practice in the field of education, provides added credibility and support for critics of the current education system.

<sup>10</sup> Information Source: Senge, P. (1990). *The Fifth Discipline: The Art and Practice of the Learning Organization*. New York: Doubleday Currency; Caine, R. a. C., G. (1997). *Education on the Edge of Possibility*. Referring to Dawkins, a British Biologist; and Csikszentmihalyi, M. (1993). *The Evolving Self: A Psychology for the Third Millennium*. New York: Harper Collins. Diagram Formulation: Conrad, I. (2004) *Reform at the Edge of Chaos: Framing a nonlinear education theory*. Unpublished doctoral dissertation, University of Pittsburgh, Pennsylvania

<sup>11</sup> A meme is used to describe a cultural belief or unit of cultural information” that literally has a life of its own. A “meme” begins as an idea, but ultimately has the power to organize and structure society in a specific way. A meme is defined as any permanent pattern of matter or information produced by an act of human intentionality. Although the individual will initially adopt memes out of usefulness, it is often the cases that after a certain point memes begin to affect actions and thoughts in ways that are at best ambiguous and at worst definitely not in our interest. Memes are the social parallel to genes in the physical organism (Csikszentmihalyi, 1993).

<sup>12</sup> A meme (or cluster of memes) can become a paradigm. When that happens, a meme, or compelling idea, has become a frame of reference. Another way of defining a paradigm, therefore, is a compelling frame of reference that has a life of its own. A paradigm is often used loosely and means different things to different people. A paradigm and a mental model show similarities, both consisting of all those deeply held beliefs and ideas that shape our grasps of reality.

<sup>13</sup> As such, a paradigm operates like a field.<sup>13</sup> Fields are “unseen structures, occupying space and becoming known to us through their effects” (Wheatley, 1992). Fields are interactive, invisible webs of relationships that permeate and are present in everything that is done or said. Garmston and Willman (1995) note that a field is as pervasive and omnipresent as gravity, and as taken for granted (Garmston, 1995). A type of field known as a morphogenic field is described as “action at a distance” meaning where “objects can affect each other even though they are not in material contact” (Sheldrake, 1988)<sup>13</sup>. Rettig, (2002) suggests that morphogenic fields are the subliminal or other type of interconnectedness and relationships in people and nature that cannot be seen. It is these connections and relationships, Rettig believes, should be sought not to control, but to allow them to flow naturally (Rettig, 2002). Wheatley believes that without a coherent, omnipresent field, a coherent organizational behavior is out of reach. (Wheatley, 1992).

<sup>14</sup> Information Source: Senge, P. (2000). *Schools That Learn*. New York: Doubleday Diagram Formulation: Conrad, I. (2004). *Reform at the Edge of Chaos: Framing a nonlinear education theory*. Unpublished doctoral dissertation, University of Pittsburgh, Pennsylvania

<sup>15</sup> See also the work of Palinscar, A. & Brown, A. 1984. Reciprocal teaching of comprehension-fostering and comprehension monitoring activities. *Cognition and Instruction*, 1, 117-175.

<sup>16</sup> Information Source: Horn, Raymond. A. Jr. Carr, Alison. A 2000). *Providing Systemic Change for Schools: Towards Professional Development Through Moral Conversation*. *Systems Research and Behavioral Science*, 17, 255-272. Diagram Formulation: Conrad, I. (2004) *Reform at the Edge of Chaos: Framing a nonlinear education theory*. Unpublished doctoral dissertation, University of Pittsburgh, Pennsylvania

<sup>17</sup> Chapter 2 of this dissertation suggests visible identifying indicators of the three dominant paradigm features in the education system, and a search for the subsequent effects on the field of education.

<sup>18</sup> Newton himself was not a mechanist in the way that mechanism is used today. He believed in God and explored astrology. However, his combined interests suggested to many scholars that he had a passionate attachment to the idea of a well-ordered universe. In this he was not alone.

- <sup>19</sup> Exodus 18:13-23. And so it was, on the next day, that Moses sat to judge the people, and the people stood before Moses from morning until evening. So when Moses' father-in-law saw all that he did for the people, he said, "What is this thing that you are doing for the people? Why do you alone sit, and all the people stand before you from morning until evening?" And Moses said to his father-in-law, "Because the people come to me to inquire of God. When they have a difficulty, they come to me, and I judge between one and another; and I make known the statutes of God and His laws. So Moses' father-in-law said to him, "The thing that you do is not good. Both you and these people who are with you will surely wear yourselves out. For this thing is too much for you, you are not able to perform it by yourself. Listen now to my voice, I will give you counsel, and God will be with you. Stand before God for the people so that you may bring the difficulties to God. And you shall tell each of them the statutes and the laws, and show them the way which they must walk and the work they must do. Moreover you shall select from all the people able men, such as know God, men of truth, hating covetousness, and place such over them to be rulers of thousands, rulers of hundreds, rulers of fifties, and rules of tens. And then judge the people at all times. Then it will be that every great matter they shall bring to you, but every small matter they themselves shall judge. So it will be easier for you, for they will share the burden with you. If you do this thing, and God so commands you, then you will be able to endure, and all these people will also go to their place in peace."
- <sup>20</sup> Of course, there are strong demonstrations that this doesn't really work, such as Cynthia Coburn's dissertation. Coburn, C.E. (2001) *Making Sense of Reading: Logics of Reading in the Institutional Environment and the Classroom*. Unpublished doctoral dissertation, Stanford University, Palo Alto, CA
- <sup>21</sup> Generally, students have been promoted regardless of standardized test scores, being held back only because of failing teacher-given grades or violation of policies such as minimal attendance requirements (Lesgold, 2005).
- <sup>22</sup> "Without rich computational capability, often reductionism is the only strategy with predictable effects (Lesgold, 2005)."
- <sup>23</sup> Lesgold, (2005) contributes that there are interesting failures of this approach in the auto world, too, such as reports of unexpected acceleration, which are usually met by claims that if each part is working, that is impossible. But, they don't always look at parts like floor mats that can jam accelerators when they are continually pushed forward by a non-system component, namely the driver's foot (Lesgold, 2005).
- <sup>24</sup> See also the *Phaedrus* of Plato, which refers to tearing apart nature at its joints
- <sup>25</sup> Robert Branson (1987) proposes that schools can't improve because they have "reached the upper limit of their capacity under the current structure and system." He suggests that traditional education has attained about ninety-seven percent efficiency, and there is almost no room for improvement in the current system. (Branson, 1987). For Thomas Guskey (1995), the cause of resistance to change is not about the system design as a whole, but rather resides in the pessimistic beliefs in the common teacher's mental model --- "New programs are merely isolated fads soon to be replaced by new ones." Teachers attend staff development meetings "only to return to the classroom, close the door, and teach as before" (Guskey, 1995). Reform of any persuasion cannot occur if the individuals in the system "fail to learn and apply the change" (Fullan, 1993). Professional development "has a poor track record because it lacks a theoretical base and coherent focus." This "failure to have a sustained cumulative impact" results in a "lack of integration in the day-to-day life of teachers" (Fullan 1995). If the mental model is resistant to change, the emergent system will also be resistant to change. To Stanley Pogrow (1996), resistance to change is caused by the reformers, the academics, and the researchers who "develop the ideas and rationales for the reformers' pet reforms" (Pogrow, 1996, pg 657). Michael Fullan attributes resistance to power disruptions and power brokers, who generally avoid conversation and opportunities to communicate with subordinates (Fullan, 1993). Subsequently, educators "fail to address fundamental instructional reform (Fullan, 1993, pg 46).

<sup>26</sup> The traditional paradigm is extremely compelling because it combines an explanation of reality with immense power to take charge of that reality. That combination, Caine & Caine (1997) suggest, has been intoxicating. Therefore, coming to terms with the fact that information is no longer owned, and that information is available in the world of instant access, is critical to genuinely rethinking the nature of the education system and our roles as educators.

<sup>27</sup> Ginsberg, 1997 describes 1<sup>st</sup> order change as change that occurs within a system which itself remains unchanged. Horn, 2000 expands on Ginsberg's description by dividing 1<sup>st</sup> order change into Piecemeal, Incremental and Systematic Change. Cuban, 1991 and Horn, 2000 refer to 2<sup>nd</sup> order change as systemic or fundamental. Ginsberg, 1997 states that 2<sup>nd</sup> order change transforms the system

<sup>28</sup> Three factors can be offered to explain why most executives, managers, and employees report that their professional lives have become more inundated with "change" than ever before:

**Volume** – every year, organizations report dealing with a greater number of significant disruptions in people's lives

**Momentum** – organizations demand an accelerated speed when people engage change today, and people are given less time to execute these initiatives

**Complexity** – the projects taken on today are much more sophisticated and involved than those assigned only a few years ago

<sup>29</sup> **Complexity Science** is the name used to describe the set of interdisciplinary studies that share the idea that all things tend to self-organize into systems. Physics, Biology, Chemistry, Chaos Theory, Cybernetics, Synergetics, and nonlinear dynamics are among the many fields that are a part of the complexity tradition (Kelly, 1999 #147).

<sup>30</sup> Complexity Science has made a paradigm shift from Physics to the Life Sciences, and parallel shifts in Business and in the study of Ecology

<sup>31</sup> Example: The immune system antibodies continuously self-organize and evolve while being a part of the many "organism elements" of a bird, and that bird is in turn an element in the formation of a flock of birds, and the flock of birds is in turn an element that is part of a particular ecosystem, and so on. (Jacobson, 2001 #104)

<sup>32</sup> An addendum of this dissertation explores the origins of the Science of Complexity including its universalities or Laws of Complexity.

<sup>33</sup> This straight-line, uninterrupted hookup had produced two important features: 1) Leadership was by "feel" ---the leader lead by using his senses of touch and hearing as much as intellect --and, because of this, 2) the organization responded to events and conditions no faster than the leader's reactions would allow (Kupers, 2001).

<sup>34</sup> Since the members of society are conscious and symbolically intercommunicating human beings who code and store information in the form of culture, human societies are not just social, but specifically "sociocultural" systems (Laszlo, #169). The *emergence* of educational movements, culture, organization, organizational climate, roles, and technologies can all be described by Complexity in these sociocultural systems (Marion, 1999 #9).

- <sup>35</sup> Edge of chaos – defined by Stuart Kauffman as the regime of system behavior that exists between order and chaos, and where the system operates at optimal level
- <sup>36</sup> Information Source: Capra, F. (1996). The Web of Life. New York: Anchor books. Diagram Formulation: Conrad, I. (2004) Reform at the Edge of Chaos: Framing a nonlinear education theory. Unpublished doctoral dissertation, University of Pittsburgh, Pennsylvania
- <sup>37</sup> These processes can be seen from the standpoint of the interdependence of *pattern and structure*, and also from the standpoint of the interdependence of *process and structure*. The interdependence of *pattern and structure* allows the integration of two approaches to the understanding of nature that have been separate and in competition throughout western science and philosophy. The interdependence of *process and structure* heals the split between mind and matter that has haunted the modern era ever since Descartes. The process dimension is implicit both in the pattern and in the structure criterion. Together these two unifications provide the three interdependent conceptual dimensions for the new scientific understanding of living systems (Capra, 1996 #175).
- <sup>38</sup> DIAGRAM Formulation: Conrad, I. (2004). Reform at the Edge of Chaos: Framing a nonlinear education theory. Unpublished doctoral dissertation, University of Pittsburgh, Pennsylvania
- <sup>39</sup> From the point of view of Classical Science, these were revolutionary new concepts that were an integral component of the human experience. The long-term study in self-organization has since been pursued both by a Brussels group as “Dissipative Structures” (G. Nicolis and I. Prigogine: Self-Organization in Nonequilibrium Systems. Wiley, New York, 1977) and at the Stuttgart group as “Synergetics” (H. Haken: Synergetics. Springer, New York, 1978)(Kaneko, 1998 #107). An examples of Autopoiesis include a cell membrane that continually incorporates substances from its environment into the cell’s metabolic processes, or an organism’s nervous system that changes its connectivity with every sense perception (Maturana, 1980). Autopoiesis is also part of certain chemical compounds and allow them to be renewed. In chemical compounds, heating a certain chemical liquid on a flame begins to change the arrangement of its molecules. At the beginning it bubbles and alters as it begins to boil. After some time, the liquid develops a circular flow, from the top to the bottom and back. Later it self-organizes itself into hexagonal cells. Because of the difference in temperatures between the bottom and top layers of the liquid, it self-organized itself to transfer the energy more efficiently. Heating the liquid created a new situation that necessitated self-organization into a new structure. [Merry, #11
- <sup>40</sup> Yet living systems are open to interact with environment (explained under Part 3-B: Dissipative Structures).
- <sup>41</sup> “What is common to all these living systems is that their smallest living components are always cells, and therefore with confidence it can be said that all living systems, ultimately are autopoietic.”
- <sup>42</sup> “It is interesting to ask whether the large systems formed by those autopoietic cells – the organisms, societies, and ecosystems – are in themselves autopoietic networks” (Capra)
- <sup>43</sup> Information Source: Capra, F. (1996). The Web of Life. New York: Anchor books. Diagram Formulation: Conrad, I. (2004) Reform at the Edge of Chaos: Framing a nonlinear education theory. Unpublished doctoral dissertation, University of Pittsburgh, Pennsylvania
- <sup>44</sup> In their book “The Tree of Knowledge” Maturana and Varela state that three types of multi- cellular living systems (organisms, ecosystems, animal and human society systems), shown in the **TABLE, below**, differ greatly in the degrees of autonomy experienced by their components. Organisms and human societies differ in their autopoietic patterning of self-organization.

### Degree of Autonomy in living systems

	Organisms	Ecosystem & Animal	Human Societies
<b>Independent existence</b>	Cellular components have minimal degrees of independent existence	Ecosystems, - animal societies and ecosystems occupy various places between those two extremes	The components of human societies, individual human beings, have a maximum degree of autonomy, enjoying many dimensions of independent existence.
<b>Cohesion (unity)</b>		The cohesion of social insects is based on the exchange of chemicals between the individuals	The social unity of human societies is based on the exchange of language, identified as the critical phenomenon in the development of human consciousness and culture
	The components of an organism exist for the organism's functioning		Human social systems exist also for their components--- the individual human beings
	The organism restricts the individual creativity of its component unities, as these unities exist for that organism		The human social system amplifies the individual creativity of its components, as that system exists for these components

<sup>45</sup> For instance, the role of “father” in contemporary western culture may be fulfilled by the biological father, a foster father, a stepfather, an uncle, or an older brother. In other words, these roles are not objective features of the family system but are flexible and continually renegotiated social constructs (Mingers, 1995)

<sup>46</sup> Information Source: Maturana, H. V., F. (1987). Tree of Knowledge. Boston: Chambhala and Capra, F. (1996). The Web of Life. New York: Anchor books. Diagram Formulation: Conrad, I. (2004) Reform at the Edge of Chaos: Framing a nonlinear education theory. Unpublished doctoral dissertation, University of Pittsburgh, Pennsylvania

<sup>47</sup> Diagram Formulation: Conrad, I. (2004). Reform at the Edge of Chaos: Framing a nonlinear education theory. Unpublished doctoral dissertation, University of Pittsburgh, Pennsylvania

<sup>48</sup> An important criterion of living systems, as summarized by Biologist, Gail Fleischaker, is that it must be self-bounded. In other words, the autopoietic network creates its own boundary that specifies the domain of the network's operations and defines the system as a unit. The components of the network continually produce and transform one another, and they do so in self-renewal (Fleischaker, 1992).

<sup>49</sup> Two Possible Types of Interactions: Activating interaction: When a cell producing pigment gives off a chemical that causes other cells to also produce pigment. This type of interaction causes cells to produce similar behavior. Activating interaction encourages growth (Bar-Yam, 2001) Inhibiting interaction: When a cell producing pigment that gives off a chemical that causes others not to produce pigment. This type of interaction causes cells to behave the opposite manner. Inhibiting interaction tends to limit the size. (Bar-Yam, 2001)



- <sup>50</sup> Note the parallel to organizations, in which actors and even specific roles change but new actors self-organize to fill similar roles, based upon inputs from connected actors around the network. This, for example, is what allows someone to become a dean without having ever been one before (Lesgold, 2006).
- <sup>51</sup> **For example:** For something to be called a bicycle, there must be a number of functional relationships among components known as frame, pedals, handlebars, wheels, chain, sprocket, and so on. The complete configuration of these functional relationships constitutes the bicycle's "pattern" of organization. All of those relationships must be present to give the system the essential characteristics of a bicycle.(Capra, 1996)
- <sup>52</sup> **Theory of Information - Theory of Signals: "Patterns of Organization,"** a product of The Theory of Information, was developed by Wiener and Shannon in the 1940s. (It becomes part of Cybernetics in the 1980s) Also known as the Theory of Signals(Weiner, 1950), Information Theory was concerned mainly with the problem of how to get a message, coded as a signal, through a noisy channel. These new notions of message, control, and feedback were referred to "*patterns of organization*" and applied to non-material entities. (Later the concept of "patterns of organization" would become crucial as a basis of a full scientific description of life.) Wiener believed that it was possible to expand the concept of "pattern," from the patterns of communication and control, that were common to animals and machines, to the general idea of "pattern" as a key characteristic of life. *Weiner coupled the notion of "patterns" with "living systems"*. (Weiner, 1950)
- <sup>53</sup> **McCulloch and "Networks" :** At the same time around 1943 Warren McCulloch showed that the logic of any physiological process, of any behavior, can be transformed into rules for constructing a network. (McCulloch, 1943) He modeled the nervous system as complex networks of binary switching elements. In the 1950s models were built of such binary networks, including some with little lamps flickering on and off at the nodes. To their amazement, they discovered that after a short time of random flickering some "ordered patterns" would emerge in most "networks". They would see waves of flickering pass through the network, or they would observe repeated cycles. Even though the initial state of the network was chosen at random, after a while those "ordered patterns" would "emerge" spontaneously, **and it was this "spontaneous emergence of order" that became known as "self-organization."**
- <sup>54</sup> Bacteria possess several types of molecular mechanisms by which sensor stimulus transduces into a modified physiological state (Segel, 2000). When a bacteria sense an increase concentration of an attractor (either positive or negative), their action is increased. Therefore a sensation of increasingly favorable conditions leads to continuation of present actions. The sensation of decreasingly favorable conditions diminishes run time and thus elevates the frequency of "trying something new." This transduction of sensory perception into altered physiological state results in a *feedback of environmental information that modifies* a bacteria's response so that it moves to a more favorable environment (Segel, 2000). The sensors are receptors that respectively bind the attractors aspartame and serine (both amino acids), sugars and dipeptides, but also bind repellent molecules such as benzoate (Segel, 2000). A metabolic system pursues a variety of overlapping and conflicting "goals" in its task of satisfying the body's ever-changing needs for energy and raw materials. From this description, states Segel, evolution has acted to select the relative weights of the different tendencies to somehow promote the long-term survival of the bacteria (It is not at all obvious why the bacteria turn out to be robust with respect to mean adaptation time to a stepwise spatially uniform change in attractant concentration, but mean tumbling time is variable (Segel, 2000).
- <sup>55</sup> The components of the network continually produce and transform one another, and they do so in self-renewal. The autopoietic network creates its own boundary that specifies the domain of the network's operations and defines the system as a unit (Fleischaker, 1992).
- <sup>56</sup> Through the history of social sciences numerous metaphors have been used to describe "self-regulatory processes" in social life. The best known is the "invisible hand" regulating the marketing the economic theory of Adam Smith, or the "checks and balances" of the US constitution. The phenomena described by these

models and metaphors all imply “*circular patterns of causality*” that can be represented by “*feedback loops*”, but none of the authors made that fact explicit (Capra, 1996)

<sup>57</sup> The first detailed discussion of feedback loops appeared in 1943 where the authors also introduced the idea of “circular causality” as the logical pattern underlying the engineering concept of “feedback”. For the first time feedback was applied to model the behavior of living organism. Taking a strictly behaviorist stance, they argued that the behavior of any machine or organism involving self regulation through feedback could be called “purposeful” since it is behavior directed toward a goal. They illustrated their model of such goal-directed behavior with numerous examples – a cat catching a mouse, a dog following a trail, a person lifting a glass from a table – analyzing them in terms of the underlying circular feedback patterns.

<sup>58</sup> In 1943 Wiener’s research included the concept of “feedback” that was introduced by Walter Cannon a decade earlier in his book “The Wisdom of the Body” (Cannon, 1939). As the essential mechanism of “homeostasis” -- the self-regulation that allows living organisms to maintain themselves in a state of dynamic balance -- Cannon gave detailed descriptions of many self-regulatory metabolic processes. Although he never explicitly identified the “closed causal loops” embodied in them. Through analogy Wiener connected the “patterns of communication” with the “patterns of organization” in organisms that included closed loops and networks, concepts of feedback, self-regulation, and self-organization.

Descartes clockworks	Cybernetic machines
	Feedback a crucial difference

The concept of “feedback” became part of Information Theory and Communication Theory.

<sup>59</sup> Throughout history there had been tension between the study of “structure” (substance) and the study of “pattern” (form) (Lilienfeld, 1978).

<sup>60</sup> The enzymes alone form an intricate network of catalytic reactions that promote all metabolic processes, and the energy carriers form a corresponding energy network to fuel them ((Capra, 1996)

<sup>61</sup> Relatively few social events are the result of simple one-way causation. Social events result from *complex interactions* among a number of variables. A number of recent social and organizational models make this argument. An example, the “**Loose Coupling**” theorist, **Karl Weick** describes “*circular causality*” and “*multiple interactions*” (Marion, 1999). “*Circular causation*” means more than confused or complicated, it means that order must be understood as the product of such interaction rather than the product of simple causality (Marion, 1999).

<sup>62</sup> (Capra, 1996)

<sup>63</sup> In animals, some cells form the heart, some form the liver, and some form the bones. No agent puts each part in its place and yet when the process is done the parts work together. In the process of development “patterns” that form the human body start with a single cell. There is a kind of process that is in part directed by the information in the initial cell (DNA) (not a blueprint or picture of the structure with each part shown) In some way the DNA tell the cell how it should talk to other cells that in turn forms the structure of the body (Bar-Yam, 2001).

<sup>64</sup> Information Source: Langton, C. (1986). Studying Artificial Life with Cellular Automata. *Physica*, 22D, 120-149. Lewin, R. (1999). *Complexity Life at the Edge of Chaos* (2nd ed.). Chicago: The University of Chicago Press.

<sup>65</sup> Examples of emergence: The development of the fertilized egg into the adult as an emergent property of complex networks of genes controlling one another’s activities The possibility that sufficiently diverse mixtures of

chemicals reacting with one another can “catch fire”, achieve catalytic closure, and suddenly emerge as living, self-reproducing, evolving metabolisms suggests evidence that such laws exist. Products and technologies-- each generating new bursts of rapid learning that increases returns and attracts capital and credit, driving further growth in that sector. The human capital, the learned skills, are naturally accumulated on a wider basis than the individual and his family. Population, technology, economics, and knowledge spin us together to emerge as a global civilization (Kauffman, 1995)

<sup>66</sup> The nervous system, Maturana suggested, operates as such a “*Closed Network*” of interactions, in which every change of the interactive relations between certain components always results in a change of the interactive relations of the same or of other components (Capra, 1996)

<sup>67</sup> *Organization* – of living systems – is the set of relations among its components that characterize the system as belonging to a particular class (such as a bacterium, a sunflower, a cat, or a human brain). The description of that organization is an abstract description of relationships and does not identify the components. A system’s organization is independent of the properties of its components, so that a given organization can be embodied in many different manners by many different kinds of components

<sup>68</sup> Those administrators applying the reductionistic, mechanistic, linear mental model to policy execution traceable to the 18<sup>th</sup> century and the ideas of Economist Adam Smith--- who has argued that when individuals are *left free to pursue their own selfish interests, patterns of economic activity would emerge* that would serve the greater good, guided, he said, “as if by an invisible hand” (Lewin, 1999). Almost a century later, Darwin incorporated Smith’s thinking into Biology, in his Theory of Natural Selection (Lewin, 1999). The core of Darwin’s theory is that species *act in their own interests to survive*, from which the *evolutionary patterns seen in the world arrive*. Competition is one of many factors that shape ecological communities, and in this context include whether one species or another (a seed-eating bird, for example) will dominate in a particular ecosystem. Whether Adam Smith’s Economic Theory, Darwin’s Theory of Natural Selection, relations between the US and Europe, or relations between US and Japan and China--- ecologists realized that “the invisible hand” was at work, and the emergent effect of “ecological webs” were at least as important, if not more so (Lewin, 1999).

<sup>69</sup> Leaders are hired because they are capable of performing the basic job duties and they have a compatible chemistry with board members and other key senior officers. In periods of escalating uncertainty, possessing basic job competence or even projecting an exciting personality is not enough

<sup>70</sup> Two Pitfalls in the Leadership Selection Process include: “*Omission-Based Assumption*” – the “how” of change is a tactical issue, if relevant at all, and need not be discussed as part of the selection process “*Commission-Based Assumption*” - superficial nature of the conversations that do occur about the human factors that impact implementation success. Usually the board can’t formulate penetrating questions about “how” the candidate would approach preparing the organization for change

<sup>71</sup> Leadership within the Old Paradigm was a manual relationship with the organization. There was a direct connection from the leader’s hands to production. The magnitude (volume, momentum and complexity) of changes and consequences incurred, if not successfully implemented, represented only first-order, straight-line change. This straight–line uninterrupted hookup produced two important features: Leadership was by “feel” – the leader lead by using his senses of touch and hearing as much as intellect – and, as a result, the organization could respond to events and conditions no faster than the leader’s reactions would allow.

<sup>72</sup> Note of caution: There is a lot of evidence in newer work on evolution that systems ordinarily do best when there is a relatively slow rate of evolution, but that when the organism is stressed then it is more adaptive to move to a faster evolution rate. I would suggest that this is the case with the education system. There is value in stability – people get time to figure out how to achieve one goal before another is substituted for it.

At the same time, there need to be mechanisms for increasing the rate of evolution when problems arise. Most of the discussion of whether the “edge of chaos” idea is valid is driven by concern that a uniformly high rate of evolution may not be very good much of the time. I suggest that you consider replacing the “edge of chaos” approach with a call for an adaptive variability in the rate of evolution that is facilitated. Sometime a leader does best work by simulating change. Sometimes, the important facilitation is to dump uncoordinated and too-rapid change. Inhibition can be a very positive force at the right moments (Lesgold, 2006). My Rebuttal: This would be all well and good if evolution could be controlled at a slow rate, but in this 21<sup>st</sup> century, with globalization and modern technology running amok, an educator does not always have the option to “slow” evolution. Often unanticipated events and trends move so quickly that they can no longer be addressed in years or months, but in minutes and seconds. An educator does not always have the option to regulate or control evolutionary pace. Therefore, it is prudent to accept, be poised for, and welcome change, because it will happen whether embraced or not.

<sup>73</sup> Note of Caution: There are a lot of very healthy systems that have combinations of facilitative and inhibitory mechanisms. Checks and balances can be seen as “internal conflict” too, but they may be good things (Lesgold, 2006). My rebuttal: When the predominant energy flow has both inhibitory and facilitative mechanisms as equally opposing each other, the effect is null or neutralized. However, when the facilitative mechanism generates more energy, it gathers momentum and synergizes other facilitative mechanisms to itself and grows in strength---goals get accomplished.

<sup>74</sup> Resistance to change is really attraction. Frequently in human systems, the behaviors that contribute to perceived resistance are merely the consequences of a powerful, though counter-productive attractor

<sup>75</sup> As the Pathways article titled, "Linking At-Risk Students and Schools to Integrated Services," states---"Many children live in vulnerable families and neighborhoods where the incidence of poverty, teen pregnancy, unemployment, substance abuse, and violence is widespread." The Civil War may be over; however, the discourse between blacks and whites is glaringly prevalent. We supply services to the disabled yet our communities respond with discomfort and awkwardness. We teach individualism, yet promote conformity.

<sup>76</sup> A frustrated professor described her encounter during a presentation to local principals, where the principals iterated their frustration at perceived pressure to implement the latest innovative program. "That's not where the problem is," they chanted. "The problem is with the child and his home life" "He's not motivated to learn."

<sup>77</sup> For some the "Full-Service School Program" is the knight in armor. It could be the first step in bridging the yesterday's fantasies with the realities of the moral and ethics of our communities. Full-service schools are based on the notion that no single magic bullet can substantially improve the lives of at-risk children and their families ((Dryfus, 1994). "Full-Service (Integrated Services) is the coordinated delivery of health, education, prevention, and social services designed to improve the quality of life for individuals and families.

<sup>78</sup> “Human kind has succeeded over time in conquering the physical world and in developing scientific knowledge by adopting an analytical method to understand problems” shares Peter Senge(1993). Influence of the scientific approach to analysis involved breaking a problem into components, studying each part in isolation, and then drawing conclusions about the whole. Just as the “machine” routinizes production, Classical Management Theory, developed out of the scientific knowledge base and promotes the idea of the rational system that focuses on the design of the total organization

<sup>79</sup> (Explained in more detail in the next section) Phase Transition – a state where the system crosses over an invisible boundary where the environment of attractors alters dramatically and changes can be explosive.

- <sup>80</sup> (Explained in more detail in the next section) Bifurcation – a state where the system has reached bifurcation when its state is unpredictable. The system can break down or break through to a new state of order
- <sup>81</sup> An example is the adaptation process of education theory under the traditional (mechanistic, reductionistic, linear) paradigm operationalized in the educational system. The fundamental ideas and purposes of “traditional” approaches to education still inhibit the type of change and adaptations needed to produce an optimal learning environment (Fullan, 1991), or edge of chaos, in complexity language . Most of the effort that has been put into changing education, states Caine & Caine (1997), has actually reinforced the basic dynamics that make change exceedingly difficult. So education has continued to struggle (Caine & Caine, 1997).
- <sup>82</sup> Many relevant publications and reports now reflect the attempt at application of complex systems type of analysis (Senge, 1990); (Wheatley, 1992) Known as Complexity Thinking approach, a growing number of texts attempt to summarize the main characteristics of this type of analysis (Holland, 1995); (S. Kauffman, 1993); (Gell-Mann, 1995); (Lewin, 1999); (Waldrop, 1992)
- <sup>83</sup> In Piagetian terms, assimilation and accommodation are not limited to acquiring new information, but are actually transformative. This process of change is also at the heart of Maslow’s (1968) Theory of Self-Actualization.
- <sup>84</sup> There is some evidence of leadership embracing Complexity Theory as a framework for organizational practice in the 21<sup>st</sup> century; however, this is still at an early stage. Confusing the matter is that the viability of Complexity Theory as a tool for leadership in policy execution has many authors in the field with a different ‘take’ on the subject, emphasizing different aspects, and so generating rather different managerial priorities (R. Stacey, 1996) (Kupers, 2001). They do; however, appear to agree that the organization will function at its best when poised at the edge of disorder. Mitchell Waldrop has written a lively introduction to the history of the people and the thinking of the Santa Fe Institute. (Waldrop, 1992) Nobel prize winner Ilya Prigogine and Isabelle Stengers have laid the foundation of the subject with a fundamental book on the origin or order (Prigogine & Stengers, 1984) Fritjof Capra in a recent work places complexity in the context of the evolution of 20<sup>th</sup> century thought (Capra, 1996) Nobel prize winner Murray Gell-Mann has put his considerable didactic and intellectual resources into an excellent and fundamental introduction to the topic (Gell-Mann, 1995) Michael McMaster has written on the organizational consequences of complexity. (McMaster, 1995) see also [www.lkworld.demon.co.uk](http://www.lkworld.demon.co.uk) Richard Pascale has described the transformation of one of the shell’s divisions. (Richard T. Pascale, Surfing the Edge of Chaos, Sloan Management Review Spring 1999, 40) Ton Van Asseldonk has looked at how complexity can help firms deal with individualized consumer demand in an eloquent dissertation. (Ton van Asseldonk, Mass Individualization, dissertation, KUB, 1998) Howard Sherman has published a book on the evolution of strategy in the light of complex adaptive systems (Sherman, 1998) John Casti, Complexification 1994 J. Horgan, The Crisis of Complexity 1995 Roger Lewin , Complexity – Life at the Edge of Chaos (Lewin, 1999) Projects – **Complexity on-line** – is a scientific information network about complex systems The Evolutionary and Adaptive Systems Group at the School of Cognitive and Computing Sciences in the **University of Sussex at Brighton** The Center of Complex Systems Research at the **University of Illinois...** Florida Atlantic University’s Center of Complex Systems and Brain Sciences (Research) Center for Futures Research, St. Gallen (Research)
- <sup>85</sup> **Information Source:** Horn, R. A. J. a. C., Alison. 2000). Providing Systemic Change for Schools: Towards Professional Development through Moral Conversation. *Systems Research and Behavioral Science*, 17, 255-272. **Diagram Formulation:** Conrad, I. (2004) Reform at the Edge of Chaos: Framing a nonlinear education theory. Unpublished doctoral dissertation, University of Pittsburgh, Pennsylvania

- <sup>86</sup> The bad news is this: Because of your resilience, you are likely to set a pace that others cannot match. Situations that look like exciting challenges to you are actively uncomfortable for many others. They simply don't look that hard to you. As a result, you may become very frustrated with the amount of resistance to change that is expressed by those around you, and with the level of disruption created by seemingly minor disruptions
- <sup>87</sup> Caine & Caine (1997) cite two main reasons for education's entrenchment. The education system is part of a larger system that is grounded in a way of thinking – a paradigm – and that way of thinking is deeply entrenched. The second reason for education's entrenchment is a paradigm that has led to the design of social systems as social machines, the essence of which is to remain stable and unchanging over long period of time, even when they are perturbed (Caine & Caine, 1997).
- <sup>88</sup> The bad news is this: Because of your resilience, you are likely to see a pace that others cannot match. Situations that look like exciting challenges to you are actively uncomfortable for many others. They simply don't look that hard to you. As a result, you may become very frustrated with the amount of resistance to change that is expressed by those around you, and with the level of disruption created by seemingly minor disruptions (Conner, 1998).
- <sup>89</sup> Resilient people are positive they can succeed in unfamiliar circumstances. They remain focused on objectives during times of confusion, exhibit flexibility about how to address inhibitors, find order within what appears to be chaos, and proactively engage change rather than run from it. Resilient people tend to be resourceful, multi-skilled, and highly motivated. They have a high tolerance for ambiguity, a desire to experiment, and a willingness to appropriately challenge authority. They resonate well with the mental and emotional conditioning necessary to succeed" (Conner, 1998).
- <sup>90</sup> Through the collaborated efforts of Warren McCulloch's group at MIT
- <sup>91</sup> The "**structure**" of the bicycle is the physical embodiment of its pattern of organization in terms of components of "specific shapes", made of "specific materials". The same pattern "bicycle" can be embodied in many different "structures." The handlebars will be shaped differently for a touring bike, a racing bike or a mountain bike the frame may be heavy and solid or light and delicate. The tires may be narrow or wide, rubes, or solid rubber. All these combinations and many more will easily be recognized as different embodiments of the same pattern of relationships that defines a bicycle. (Capra, 1996 #175)---"Note that the bicycle cannot change itself from a mountain bike into a touring bike. What is especially interesting about autopoietic systems is that they can be self-transforming while preserving a pattern or organization.
- <sup>92</sup> Closed Thermodynamic Systems, according to Mark Michaels 1994, have a lot of movement, but the input and the output are totally predictable. Machines, an assembly line, and an engine of a motor vehicle are examples.
- <sup>93</sup> Self-Organizing Systems, as have been explored in the previous section, describe the workings of a system from within, as it utilizes its ability to internally self-organize quickly and effectively in the face of change. The ability (fitness) to change can be measured and ranges from: ineffective self-organization that freezes a school in place, through an ability to keep pace with today's rapid rate of change but not to lead this change, to an ability to reorganize much faster than others (Kelly & Allison, 1999)
- <sup>94</sup> Weather: It does interact with the environment with all the interplay between temperature and evaporation and land mass and energy – in fact, it's difficult to tell where weather begins and ends. At the same time, even with advances in Doppler radar and other technologies, people find it difficult to make specific predication about what will happen as a result of all the activity (Caine & Caine, 1997). (Example Hurricane Katrina, 2005)

- <sup>95</sup> Information Source: Bar-Yam, Y. (2001). *Introducing Complex Systems*. Paper presented at the International Conference on Complex Systems, Nashua, New Hampshire; and Kelly, S. A., M. (1999). *The Complexity Advantage*: McGraw-Hill.
- <sup>96</sup> Through laboratory experiments and quantitative formulations, Prigogine reproduced an energy flow from a source to a sink, and placed the test objects within the flow. Prigogine's 'Brusselator' modeled a chemical auto-catalytic system. The Brusselator consisted of the following series of reactions...shown on pg 112... (Laszlo, 1996 #11). General Information: The parameters of the system were given by the products A., B., D., and E. A and B are inputs. E is the output These represent the matter-energy flow through the system (Laszlo, 1996 #11). When the "concentration" of 'B' exceeds a critical threshold, while A is kept constant, *the system leaves the stationary states and reaches a limit cycle*; the external induced concentrations of X and Y begin to *oscillate with a well-defined periodicity* (Laszlo, 1996 #11). The determining factor was the increase in the "concentration" of the input factor B beyond the critical threshold. This was *externally induced 'perturbation' that pushes the system into the oscillatory mode* (other inputs and outputs being kept constant)(Laszlo, 1996 #11). A large variety of chemical systems capable of oscillating between two or more steady states have been designed in the laboratory.
- <sup>97</sup> Life-like behaviors in various nonlinear, self-organizing systems are seen, for instance, in the New York Times article about two crystals that appear to "find" each other and establish a two-way communication link (O'Regan #171).
- <sup>98</sup> Prigogine's Belousov-Zhabotinski reaction. Presented in wavelike activity in chemical clocks. These were reactions far from chemical equilibrium which produce very striking *periodic oscillations* (Prigogine, 1984 #317). To change color all at once, the chemical system has to act as a whole, producing a high degree of order through the coherent activity of billions of molecules. Different experimental conditions may also produce waves of chemical activity. As in the Bernard convection, (see Endnote 37) this coherent behavior reemerges spontaneously at critical points of instability far from equilibrium (Capra, 1996 #175).
- <sup>99</sup> While possessing relatively constant form, a whirlpool in a river has no existence other than in the movement of the river. Thanks to the work of David Bohme, problems solved through modern physics, such as whirlpool dynamics, have important consequences for organizations, such as education. The whirlpool in the river suggests that "the secrets of the universe are found in hidden tensions and connections that simultaneously create patterns of unity and change (Morgan, 1997 #67) p. 251. Understanding the secrets of the universe is critically contingent on how and where the linkages (relations) exist and how they are "dependent" on each other.
- <sup>100</sup> Equilibrium: The traditional view in Ecology was encapsulated in the phrase, "The Balance of Nature" in which ecosystems were seen to rest at "equilibrium" until they were disturbed. They then found a new equilibrium. "Ecologists didn't deny that complex dynamics existed in nature, claimed Stuart Pimm, but were explained as the result of genuinely unpredictable factors in the external world, such as fluctuations in climate for example. One essential factor was whether the system was stable or perturbed. More technically, there was a strongly ordered, stable state, in which activity continued, but nothing much changed (Bryson, 1988; Caine & Caine, 1997). What Prigogine and others found was that a system could be at *equilibrium* and when confronted with change, would fall apart, but it would fall apart so that it could reorganize itself (Wheatley 1995).
- <sup>101</sup> Stacy 1995 describes the system as '*far from equilibrium*', a concept borrowed from Prigogine and Stengers 1984 (R Stacey, 1995).
- <sup>102</sup> Catalytic Loops: Typically, "catalytic cycles" are the basic mechanisms that maintain and balance nonequilibrium systems in a flow of energy through self-balancing feedback loops It was discovered that of

the various types of reactions that organize the system so as to increase its capacity to absorb some portion of the energy throughout, “catalytic cycles” are naturally the most stable reactions and have the fastest reaction rates. In living organisms (chemical systems), Prigogine’s findings suggested that systems require the presence of “catalytic loops” (that is nonlinear, irreversible chemical processes) to lead to instabilities through repeated self-amplifying feedback (Prigogine, 1984 #317). There are two principle varieties of Catalytic Cycles: Auto-Catalysis – where a product of a reaction catalyses its own synthesis. In relatively simple chemical systems auto-catalytic reactions tend to dominate. Cross-Catalysis – where two different products, or groups of products, mutually catalyze each other’s synthesis. In more complex processes, characteristic of living phenomena, entire chains of cross-catalytic cycles appear. For example: nucleic acid molecules carry the information needed to reproduce themselves as well as an enzyme. The enzyme catalyzes the production of another nucleic acid molecule, which in turn reproduces itself, plus another enzyme. The loops may involve a large number of elements. Ultimately it closes in on itself, forming a cross-catalytic reaction cycle remarkable for its fact reaction rates and stability under diverse parametric conditions. (Laszlo, 1996)

<sup>103</sup> It is like the stock market that becomes much more volatile when more money flows in or more disturbing political news is broadcast. (Caine & Caine, 1997) Or human societies, composed of human beings and their relations that are maintained in the flow of energy in their larger biosphere.

<sup>104</sup> Brian Goodwin, Biologist, applied Prigogine’s mathematical techniques to model the stages of development of a very special single-celled alga (Goodwin, 1994 #385). By setting up differential equations that interrelate, patterns of calcium concentration in the alga’s cell fluid with the mechanical properties of the cell walls, Goodwin was able to identify “*feedback loops*” in a *self-organizing process of the single-celled alga*, in which structures of increasing order emerge at successive bifurcations points.

<sup>105</sup> The catalytic loop self-amplifying processes combine two different phenomena: chemical reactions and diffusion (the physical flow of molecules due to differences in concentration) (Laszlo, 1996 #11).<sup>105</sup>

<sup>106</sup> Described in more detail in next section

<sup>107</sup> Fossil history points out this evolutionary *pattern* throughout time and is referred to as *Punctuated equilibrium* (Kelly & Allison, 1999).

<sup>108</sup> In whirlpools instability is mechanical. It originates as a consequence of the first rotary motion in the *catalytic cycles* that are a central feature of all metabolic processes (Laszlo, 1996 #11).

<sup>109</sup> Mathematically: There are certain locations in parameter space where changes are explosive. The system crosses over an invisible boundary and the landscape of *attractors* alters dramatically. The *phase space portraits* in the new region of parameter space again change gradually just as they did in the first region, but they may differ dramatically in form from those in the former region. As *parameters* continue to change in the new region of *parameter space*, the *attractors* in this region slowly alter until once more, a *bifurcation boundary* is reached and the *phase space portraits* again change (Marion, 1999).

<sup>110</sup> Chaos with its sensitive dependence and unpredictability exists in these catacombs

<sup>111</sup> Also known as the *point of discontinuity*, the *onslaught on non-average behavior*, the “*leap*” or “*point of instability*”



- <sup>112</sup> Previously the only type of instability studied in some detail was “turbulence” – caused by the internal friction of a flowing liquid or gas (Briggs & Peat, 1989). Leonardo da Vinci made careful studies of turbulent flows of water, and in the 19<sup>th</sup> century a series of experiments was undertaken that showed that any flow of water or air will become turbulent at sufficiently high velocity – in other words, at sufficiently far “distance” from equilibrium (the motionless state). Prigogine noted that the reactions to “turbulence” experienced in physical reactions were not true for chemical reactions. *Chemical instabilities did not automatically appear “far from equilibrium.”* This breakthrough occurred for Prigogine when he realized that systems far-from-equilibrium were best described by nonlinear equations. Nonlinear mathematical formalism was capable of modeling multiple interlinked feedback loops.
- <sup>113</sup> Stages & Patterns in Society: Joseph Tainter, an archaeologist, has identified several telltale features in the collapse of complex societies. A flurry of collective activity, often involving construction, just prior to collapse is one of them, as if the society was desperately trying to counter rising stress of some nature. Tainter detects the phenomenon in the terminal stages of societies as different as the Roman Empire, the Mayan civilization, and at Chaco. “It’s a common pattern in the Southwest. You often see aggregation of communities, lots of new activity, right before collapse” (Tainter, 1988). Archaeologists acknowledge that transitions between these different levels of organization – band, tribe, chiefdom, and finally to state – increasing levels of complexity – occurred rapidly. They were punctuations in the history of societies--- rapid transitions such as you see in biological systems and in physical systems, known as *phase transitions* (Lewin, 1999).
- <sup>114</sup> Fundamental sources of Unpredictability: The *course graining*, with all its accidents (branchings), necessary for a quasi-classical realm The probabilistic character of all the accidents (branchings) of that realm in the future Ignorance on the part of a given IGUS (information gathering and utilizing system) of the outcomes of most of the accidents that have already occurred, together with the exacerbation of the resulting unpredictability by amplification mechanisms Approximations and limitations on accuracy imposed by computational tools available (Gell-Mann, 1997).
- <sup>115</sup> Programs that utilize bifurcations awareness: Both chaos theory and TQM provide support for the notion that when systems leave their normal operating parameters, opportunities for new processes and problem-solving arise. The literature of TQM presents interesting arguments for the functional value of exceptional or non-average events (Kiel, 1997). The primary nexus between TQM and chaos theory is the visual similarity of the TQM statistical process control charts and the time series of deterministic chaos produced by simple algebraic equations (Dooley, Johnson, & Bush, 1995; Lewin, 1999) Statistical process control charts are based on the determination of upper and lower control limits for examining the variation in some defined quality surrogate as it is measured over time Graphs of deterministic chaos reveal that data points in such chaotic time series are also bounded by upper and lower control limits Exceptional or non-average events occur in statistical process control charts when a data point exceeds the upper or lower control boundaries of the defined range of variation in the system. This is then used as a means for examining the work process in an effort to determine the cause of the excessive variation
- <sup>116</sup> It is the “non-average,” the unusual event, that pushes the boundaries of existing structures and processes and leads the way for new forms of organizational response and evolution after *bifurcating events*<sup>116</sup> (Kiel, 1997). History-making events: The importance of non-average behavior is also evidenced in a recent scholarly effort to define “history-making” or those human endeavors that lead to changes in “everyday practices” (Spinosa, 1997). In their review of entrepreneurial behavior, Spinosa, et al. examine the consistent pattern among entrepreneurs to identify “anomalies” as a source of creative thinking leading to new social and economic innovations. Spinosa appears to recognize the importance of the “non-average” to the creation of social and economic innovation, when noting. “ We have also seen that the kind of thinking that leads to innovation requires an openness to anomalies in life. It requires an interest in holding on to these anomalies in one’s daily activities and in seeing clearly how the anomalies look under different conditions (Bryson, 1988; Spinosa, 1997)

- <sup>117</sup> Awareness of alternative choices: “a point at which alternative futures become apparent” (Bryson, Ackerman, Eden, & Finn, 1996) . Such a critical point seems to match the notion of the complex *bifurcation diagram* representing the multiple pathways open to systems after critical events (Kiel 1994).
- <sup>118</sup> Mathematically a “*bifurcation point*” represents a dramatic change of the system’s *trajectory* in *phase space*. Its *trajectory* over time *bifurcates* and a new *attractor* may suddenly appear (Laszlo, 1996).
- <sup>119</sup> In the field of Education, this larger breakdown is evident in such activities as calls for vouchers, charter schools, satellite and computer-based delivery systems, schools run by businesses, changes in funding, and more active school board participation in curricular and instructional issues.
- <sup>120</sup> Use Leverage points for bifurcation: Public managers understand “leverage” on a routine basis. i.e.: instance of interjecting incremental, 1<sup>st</sup> order changes in organizational processes in hopes of producing greatly enhanced productivity. The hope is that incremental improvements will eventuate in a “critical” state in which work unit or process behavior is fundamentally altered. The approach is generally not driven by any definable administrative theory but rather by notions of incremental change and numerous small efforts, based more on the manager’s responsibilities and short time frame for analysis rather than by an appreciation for nonlinearity (Kiel, 1997).
- <sup>121</sup> This concept of “structural determinism” sheds new light on the age-old philosophical debate about freedom and determinism. According to Maturana, the *behavior of a living organism* is determined. However, rather than being determined by outside forces, it is *determined by the organism’s own structure* – a structure formed by a succession of autonomous structural changes. Thus the behavior of the living organism is both determined and free. Behavior of the living organism is determined in the sense that the organism forms its own structure. It is free in the sense that the process of creating that structure is autonomous.
- <sup>122</sup> Branching – refers to the coarse-grained histories branching as time goes forward, with probability for the different alternatives at each branching. Of course, only one outcome at each branching is possible, which is unpredictable in advance except for probabilities (Gell-Mann, 1997).
- <sup>123</sup> Fine-grained histories – would specify the values of a complete set of variable at every instant of time Coarse-grained histories – regarded as bundles of fine-grained histories
- <sup>124</sup> Quasi-Classical Realm – where the system operates over long stretches of time, with high probability with frequent small fluctuations and occasional major branchings
- <sup>125</sup> \_In social systems, the nature of the new order that *emerges in the turbulence of bifurcation points*, states Laszlo, is indeterminate with respect to the overall direction of historical development at any given moment in *history*. The sum of social transformations in the course of time does tend, with statistical probability, toward high-energy societies with great structural complexity and low entropy (Laszlo, 1996; E. Laszlo). “The general *irreversibility* of technological innovation overrides the indeterminacy of individual points of *bifurcation* and “drives” the processes of history in the observed direction – from primitive tribes to modern techno-industrial states” (Laszlo, 1996)
- <sup>126</sup> Laszlo believes that all revolutions repeat the *dynamic patterns* over and over again the widest spectrum of historical circumstances (Laszlo, 1996). The outcome of revolutions and evolutions are always unpredictable and often surprising, states Laszlo; however, they are consistent with the general directionality of historical development (Laszlo, 1996). Laszlo believes that although they were functional solutions of a societal problem or crisis at the time, they were not final answers to the issues which confront these societies in the changing national and international milieu. Regimes established in the wake of revolutions and other discontinuities master the new technologies more effectively than their

immediate predecessors, and create high-energy, low-entropy and structurally complex societies (Laszlo, 1996) .

- <sup>127</sup> At the very heart of traditional science was the assumption that all physical events could be understood, that there was ultimately, a basic rationality to nature (Marion, 1999). Nature was not an automaton, predestined at the moment of the big bang; rather it is capable of free will, of creativity, of teleology. God cannot, after all, be banished from the gaps, for the gaps are axiomatic in nature (Marion, 1999). A phenomenon is either repetitive and stable or it is random and without pattern (Marion, 1999). There was an assumption that causality was time independent--that which works in one temporal direction will work in the other. If an event can be projected mathematically into the future, it can be reversed and projected into the past. If one only knows the current state of a system and knows the laws of its motion, one can determine where it is going and where it has been. Time travel is, hypothetically, possible (Marion, 1999) Much of administrative action and thought center around a belief that “similar” situations expedite “similar” if not the same solutions which represents a larger problem in management thinking (Kiel, 1997).
- <sup>128</sup> *Sensitivity to initial conditions* means that the “initial condition” or starting point of any social or organizational system determines its evolutionary path or history. Two systems with very similar starting points may evolve along very different *trajectories* (Kiel, 1997).
- <sup>129</sup> The clear recognition of this link between “*far from equilibrium*” and “*nonlinearity*” opened an avenue of research for Prigogine that would culminate a decade later in his *Theory of Self-Organization* (Prigogine & Stengers, 1984).
- <sup>130</sup> In order to solve the puzzle of stability “far from equilibrium” Prigogine turned to the “Benard Instability Phenomenon”, an example of spontaneous, self-organization, where a very striking ordered pattern of hexagonal cells appear, in which hot liquid rises through the center of the cells while the cooler liquid descends to the bottom along the cell walls (figure 5-1). Prigogine’s detailed analysis of those cells showed that as the system moves farther away from equilibrium (that is, from a state with uniform temperature throughout the liquid) it reaches a *critical point of instability* at which the ordered hexagonal *pattern emerges* (Prigogine & Stengers, 1984). The nonequilibrium that is maintained by the continual flow of heat through the system generates a complex spatial pattern in which millions of molecules move coherently to form the hexagonal convection cells.
- <sup>131</sup> The phenomenon of “turbulence” is a case in point. It has been known since the 19<sup>th</sup> century, but its origins have been imperfectly understood. It now appears that turbulence is an aspect of the tendency of nonequilibrium systems to evolve, under certain conditions, in a disordered manner (Laszlo, 1996).
- <sup>132</sup> The systemic patterns described by Complexity Science come from a simple set of rules applied over and over again to the latest results in a sequential process called *recursion*. This is why even very small differences at the start of the process can produce very large accumulated differences in later performance (Kelly & Allison, 1999).
- <sup>133</sup> *Feedback Loops* increase the instability because the effects are fed back into the system and *amplified*; and so change begets more change, and there is more and more *instability*.
- <sup>134</sup> “You can see these two species coexisting in a long *period of stability*; then one of them drops out and all hell breaks loose. It creates tremendous instability. That’s the Soviet Union pointing to the species that dropped out. I’m no fan of the Cold War, but my bet is that we’re going to see a lot of instability in the real world now it’s over. That is, if these models of ours have any validity at all” (Lewin, 1999).
- <sup>135</sup> Information sources: Capra, F. (1996). *The Web of Life*. New York: Anchor books and Maturana, H. V., F. (1987). *Tree of Knowledge*. Boston: Chambhala. Diagram Formulation: Conrad, I.

(2004) Reform at the Edge of Chaos: Framing a nonlinear education theory. Unpublished doctoral dissertation, University of Pittsburgh, Pennsylvania

- <sup>136</sup> **Turbulent:** Work environments that contain increasing “volume”, “momentum”, and “complexity” of change.
- <sup>137</sup> Structural Coupling is defined a key component of the cognition process of a system, which is described in detail in the next section
- <sup>138</sup> Conner believes that to continue succeeding in fast-paced uncertain markets and achieving a high return on change means leading the organization through the adaptation process quickly and effectively. The human elements affecting this process are key.
- <sup>139</sup> A small change in managerial style or in training and development can, for example, bring great unexpected results, as the system experiences *states of mutual causation---a small change can emerge into an entirely different basin of attraction*. This often happens if the organization is ripe for change (Conner, 1998). It is somewhat similar to the fall of one more snowflake that triggers an avalanche (U. Merry).
- <sup>140</sup> Rather than trying to consolidate *stable equilibrium*, the organization should aim to position itself in a region of “*bounded instability*”<sup>140</sup> and seek the “*edge of chaos*” (R. Stacey, 1996)
- <sup>141</sup> To seek a *stable equilibrium relationships with an environment* which is inherently unpredictable is bound to lead to failure (R. Stacey, 1996).
- <sup>142</sup> The distinction between ETCH and traditional school operations has to do with how knowledgeable people are about the strengths they possess.
- <sup>143</sup> The Butterfly Effect describes an event that produces exponential change. Both Holland in reference to public policy problems and Senge in reference to organizational change believe that efforts to identify “butterflies” that produce exponential change are essential for effective policy and organizational management (Holland, 1995) (Senge, 1990) Senge – refers to butterflies as “leverage.” Holland uses the term “lever points.” Both Senge and Holland present what are fundamentally efficiency arguments for the application of “leverage” to organizational or policy problems.
- <sup>144</sup> Higher levels at the edge of chaos (future shock) are the most destructive because not only will the current project fail to meet its objectives, but the higher levels erode the organization’s overall capacity to engage in future change efforts. The damage done to the organization’s absorption mechanism will reduce the likelihood of success with future change initiatives. At mid-range of the continuum, the edge of chaos (future shock) produces a greater loss of productivity and quality than any single change effort is worth. At the lower end of the future shock continuum, however, there exists a dangerous, but nonetheless potentially beneficial, amount of dysfunction. Leaders who seek the elasticity of a nimble operation know that as risky as high levels of change are for an organization, they must flirt with the rim of chaos if they are to keep their organization competitive in today’s markets (Conner, 1998).
- <sup>145</sup> Like preparing those already employed to embrace resilient characteristics
- <sup>146</sup> In recent years, this area has become the subject of intense investigation in such areas as Biology and Physics. From this kind of study has unfolded a better understanding of what happens just before and just after loss of control. The scientists in this new field call this a “*bifurcation zone*” – when something that was whole and consistent splits and goes in two different and unpredictable directions (Conner, 1998).

- <sup>147</sup> This sequence does produce some loss of control, but not much and not for very long. (An acceptable amount of dysfunction – acceptable because of the speed being achieved as the corner is taken). To accomplish the maximum speed while maintaining balance, the skater will suffer some reduction in progress, lower efficiency, however briefly, and effectiveness to some degree. In addition the risk of a minute miscalculation or momentary loss of concentration can produce a disastrous fall. The way to stay in control is to find and stay within this elusive, but essential, zone where a contained slide is possible
- <sup>148</sup> Self-Organization takes place only under conditions of disequilibrium (Kelly & Allison, 1999). The critical feature is that the system itself needs to sustain or move into this excitement for Self-Organization to be possible. But when it does, Self-Organization is actually inevitable (Caine & Caine, 1997).
- <sup>149</sup> “Constrained” businesses are weak or altogether deficient in these resilient qualities
- <sup>150</sup> Traditional leaders motivate others to follow direction by either: instilling fear fostering faith and credibility (Conner 1998)
- <sup>151</sup> Unfortunately with many organizations, after a brief orientation about the rules, everyone is thrust into the fray. People either perform well under these kinds of on-the-job training conditions or they don’t (Conner 1998).
- <sup>152</sup> Resilient people are positive they can succeed in unfamiliar circumstances. They remain focused on objectives during times of confusion, exhibit flexibility about how to address inhibitors, find order within what appears to be chaos, and proactively engage change rather than run from it. Resilient people tend to be resourceful, multiskilled, and highly motivated. They have a high tolerance for ambiguity, a desire to experiment, and a willingness to appropriately challenge authority. They resonate well with the mental and emotional conditioning necessary to succeed”(Conner, 1998).
- <sup>153</sup> **Human Reactions to Ambiguity – (Substitute “The unfamiliar” for “ambiguity”)** When facing the unfamiliar, **1) fight or 2) flight is** the option first exercised When fight or flight appears to be unfeasible – **3) immunity – indemnity** from the impact of change. Use this bogus acceptance as a way to circumvent the real issues and secure an exemption from the emotional stress of uncertainty rather than learn to operate within it. When those don’t work – **4) tolerating the ambiguity while maintaining high performance.** This strategy calls for a form of acceptance, but of a very different kind from that associated with immunity. Here, a person fully recognizes that discomfort is the constant companion of significant uncertainty. As such, he understands that major change always will be tied to some level of unpleasantness, irritation, and aggravation. The person using this approach is able to acknowledge that, regardless of the pain and suffering endured, he still is held accountable for whatever job responsibilities or duties have been assumed Courage is not taking action fearlessly; it is acting despite feeling fearful. Tolerance for ambiguity means performing well despite the discomfort one is sure to feel when facing the unknown. Nimble organizations consistently operate within this 4<sup>th</sup> option. They hire and promote people who have a strong tolerance for ambiguity, and then they train, coach, and reward this behavior to fortify it further. Tolerate ambiguity has to do with working synergistically with others, and more specifically, finding creative solutions to presenting problems. By tolerating ambiguity, delay in judging new situations is likely to find value in them and to creatively transform them into opportunities (Conner 1998).
- <sup>154</sup> These styles should be viewed in relation to the two basic types of change that facilitators address within learning institution settings: **First-order change** is incremental in nature and reflects movement that is more or less already taking place. The reference to first-order change being incremental in nature implies implementing an initiative that results in going faster or slower, or doing more or less within a relatively stable context. First-order change is common to the first four leadership styles, which pursue change by extrapolating from

past experience. They represent perspectives where future success or failure can be fairly accurately predicted on the basis of historical successes and failures. **Second-order change** is nonlinear in nature and reflects movement that is fundamentally different from anything seen before within the existing framework. Second-order change requires shifting context; it represents a substantial variation in substance and form that discontinues whatever stability existed before.

- <sup>155</sup> **Adaptation Capacity** – the amount of disruption humans can absorb before displaying unacceptable dysfunctional symptoms. The true parameters that establish how much unanticipated variation a person, group, or entire organization can really accommodate without displaying disabling dysfunction are not made known without imposing far more change than people find comfortable. Humans tend to first grumble. Then complain. And finally scream when a sense of balance is threatened. If leaders are overly sensitive to these expressions of discomfort, they will mistakenly come to rely too much on the “I’m -frustrated-and-unhappy” scale to determine the limits of change people can successfully undergo. Detachment –A thick skin is mandatory (Conner, 1998).
- <sup>156</sup> Facilitators can determine what contributes to a powerful quality system by identifying the “best-practice behavior” demonstrated by nimble organizations. Many organizations benchmark each other, but replicate the behavior, processes, and structures of their rivals. This kind of parroting, even when all the correct actions appear to be in place, is seldom able to produce the desired result (Conner, 1998).
- <sup>157</sup> A good way to affect this step, suggests Segel, is to make a mathematical/computer model of the whole system. Then use a genetic algorithm to make parameter modifications that will result in better operation of individual options and better balance among various alternative ways to attract a given task. The genetic algorithm can seek to improve some function that describes quantitatively how closely the system carries out its overall purpose. The details are functional and not critical, for the genetic algorithm is seen as a guide to improvement, not to optimization (Segel, 2000).
- <sup>158</sup> An example of an observable feedback will include the following process. First compile a list of “Performance Goals”: don’t worry about overlap or contradiction. (It is wise to keep the goals general, so that they may be reached in a variety of ways) Install “sensors” that identify information about “progress” toward the various goals and also “information on the state of the system and its environment.” “Sensors” should report only information that is local in time and space. “Outline a plan” that provides “progress” toward the various goals. Make the plan “sloppy” in that several overall options are “simultaneously employed” to improve a given type of “performance” and that each option is designed to permit considerable flexibility of operation. Design “feedbacks” from the various “sensors” to signal action for more effort in some options and less in others (this is “effector choice”) as well as desirability of modifying the operation of a given option (Improving the action of a given “effector”) (Segel, 2000).
- <sup>159</sup> These styles should be viewed in relation to the two basic types of change that leaders address within organizational settings: **First-order change** is incremental in nature and reflects movement that is more or less already taking place. The reference to first-order change being incremental in nature implies implementing an initiative that results in going faster or slower, or doing more or less within a relatively stable context. First-order change is common to the first four leadership styles, which pursue change by extrapolating from past experience. They represent perspectives where future success or failure can be fairly accurately predicted on the basis of historical successes and failures. **Second-order change** is nonlinear in nature and reflects movement that is fundamentally different from anything seen before within the existing framework. Second-order change requires shifting context; it represents a substantial variation in substance and form that discontinues whatever stability existed before.
- <sup>160</sup> Tolerating ambiguity has to do with working synergistically with others, and more specifically, finding creative solutions to presenting problems. Courage is not taking action fearlessly; it is acting despite feeling fearful. Tolerance for ambiguity means performing well despite the discomfort one is sure to feel when facing the unknown. All levels of the system operate within this option. By tolerating ambiguity, delay in judging

new situations would find value in them and to creatively transform them into opportunities (Conner 1998). **Human Reactions to Ambiguity – (Substitute “The unfamiliar” for “ambiguity”)** When facing the unfamiliar, **1) fight or 2) flight** is the option first exercised When fight or flight appears to be unfeasible – **3) immunity – indemnity** from the impact of change. Use this bogus acceptance as a way to circumvent the real issues and secure an exemption from the emotional stress of uncertainty rather than learn to operate within it. When those don’t work – **4) tolerating the ambiguity while maintaining high performance.** This strategy calls for a form of acceptance, but of a very different kind from that associated with immunity. Here, a person fully recognizes that discomfort is the constant companion of significant uncertainty. As such, he understands that major change always will be tied to some level of unpleasantness, irritation, and aggravation. The person using this approach is able to acknowledge that, regardless of the pain and suffering endured, he still is held accountable for whatever job responsibilities or duties have been assumed (Conner, 1998 ).

- <sup>161</sup> The state cycle is an attractor and the collection of trajectories that flow into it is called the basin of attraction. Think of an attractor as a lake, and the basin of attraction as the water drainage flowing into that lake (Kauffman, 1995).
- <sup>162</sup> In other words kicking a stone (a linear event) and kicking a dog (a nonlinear event) are two very different stories (Bateson, 1979). The stone will react to the kick according to a linear chain of cause and effect. Its behavior can be calculated by applying the basic laws of Newtonian mechanics. The dog will respond with “structural” changes according to its autopoietic nature and (nonlinear) pattern of organization. The resulting behavior is generally unpredictable
- <sup>163</sup> The same considerations apply to the genetic information encoded in DNA. “For many years biologists considered protein sequences as being instructions coded in the DNA. It is clear, however, that DNA triplets are capable of predictably specifying an amino acid in a protein if, and only if, they are embedded in the cell’s metabolism, that is, in the thousands of enzymatic regulations in a complex chemical network. It is only because of the emergent regularities of such a network as a whole, that makes it possible to bracket out this metabolic background, and thus treat triplets as codes of amino acids” (Varela et al., 1991).
- <sup>164</sup> It is worth pointing out that our representational capabilities are different for emotion, perception and behavior. Different parts of the brain learn rules, patterns, and emotional connections (Lesgold,2006).
- <sup>165</sup> They sense chemical differences in their surroundings, and accordingly swim toward sugar and away from acid; they sense and avoid heat, move away from light or toward it, and some bacteria can even detect magnetic fields (Margulis, 1995).
- <sup>166</sup> Structural changes in the system constitute acts of cognition, but not all physical changes in an organism are acts of cognition, and not all disturbances from the environment cause structural changes (Maturana, 1987). In other words, there are many disturbances that do not cause structural changes because they are “foreign” to the system. Living organisms filter out what they do not need for survival(Maturana, 1987). In this way each living system builds up its own distinctive world according to its own distinctive structure. When part of dandelion is eaten by a rabbit, or when an animal is injured in an accident, those structural changes are not specified and directed by the organism. They are not changes of choice and therefore are not acts of cognition (Maturana, 1987). However, these imposed physical changes are accompanied by other structural changes (perception, response of the immune system, and so forth) that are acts of cognition. Conversely, not all disturbances from the environment cause structural changes. Living organisms respond to only a small fraction of the stimuli impinging on them (Maturana, 1987). In other words, there are many disturbances that do not cause structural changes because they are “foreign” to the system. Living organisms filter out what they do not need for survival. In this way each living system builds up its own distinctive world according to its own distinctive structure (Maturana, 1987). Additionally, humans possess “an abstract world of language, thought, and consciousness through which they bring forth their world together” (Varela et al., 1991).

- <sup>167</sup> Living systems are autonomous. The environment only triggers the structural changes, it does not specify or direct them.
- <sup>168</sup> Information Source: Varela, F. M., H.; Uribe, R. (1974). *Autopoiesis: The Organization of Living Systems, Its Characterization and a Model*. *Bio Systems*, 5, 187-196; Stewart, I. (1989). *Does God Play Dice?* Cambridge, MA: Blackwell; and Capra, F. (1996). *The Web of Life*. New York: Anchor books. Diagram Formulation: Conrad, I. (2004) *Reform at the Edge of Chaos: Framing a nonlinear education theory*. Unpublished doctoral dissertation, University of Pittsburgh, Pennsylvania
- <sup>169</sup> Different species bring forth dissimilar worlds. Cats or birds will see trees, for example, very differently from humans, because they perceive light in different frequency ranges. Thus the shapes and textures of the “trees” they bring forth will be different from humans. Therefore, when a tree is seen, the tree is not inventing reality.
- <sup>170</sup> Leave open the question of whether the agents or population actually achieves improved performance, clearly, different agents in a population may use different measures of success. So changes that are adaptations from some may not be for others (Axelrod, 1999).
- <sup>171</sup> There are many complex systems, but not all are “adaptive,” which include the strategies used by agents or a population that can change over time, even if the agents or populations are working for improved performance. In fact, there may be a tension between organization and the capacity to adapt. The very same internal organization that enables adaptation also channels change along specific directions while conveying resilience and vulnerability along others (Axelrod, 1999).
- <sup>172</sup> Learning from experience can lead to false conclusions: imitation of apparent success can be misleading; and cutting the less effective members of the population can lead to the inadvertent elimination of potentially successful strategies. Even more subtle is the point that as agents adjust to their experience by revising their strategies, they are constantly changing the context in which other agents are trying to adapt (Axelrod, 1999).
- <sup>173</sup> Information Source: Varela, F. M., H.; Uribe, R. (1974). *Autopoiesis: The Organization of Living Systems, Its Characterization and a Model*. *Bio Systems*, 5, 187-196; Bateson, G. (1979). *Mind and Nature: A Necessary Unity*. New York: Dutton; Stewart, I. (1989). *Does God Play Dice?* Cambridge, MA: Blackwell; and Capra, F. (1996). *The Web of Life*. New York: Anchor books. Diagram Formulation: Conrad, I. (2004) *Reform at the Edge of Chaos: Framing a nonlinear education theory*. Unpublished doctoral dissertation, University of Pittsburgh, Pennsylvania
- <sup>174</sup> Birdsongs are among the most beautiful kinds of nonhuman communication. The coordination of behavior is determined not by meaning, but by the dynamics of structural coupling (Maturana, 1987). In Maturana’s view such linguistic behavior is the basis for language (Maturana, 1987). Honeybees indicate the location of specific flowers to each other by dancing out intricate patterns. Although some primates seem to have the potential of communication in sign language their linguistic domain is extremely limited and does not come anywhere near the richness of human language
- <sup>175</sup> It becomes more and more subtle and elaborate with nervous systems of increasing complexity (Capra, 1996).
- <sup>176</sup> The crucial role of language in human evolution was not the ability to exchange ideas, but the increased ability to cooperate, conceptual thought and consciousness (Capra, 1996).
- <sup>177</sup> In an interview with Bill Moyers, Candice Pert, a leading researcher in the nature of peptides, stated that intelligence is in every cell of the body. In her view, the mind is found throughout the brain and the body,



and is not confined to the space above the neck (Moyers, 1993). The mind can be affected by what is done to or with the brain and the body. The mind can also influence the body and the brain. That is, all three – body, brain, and mind – totally interpenetrate and influence each other (Caine & Caine, 1997; Moyers, 1993).

- <sup>178</sup> In other words, through recurrent interactions (structural coupling with environment), structural changes are triggered (development and learning) in *perception*, emotion,<sup>178</sup> and behavior within the living system.
- <sup>179</sup> This term, and a first pass on the ideas just stated, was introduced by Donald O. Hebb a few decades ago.” (Lesgold, 2005)
- <sup>180</sup> Laurillard counters by suggesting that the education system consider how learning processes need to be understood within the context of the larger whole. She suggests that if universities are to become “learning organizations” they need to have structures that will enable “learning conversations.” (Laurillard, 1999).
- <sup>181</sup> An example is the legal system that tries to make the punishment fit the crime, or in the scientific system that tries to identify and then measure the individual impact of independent variables. In both cases, much of the context is ignored.
- <sup>182</sup> It’s worth reflecting on accountability. If we really believed that we could specify everything top down and control everything, we would not have outcome measures for accountability. While we have had measures, the ideas of measuring outcomes are not incompatible with a complex system view. If a particular person or unit – when put into a system – makes things worse, this is worthy of note (Lesgold, 2006)
- <sup>183</sup> Of course, there are strong demonstrations that this doesn’t really work, such as Cynthia Coburn’s dissertation. Coburn, C.E. (2001) *Making Sense of Reading: Logics of Reading in the Institutional Environment and the Classroom*. Unpublished doctoral dissertation, Stanford University, Palo Alto, CA And also see “*The One Best Way*: Frederick Winslow Taylor, and *The Enigma of Efficiency* by Robert Kanigel
- <sup>184</sup> In most schools, there is very little contact between principals and teachers around instruction. The system was supposed to be very top-down, but it generally isn’t. The problem is that there is no investment in building the shared representations needed to keep instruction on task, and the representation that has been built is one in which it is assumed that many children cannot learn (Lesgold, 2006)
- <sup>185</sup> For example, asking and answering questions about the effects of assessment on children, the purpose of assessment in relation to their performance, and the purpose of assessment as a sorting tool in terms of expected school functions can lead to systemic change because they call communities to dialogue about deep values and beliefs. (Horn & Carr, 2000).
- <sup>186</sup> He uses the example of professional development to exemplify his point by stating that it “has a poor track record because it (professional development) lacks a theoretical base and coherent focus.” This “failure to have a sustained cumulative impact” results in a “lack of integration in the day-to-day life of teachers” (Fullan 1995).
- <sup>187</sup> Therefore, coming to terms with the fact that information is no longer owned, and that information is available in the world of instant access, is critical to genuinely rethinking the nature of the education system and our roles as educators.
- <sup>188</sup> Drugs often are given to maintain an individual in a dysfunctional situation; to tolerate a miserable job; or a destructive marriage. By taking relaxants regularly the individual could avoid the growth inherent in taking a personal step toward positive change (Freeman, 1995). "I need some acetylcholine; instead of self-

control, I need more or less dopamine (to deal with my hedonistic nature); I need some endorphins for pain relief, histamine for arousal, melatonin to keep me from having to give up habits that influence my ability to sleep, serotonin to relax me, and vasopressin before I go in to fight for my raise or to mediate my feelings of jealousy" (Freeman, 1995).

<sup>189</sup> By definition it is presently defined as a system of public, and private schools, and colleges that offer students formal education from kindergarten to college graduation (J. Lemke).

<sup>190</sup> Equally dysfunctional is a 2<sup>nd</sup> order facilitator without enough 1<sup>st</sup> order guidance. 1<sup>st</sup> order change only becomes problematic when its mentality so predominates an organization that leaders lose their ability to navigate the organization's more strategic 2<sup>nd</sup> order changes. The primary symptom of institutions consumed by 1<sup>st</sup> order mentality is their persistent belief that they are but one "event" away from sustained success. When people invest disproportionate hope in any one 1<sup>st</sup> order change they invest disproportionately in the resources that go toward managing those changes. These 1<sup>st</sup> order changes consume so much time and effort that people often feel depleted after the emotional high and low that accompany them

<sup>191</sup> Traditional Leaders usually try to maintain their school/district's equilibrium by directing and predicting events. Traditional leaders were taught by mentors who owed much of the success to foretelling events. Leadership competency in earlier, less chaotic times was defined in large part by the ability to foresee what "events" were going to happen next. In the past, when there was less uncertainty and a longer shelf life for solutions, it was possible to lead this way (Conner, 1998).

<sup>192</sup> Information Source: Conner, D. R. (1998). *Leading at the Edge of Chaos*. New York: John Wiley & Sons, Inc. Diagram Formulation: Conrad, I. (2004) Reform at the Edge of Chaos: Framing a nonlinear education theory. Unpublished doctoral dissertation, University of Pittsburgh, Pennsylvania

<sup>193</sup> The Natural Course administrative approach of the education system's operations is laissez faire and non-interventional as the school/district moves through the Building, Harvest, Uncertainty, Decay, and Renewal Phases of the operational paradigm. The risk is vulnerability to both *internal and external fluctuations* in the environment that may result in an inability to meet, let alone beat, the "competition." The cost is tremendous waste of *adaptation resources*. Both the leader and the organization are reduced to distraction and the threat of dwindling learning achievement.

<sup>194</sup> First order changes address the array of day-to-day dangers and opportunities encountered in the normal course of operating a business. They reflect minor changes in an individual's life or organization – the individual or organization is basically the same. (when who you are at the end is no different from who you were at the start) First order changes are discrete episodes that occur within precise time frames (when people move from a specific starting point toward a distinct, predetermined destination. First order changes are planned with precision down to the last detail--measured in discrete units of time like hours, days, or years.

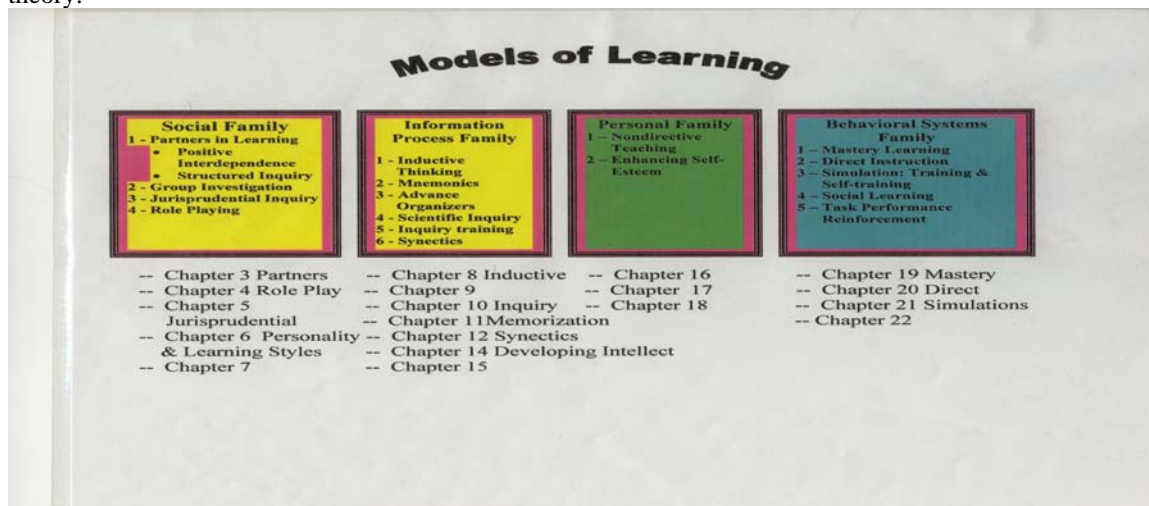
<sup>195</sup> Float among the alternatives (seldom take a position that could be seen as permanent) along the continuum formed when apparent contradictions are viewed as paradoxical aspects of the same thing Synthesize a solution from the choices available (rather than compromise between the opportunities) They are able to remain in the tension of uncertainty by integrating options instead of choosing one over another. A nimble operation may sometimes choose to identify and then merge the best attributes from two or more possible choices and reconstitute the contents of these choices to form a completely new alternative with a combined strength greater than any of the separate options (Conner, 1998)

<sup>196</sup> Information Source: Conner, D. R. (1998). *Leading at the Edge of Chaos*. New York: John Wiley & Sons, Inc. Diagram Formulation: Conrad, I. (2004) Reform at the Edge of Chaos: Framing a nonlinear education theory. Unpublished doctoral dissertation, University of Pittsburgh, Pennsylvania

- <sup>197</sup> The mission/vision is written and reflects the district's resolve to pursue a student-centered optimal learning environment.
- <sup>198</sup> Traditional paradigm schools seldom have any stipulations about increasing the school's ability to absorb the *escalating demands on its adaptation resources*. Historically, Boards have not included such specifications as part of their mandates because, the demands of change were nowhere near what they are today or will be in the future (Conner, 1998)
- <sup>199</sup> In the functional areas vital to an ETCH organization's operations (technology, finances, and personnel) there is usually a dedication to building and constantly updating rapid response "*processes*." In some cases, these courses of action are formalized and documented, at other times, they are more intuitive and are applied with much less structure
- <sup>200</sup> Two primary contributors to needless waste of resources are : Nonessential Change Initiatives - appetite most leaders have for one favorite innovation And Unskilled People in Key Roles - do not apply the proper mind-set, resolve, techniques, diagnostic tools, and planning to successfully execute their projects
- <sup>201</sup> Stephen Wolfram described four types of order in systems. **Type 1 order – Stephen Wolfram** – the same order you get with a pendulum at rest (Marion, 1999) **Type 2 order or periodic order** – systems would rotate through several states repeatedly, in much the same way that a swinging pendulum repeats its back-and-forth motion over and over. (Like type 1 order such systems are frozen with no information being shared) (Marion, 1999) **Type 3 or chaotic order** – lots of movement and state change in this system. The computer screen looked like one big mass of dots all changing colors madly and with no observable pattern. Information was lost as soon as it was created, and there was no predicting where the system would go (Marion, 1999) **Type 4 orders – the Edge of Chaos** – this state came suddenly. The change was much like the *phase transition* that occurs when ice is warmed to slightly above 0 C. The new state was somewhat like the *ordered states* created by *lower levels* because there was some sense of predictability to what was happening on the screen, yet it was also akin to the chaotic states of higher lambdas because units were sharing information with one another (pg 25-26) (Marion, 1999) **Chris Langton – Complexity Theory – believed that at the Edge of Chaos** one finds "biological evolution, cultural evolution, concepts combining and recombining and leaping from mind to mind over miles and generations (pg 27) (Marion, 1999)
- <sup>202</sup> "Predictable" situations that can be anticipated are easier to manage. "Predictability" provides people with some sort of anchor when struggling through "ambiguity" and "uncertainty" in their lives. Reliable "predictions" allow the time to generate and evaluate alternative response strategies.
- <sup>203</sup> "Nimbleness" is the ability for an organization to consistently succeed in unpredictable, contested environments by implementing important changes, successfully solve problems, and exploit more efficiently and effectively than its competitors, and thereby maintaining its desired "return on change (Conner ).
- <sup>204</sup> Another way to think of this early "future shock" is as a potentially dangerous medical treatment that, if administered properly, can become a lifesaving remedy (IE: radioactive material used to fight cancer, warfarin, used to kill rate, is given in small doses to humans as a blood thinner, and polio and measles vaccinations work by injecting small amounts of the offending substance.) If calibrated appropriately, certain adversities can be used to promote opportunity. (Conner, 1998)
- <sup>205</sup> A cross-disciplinary view suggests that as connections (networks) through relations in populations of agents subdivide into types (buyers and sellers) that tremendous variety develops in what those relations are and how they work. Examples include magnetic attraction, organizational authority, electrical stimulation, sexual affinity, chemical inhibition, geographic proximity, or ethnic hostility. Each element in one of these complex systems has patterns of actions that affect those connected to it. (Marshall 1995)

- <sup>206</sup> Conner believes that organizations that provide customers what they want, when they want it, at a price they will pay no longer separates those who once dominated from the rest.
- <sup>207</sup> Credibility assessments determine *coherence* of the new theory---ETCH. *Coherence* occurs when all relevant propositions are connected in an overall logical argument. Does ETCH consider, explain, and hold together to fit the present traditional paradigm of the educational system? Credibility Assessments also determine *validity* of ETCH. *Validity* is achieved if ETCH (the conclusion) logically follows from its assumptions or premises. ETCH addresses the worth of the explanation constructed in Chapter 2 described by the traditional paradigm indicators, the universalities of complexity indicators in Chapter 3 and 4, and application of the universality indicators to the educational philosophy of a state-licensed high school in Chapter 5. Is ETCH testable from these assumptions or premises? YES. And finally, credibility assessments determine *verifiability* of the explanation and value assessments to determine the significance, scope, and utility of ETCH. *Verifiability* determines whether ETCH can be tested directly. Is the conclusion testable for existing information, either to support or refute. The scenario examples from the Lancaster Institute provide supporting argument that establishes ETCH as a coherent, valid, verifiable theory. These examples account for the present traditional paradigm as well as offer an alternative.
- <sup>208</sup> An enigma in the education industry, the Lancaster Institute of Learning, was a culminating five-year project, (which emerged from its predecessor, TUTOR-US Learning Center---a three year state-licensed one-on-one kindergarten through adult tutoring school venture). The Lancaster Institute was a cutting-edge, student centered and student driven, state-licensed private high school. It was born from the need for an alternative to traditional schools and the traditional school setting for children who were languishing on the periphery. The high school was designed to meet the educational and social development needs of students from grades 7-12, while the tutoring division of the school remediated and enriched students from K through adult during school hours, evenings, and weekends. The tutoring division also included a homework center, which tailored homework assistance and test reinforcement for elementary, middle, and high school students during the school year. During the summer the tutoring division supported a summer school for high school students needing to make up credits for their home schools. The draw for families to select the Lancaster Institute was one-on-one instruction, where public or other private schools either referred students, or parents transferred their child to LIL.
- <sup>209</sup> As the founder, CEO, and administrator of the Lancaster Institute of Learning, my bias in defense of the Institute's program and its longevity is obvious and expected, as is true with any mother who gives birth to her offspring. My present purpose is not specifically to defend the Institute but rather to show how its structure embodied the decision-making rationale of my complexity hybrid.
- <sup>210</sup> Since LIL was a drastic change from the structure of public schools, intensive training of incoming staff was crucial to enable the mental model shift between the traditional and LIL education systems. A mental model retraining of a similar nature to create a paradigm shift is also necessary of the traditional public school administrator who will struggle with the structure differences of the cutting edge student-centered high school (LIL) and his/her comfort level of the traditional public school system. The "Models of Teaching" text, written by Bruce Joyce, (which was the product of teachers who have "beaten a path for us and hacked out some clearings where we can start our inquiries"), provides the conduit to explain and describe the rationale for the creation of the Lancaster Institute of Learning---an alternative student-driven high school. Although envisioning an operationalized student-centered school could be troublesome for some, the Models of Teaching text not only provides the conduit for commonality but also provides the conduit for the complexity theory hybrid (ETCH) lens to juxtapose an alternative education system on to the traditional paradigm currently in operation. The text's four instruction model categories (Social Family, Information Process Family, Personal Family, and Behavioral Systems Family, **shown in the diagram**

below have anchored the Lancaster Institute’s Mission, Vision, and Execution into present education theory.



<sup>211</sup> In the functional areas vital to an ETCH organization’s operations (technology, finances, and personnel) there is usually a dedication to building and constantly updating rapid response “*processes*.” In some cases, these courses of action are formalized and documented, at other times, they are more intuitive and are applied with much less structure. To lead at the edge of chaos requires a shift from a preoccupation with “what” (event) will occur in the future to a process mentality---a focus on “how” (Process) to address key events as they unfold. (“what” are the particular needs of the client is replaced by “how”(process) to address the needs of the client ) In turbulent waters concrete predictions are unreliable; therefore maintaining a sense of balance by attempting to foresee distinct events is fruitless. Leaders of traditional schools usually try to maintain their school’s equilibrium by directing and predicting events. Traditional leaders were taught by mentors who owed much of the success to foretelling events. Leadership competency in earlier, less chaotic times was defined in large part by the ability to foresee what “events’ were going to happen next. In the past, when there was less uncertainty and a longer shelf life for solutions, it was possible to lead this way

<sup>212</sup> Stakeholders i.e.: school board members, parents, community, state and federal agencies (with mandates and regulations)

<sup>213</sup> Through the emergence of ETCH, the LIL education system, in Dr. Jay Lemke words, can be defined by its “dynamics” or “how” the system was put together and “how” it interacted (J Lemke, 2002).

<sup>214</sup> Daryl Conner suggests that knowing “how” to utilize various forces (processes) to influence a situation as the strategy for securing control has several guidelines for beginning the path forward, beginning with a focus on the “process” (the “how”) not the event (what) “How” to identify which changes are the school’s priorities have several elements: Identify the specific key success factors (Provide what the stakeholders(agents) need now) Identify the impact indicators of internal or external pressures (React quickly to unanticipated needs and events as they unfold, instead of trying to predict events<sup>214</sup>) Identify adjustments to success factors and the specific nature of the required changes. (Scan the horizon for early signs of emerging agent requirements, new threats, or opportunities and procedures so that an early onset of the development cycle for an innovative response can occur.<sup>214</sup> Managing agent relations does not mean correctly guiding the details of next year’s demand and then tooling up to provide only that product or service ) Formalize decisions to implement these changes (Educate agents about capabilities and possibilities they did not realize were feasible) Execute changes to achieve the desired results while preserving the human adaptation capacity for future changes.

- <sup>215</sup> "The relationship is free from any type of pressure or coercion. The teacher avoids showing personal bias or reacting in a personally critical manner to the student. Every learning task is viewed as an opportunity to help the student grow as a person " (Joyce, 2000) Chapter 16.
- <sup>216</sup> Conner has suggested the following directives to facilitate observable feedback as part of the empowered process. First compile a list of "Performance Goals": don't worry about overlap or contradiction. (It is wise to keep the goals general, so that they may be reached in a variety of ways) Install "sensors" that identify information about "progress" toward the various goals and also "information on the state of the system and its environment." "Sensors" should report only information that is local in time and space. "Outline a plan" that provides "progress" toward the various goals. Make the plan "sloppy" in that several overall options are "simultaneously employed" to improve a given type of "performance" and that each option is designed to permit considerable flexibility of operation Design "feedbacks" from the various "sensors" to signal action for more effort in some options and less in others (this is "effector choice") as well as desirability of modifying the operation of a given option (Improving the action of a given "effector") (Segel, 2000).
- <sup>217</sup> Think-tank: " Metaphor used to describe a thinking environment, where stakeholders converge with idea contributions, to give birth to new knowledge in solving challenges"
- <sup>218</sup> A note of caution: The specifics of the Institute cannot be used as a cookie cutter for applying my complexity hybrid to other situations, since the interactions that took place in LIL were, by the very theory being illustrated, conditioned partly on local agency that will not be identical elsewhere. What is of value, though, is the insight that schools are CAS which include the common universality thread that permeates all living systems (both traditional and those that reflect the complexity hybrid), and the tool it provides to facilitators of all school types.
- <sup>219</sup> On a school district level, a combination of simultaneously operating processes interwoven through feedback loops emerge to provide the system's operationalized Vision (can be student-centered, teacher-centered, union- centered, job-security-centered, and sustainability-centered). The District's Vision emerges into its --Mission, which evolves into its--Directives/Purpose. The Directives/Purpose emerge into --guidelines/principles/ procedures--, and consequently into the --holistic standards for the fitness of the system, as it aligns and loops back to adjust the district's Vision and Mission. Simultaneously additional feedback loops emerge the ---resources, curriculum, learning objectives, instruction --that emerge from standards to provide guidelines for instruction. And finally -student knowledge and skill acquisition is assessed through application. Those assessment results feed-back to adjust the mission and vision of the school, and the cycle repeats. The point here emphasizes how through the feedback loop (both positive and negative) process, a system uses its own output to make adjustments in its inputs and or processes.
- <sup>220</sup> "To succeed, we need to infuse the curriculum with intellectual activity so that learning to think is an important component of every activity" (Joyce, 2000) Chapter 8.
- <sup>221</sup> "It should not be assumed that all persons progress naturally through the higher stages of development. Many persons appear to be arrested in their development before or at the stage of the "good boy nice girl" orientation. Thus, the attempt to increase moral development is relatively critical" (Joyce, 2000). Chapter 14).
- <sup>222</sup> "Match the curriculum to the student's level of development, which necessarily involves accurately assessing the student's stage of growth " (Joyce, 2000), Chapter 14).
- <sup>223</sup> "From this stance the task of the psychologist is to discover what kinds of environmental variables affect behavior in which ways. The task of educators is to translate that knowledge- to design instructional materials and interactions that encourage productive learning and to avoid the environmental variables that can discourage it. If we can do that, so can the student learn to do it. Thus, what appears to first to

be a technique for controlling others can be used to free people by increasing their capabilities for self-control" (Joyce, 2000) pg 318.

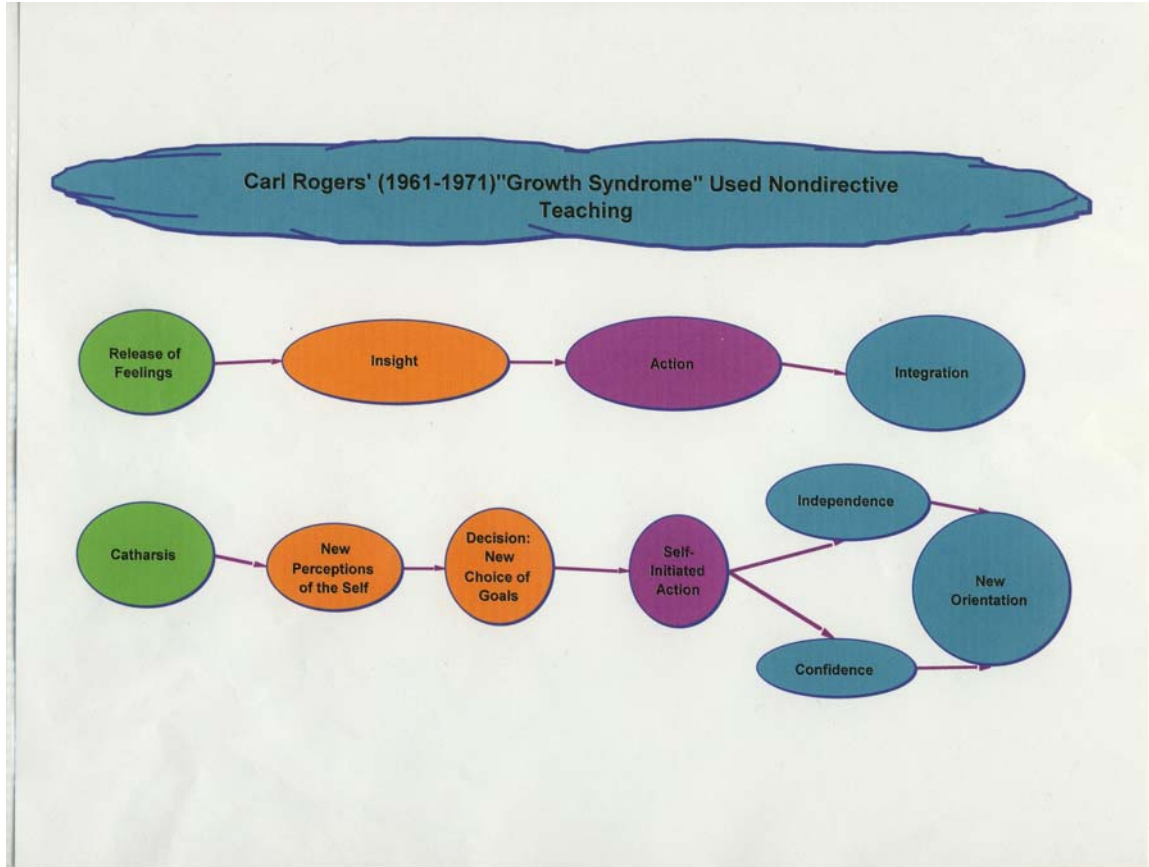
<sup>224</sup> "Retention in grade is devastating emotionally and frequently has the effect of destroying interest in school. The embarrassment from it continues for a long time and generates aversion to the schooling process and even the social interchange in school. It seriously reduces the probability of later successful school work" (Joyce, 2000) pg 322. "Labeling a child as having learning problems can generate aversion as well. No doubt one of the reasons for the general ineffectiveness of special education is that the child, labeled as having a "learning disability" feels devastated and approaches learning tasks with poor feeling that become attached to learning itself. In the worse cases, the children so labeled "give themselves permission" to avoid the learning tasks whenever possible" (Joyce, 2000) pg 322.

<sup>225</sup> "People respond to variables in their environment with a conditioning effect. These external forces stimulate individuals to engage in or avoid certain behaviors. Once a behavior has been learned, the probability that it will occur again can be strengthened or decreased by response from the environment. (Joyce, 2000) pg 317-318.

<sup>226</sup> "Students are also reinforced by controlling their environments" (Joyce, 2000) pg 321.

<sup>227</sup> "As they begin to understand the reasons for their behaviors, they begin to see other more functional ways of satisfying their needs " (Joyce, 2000) pg 289-290.

<sup>228</sup> These alternative options can be understood partly from the viewpoint of Carl Rogers, as shown in FIGURE 41, below.



### CARL ROGER'S NONDIRECTIVE TEACHING MODEL

Carl Rogers, whose work led to the "nondirective teaching model" in 1961-1971 (one of the Personal Systems Family) believed that "Responding on a purely intellectual basis to students' problems inhibits the expression of the feelings, which are at the root of the problem of growth " (Joyce, 2000) Chapter 16. "Human relationships enable people to grow, and therefore that instruction should be based on concepts of human relations in contrast to concepts of subject matter" (Joyce, 2000) Chapter 16. "The client's capacity to deal constructively with his her own life is respected and nurtured" (Joyce, 2000) Chapter 16.

<sup>229</sup> Chapter 17 in the Models of Teaching text "attempts to deal conceptually with the States of Growth that result from schooling" 1. "All students can learn how to learn and they can respond to a great variety of teaching/learning environments. Students can accelerate their ability to learning in a great number of ways if we provide them with the opportunity" 2. "The more skills students develop and the more they widen their repertoire, the greater their ability to master an even greater range of skills and strategies " 3. "The learning community developed in the school and the classroom has great influence on how students feel about themselves, how they interact, and how they learn. The social climate is part of the substance of schooling. It provides a curriculum that greatly affects the results of the academic curriculum" (Joyce, 2000) Chapter 17.

<sup>230</sup> "The role of the past in shaping a person's behavior is de-emphasized. Concentrated efforts created conditions that enabled students to progress and gain satisfaction quickly. The stance regards human behavior with optimism and does not dwell on the past. The assumption is that past failure did not



result in conditions that cannot be corrected. The more difficult problems just take a little longer to fix " (Joyce, 2000)pg 320. Instruction may have caused a failure to learn to read, but the focus is on learning to read now.

<sup>231</sup> While threat perhaps cannot be wholly eliminated from the educational process, Combs believes that threat can have very adverse effects in creating a hatred of the learning process. Combs believes that it has something to do with the retreat of children into drugs and guns, which substitute artificially induced euphoria for learning. Today's drug problem, suggests Combs, may be in considerable part a failure of the educational system to produce people who reject temporary euphoria in place of the life-long excitement of exploring the immense potential of the human brain (A. Combs, Blume, Newman, & Wass, 1974).

<sup>232</sup> "Counterconditioning always involves relearning. In counterconditioning, a new behavior incompatible with the old behavior is substituted, such as relation for anxiety" (Models of Teaching, pg 318) "We can use the behaviorist position to build simulations that work - students interacting will them learn something - and simultaneously accept the personalistic position that students can direct their own behavior" (Joyce, 2000) pg 138.

<sup>233</sup> Caine and Caine explored the impact of stress on the immune system and the difference between helplessness and challenge. They also examined traditional theories of memory and looked for guidance on the difference between memorization and the construction of learning. They examined the ways in which people interpret experience, and at the difference between structured activities and experiences. They combed the research on reflection and metacognition and explored the social construction of knowledge, the power of relationships, the nature of individual differences, and more. The synthesis of their findings, and their theory of how people learn, is spelled out in "Making Connections: Teaching and the Human Brain" (R. Caine & Caine, 1994). They advocate "brain-based learning" in a theory to attempt to redefine the learner--- moving the picture of the learner from an absorber of information to one who interacts dynamically with it (Caine & Caine, 1997).

<sup>234</sup> " Behavior theorists believe that internal responses, which mediate our observable responses can be changed (Rimm and Masters, 1974). The approach involves continuous inquiry - a careful study of the student, the design of the environment, a study of responses, and continuation or modification of the course of action" (Joyce, 2000)Pg 319. "Two externally similar responses do not necessarily proceed from the same original stimulus. Conversely, no two people will respond to the same stimulus in precisely the same way" (Joyce, 2000) pg 320. "Consequently, the procedures for encouraging new behaviors involve setting specific, individualized behavior goals" (Joyce, 2000) pg 320.

<sup>235</sup> " This does mean that the goals for each student may differ and that the training process will need to be individualized in terms of pacing or content. The instructional materials prepared from the behaviorist's stance are almost always "self-paced" (Becker 1977 and Carnine 1980 Becker, Englemann, Carnine, and Rhine 1981) (Joyce, 2000) (Models of Instruction pg 320). " Behavioral practitioners have often reported that they have been able to alter maladaptive behaviors in a short time, even in the case of severe phobias or long-term withdrawal patterns. Many shy people have felt relaxed and socially effective in a short time, and students who had remained virtually illiterate have progressed quickly (Resnick 1967;(Joyce, 2000) pg 321.

<sup>236</sup> " Thus, we can search for the amount of structure the student needs, and we can modify models to increase or decrease their structure to fit the level at which the student operates best" (Joyce, 2000) pg 102.

<sup>237</sup> "Optimal Environments: The best procedure for inducing an individual to progress toward complexity and flexibility is to match that person's present stage of personality development to an environment tailored to the characteristics of that stage, but in such a way as to pull the individual toward the next stage of development" (Joyce, 2000) pg 101.

- <sup>238</sup> "As the individual becomes more complex, the environment needs to change with him or her if growth is to continue at an optimal rate." "Environmental prescriptions can be made to increase the integrative complexity of the individual - that is, the optimal environments for growth in personality can be identified" "Hunt's model is really a plan for changing social systems to match the complexity of the learner. Hunt's model suggests principles for behaving in relation to the student, depending on the kind of person he or she is." "When environment and trainee personality were matched (high structure with low complexity), the greatest growth took place" (Hunt and Hardt, 1967)
- <sup>239</sup> "Growth is "an interactive function of the person's level of personality development and the environmental conditions he encountered" (Hunt, 1970b, pg 4;(Joyce, 2000) pg 97. "Particular behavior patterns are characteristic of different levels of integrative complexity. The goal is to help students progress toward greater integrative complexity and is accomplished by modifying the environment to increase the probability that development will take place. Schroeder; Driver; and Streufert identify and describe four levels
- <sup>240</sup> "One of the important uses of developmental psychology is a guide for adjusting instruction to the developmental level of the students " (Joyce, 2000) Chapter 14.
- <sup>241</sup> It is unlikely that any one model could have achieved effects of this magnitude, but the combination of models helped students acquire a variety of learning strategies, which together enabled them to educate themselves more strongly" (Joyce, 2000) Chapter 15.
- <sup>242</sup> "So long as we remember that when they are studying a particular subject, they need the hands-on experience to connect their minds to that subject. And so do we all. Abstractions are formed by conceptualizing experience. They do not come out of thin air" (Joyce, 2000) Chapter 14.
- <sup>243</sup> "Learning how to be a committed and self-aware person is enhanced by learning to think about one's growing self and to analyze one's development and social milieu" (Joyce, 2000) Chapter 8. Should the Lancaster Institute resurface, the focus of further research will center on the stages through which the older student proceeds as the paradigm shift occurs that helps him/her realize that they have worth, and have the control and power, to reach for any opportunity that unfolds in their lives
- <sup>244</sup> When the education system grasps the significance of the connectedness and integration between body, brain, mind, as well as a related interconnectedness between individuals, is the point that a more practical and complex sense of what teaching and learning would be acquired. (figure 5.2 pg 110 Brain-based Learning Model - shows how we conceive of the different types of knowledge and meaning with which education needs to deal (Caine & Caine, 1997).
- <sup>245</sup> "Behaviorists like to arrange instruction so that success is highly probable. Self-instructional programmed materials is sequenced in such small steps as to virtually ensure correct responses, and simulations are designed to generate much successful activity as concepts and skills are being learned" (Joyce, 2000) pg 321. "The effectiveness of reinforcement programs is determined not only by establishing a close temporal relation between reinforcement and behavior and by the type of reinforcement selected, but also by the scheduling or frequency of reinforcement. One of the most difficult skills for teachers, or anyone, to master is to be consistent, immediate, and frequent in rewarding the desired responses when they occur. If a response goes un-reinforced it will become less and less frequent until it is extinguished" (Joyce, 2000) pg 322.
- <sup>246</sup> Recent years have produced a flood of information about the brain, with varying degrees of use to educators. Some information has come from neuroscientists. (Damasio, 1994),(Edelman, 1992); (Freeman, 1995) are

examples. Other contributions have come from the work of professionals in related or connected fields – Psychologists such as (Ornstein, 1991), and Biologists such as (Sylwester, 1995). Yet others such as (P. Russell, 1995) and (Cleveland, 1995) cross disciplines freely. “Education on the Edge of Possibility,” Caine & Caine explored research in the cognitive sciences and neurosciences and cross-checked it against advances in other fields, ranging from creativity and whole language to sports psychology and research on perceptual change (Caine & Caine, 1997). And the whole subject is making its way into the general media, as illustrated by the cover story in Newsweek. “Your Child’s Brian: How Kids Are wired For Music, Math, and Emotions” (Begley, 1996)

<sup>247</sup> The reductionist paradigm has fragmented the body, mind, and brain and instilled an artificial separation of people from each other. Present learning outcomes influenced by reductionism creates a distorted unclear sense of what it means to learn. The result is not teaching for meaning and complex knowledge acquisition with subsequent application, but a functioning at a much more superficial level. Caine and Caine feel that many stakeholders hold basic beliefs that are far too limited, about learning in general, and specifically, about how human beings learn. Neither brain science nor education research has been able to free the majority of America’s schools from the 19<sup>th</sup> century roots. “The existing systems of education were not designed for the 21<sup>st</sup> century, not even for the 20<sup>th</sup>. They are the creation of the 19<sup>th</sup> century industrial machine age... Their basic organizing principles are obsolete.” Force of habit rules the hallways and classrooms. Caine and Caine believe that the problems in and with education cannot be solved until these beliefs are changes (Caine & Caine, 1997). They cannot be sustained in their present form in the face of the new realities of massive societal transformations” (Banathy, 1995). Consequently, Banathy argues that second-order change is necessary; first order incremental change is insufficient.

<sup>248</sup> Figures 3&4 from Laurillard, 1999, show how absence of either the autopoietic or dissipative structure component of the student would present in a failure to learn. Figure #3 exemplifies reflection and adaptation absent so learning is nothing more than conditioning to the particular environmental conditions. Figure #4 shows the internal conversation absent, so although reflection is present its scope is restricted to the particular context. This would represent the common failure to transfer learning to alternative contexts (Laurillard, 1999).

<sup>249</sup> "One should not underestimate the function of social climate to generate reinforcement. The range of naturally occurring positive reinforces available to teachers is broad - a smile, enthusiasm, show of interest, attention, enjoyment, and casual conversation. Perhaps most powerful is a pervasively positive atmosphere, where just being in that classroom brings pleasure and confidence - an environment filled with little positive events just waiting at attach themselves to appropriate behaviors (Joyce, 2000) pg 321. "Training models using modeling and practice illustrate the basic behavioral concepts. Only a small number of skills are taught in any one lesson, so that the learner has a high probability of mastering them" (Joyce, 2000) pg 322.

<sup>250</sup> " Desensitization procedures make use of stimulus control by gradually enlarging the range of stimuli to which individuals can response without anxiety. Stress reduction models depend on people's recognizing a range of cues indicating body tension or mental stress and taking action to substitute positive for negative feelings in an increasing variety of situations (Joyce, 2000) pg 322.

<sup>251</sup> For the LIL child who had difficulty in skill or data mastery the process for learning was the following five components: 1. To have the learning objectives defined 2. To divide the objectives into small learning units 3. To tailor the instructional strategy with the learning materials for the student 4. To administer a diagnostic test to identify problems the student is having and provide feedback to the student as reinforcement 5. To implement supplementary instruction for weak areas disclosed from testing data

- <sup>252</sup> "As teachers, the task is to identify the skills necessary to use the model productively, find out which ones our students possess, and teach them the others." "Also, since people at different stages of development respond differently to various models of teaching, he (Hunt) wants to help us shape teaching strategies to match the learner's development" (Hunt, 1970b)
- <sup>253</sup> "Theoretically, the closer a teaching strategy is tailored to the learner's conceptual level, the more learning will take place" (Hunt, 1970b, pg2)
- <sup>254</sup> "A major goal of education is to help students develop the skills they need to react productively to an increasingly broad spectrum of approaches to learning " (Joyce, 2000) pg 105."The ability to respond productively to any model of teaching is more a matter of skills on the part of the learner than it is a matter of any kind of immutable characteristic" (Joyce, 2000).
- <sup>255</sup> "Throughout the process, we continuously adjust the activities to the ability levels of the students as they gradually learn the model" (Joyce, 2000).
- <sup>256</sup> "More flexible students function more effectively as the cognitive demands of the model increase, resulting in the development of greater conceptual activity and hence increased numbers of concepts learned" (Joyce, 2000).
- <sup>257</sup> "When students are first learning to engage in-group investigation we can provide more structure, taking a more active leadership role, so that students are not asked to engage in activities beyond their independent capabilities" (Joyce, 2000).
- <sup>258</sup> "Direct training of the students is much of the key to whether any cooperative learning strategy makes a difference in how students learn in cooperative learning" (Johnson and Johnson, 1999).
- <sup>259</sup> "Theoretically, the closer a teaching strategy is tailored to the learner's conceptual level, the more learning will take place" (Hunt, 1970b, pg2; (Joyce, 2000) pg 98.
- <sup>260</sup> "Optimal development occurs when the environment facilitates the "conceptual work necessary for the person's conceptual growth " (Joyce, 2000)
- <sup>261</sup> "The emphases are more with the development of effective long-term learning styles and the development of strong, well-directed individual personalities than they are with short-term instructional or content objectives" (Joyce, 2000) Chapter 16

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