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# Robert L. Bailey's Disciplined Creativity Process for Engineers Compared to the Creative Problem-solving Process

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The International Center for Studies in Creativity

**Robert L. Bailey's Disciplined Creativity Process for Engineers  
Compared to the Creative Problem Solving Process**

A Project in  
Creative Studies

By

Edward D. Pettitt

Submitted in Partial Fulfillment  
of the Requirements  
for the Degree of

Master of Science  
May 2002

## Abstract

Robert L. Bailey's disciplined creative problem solving process for engineers was reviewed and compared to the Creative Problem Solving (CPS) process. Bailey's six-step process, which consisted of *Problem Inquiry*, *Specifying Goals*, *Determining Means*, *Solution Optimization*, *Construction and Verification*, and *Convincing Others*, was taught for two decades to engineering undergraduate students at the University of Florida. By comparing the Creative Problem Solving process to Bailey's six-step process, an understanding of the applicability of CPS to creative engineering problem solving was gained. This project contains historical information related to the development, use, and teaching of the disciplined creative problem solving process to add depth of understanding. It also contains personal and biographical information from and about Mr. Bailey who was a pioneer in researching, developing, and teaching methodical creative problem solving to engineers were incorporated. Mr. Bailey's accomplishments serve as an inspiration to all, but especially to technical people, as he continues to produce creative products through a disciplined approach to creative problem solving.

Buffalo State College  
The International Center for Studies in Creativity

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I acknowledge the support that I have always received from my parents George S. and Marion D. Pettitt who have encouraged me to excel in my educational pursuits. Also I credit my father especially for the example of creativity that he displayed in solving problems and inventing new devices around our farm.

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I cannot say enough about the support, guidance, cooperation and generosity of Robert L. Bailey who gave of his time, his possessions, and his memories to help me understand the person behind the process. I have never met a more truly creative professional. He is an inspiration on many levels.

Finally, I am indebted to Dr. Mary Murdock for her guidance of my progress in the understanding and application of the science of creativity. Should I teach someday, I will have her in my vision of how I want to be as an educator.

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## Section 1: Project Introduction and Significance

### *Background*

As an engineer with over 17 years of experience in the profession, and both a Bachelor and Master of Science in Mechanical Engineering, I both realized the importance of creativity in the engineering field and that it was largely, if not totally, neglected in engineering education. Even though I innately knew that creativity was important in the work of engineering, I only recently became aware that creativity was a teachable, learnable, and applicable subject matter. I now question why creativity was not covered at any time during my engineering education. Problem solving was so intimately a part of engineering that many defined an engineer as a problem solver. Theodore von Kármán, a famous aeronautical engineer, was quoted as having said, “The scientist explores what is – the engineer creates what has never been” (Lumsdaine, Lumsdaine & Shelnut, 1999, p. 315). Also, engineers were the ones that applied the laws of science to create useful products and processes for the benefit of mankind. Creativity and innovation were largely what engineering was about. Engineering design was described as “the communication of a set of rational decisions obtained with creative problem solving for accomplishing certain stated objectives within prescribed constraints” (Lumsdaine, et. al, 1999, p. 316). Like me, many should ask why creativity was not a part of engineering education if it was such an integral part of engineering practice.

While researching material for a paper related to why inventors were creative which I was writing for my first course in Creative Problem Solving, I came across the textbook Disciplined Creativity for Engineers by Robert L. Bailey. From that book I

realized that there was a person who also believed that creativity was integral to the subject of engineering and had actually developed and taught a creative process. I felt that further exploration of Mr. Bailey's work would be beneficial to my understanding of creativity as it relates to engineering.

In addition, Mr. Bailey was unique in that he developed a creative process outside the mainstream of the creativity domain, published his work, and taught creativity to engineering students for over two decades. Anyone who has an interest in creativity and applying it to the field of engineering practice and education can learn by the experiences and work of Robert L. Bailey. In many cases, of which this is one, a depth of understanding of the process can be gained through first-hand accounts of the pioneer in the field. Such an opportunity could not be passed up.

### *Project Scope*

The general scope of this project was to link Creative Problem Solving (CPS) to engineering. In a broad sense, I wished to stand at the hedgerow between the fields of engineering and creativity and to benefit one with the other. It was within the scope of this project to study how CPS may be linked to engineering through process and teaching. This project then fell within the Creative Studies department research theme of "Developing or Improving Our Understanding of CPS." One must understand a process developed in one's domain in order to apply it to another. For certain, one will understand the process best when applying it to a different domain.

Since this project crossed the fields of engineering and creativity, the best path was to compare the well-established Creative Problem Solving Process with Mr. Bailey's

disciplined creativity process for engineers. This activity then matched the Creative Studies department initiative of "Linking CPS to Other Areas or Constructs." It was within the limits of this project to link CPS to Mr. Bailey's creative problem solving process. In addition, it was within the scope of this project to capture the history around the development of Mr. Bailey's process and to include recognition of Mr. Bailey's pioneering efforts.

### *Project Purpose*

The project purpose was formulated as part of the development of the project Concept Paper found in Appendix B (Pettitt, 2001). The basic research questions, which related to the specific purpose of this project, were:

1. How does the disciplined creativity process for engineers compare to Creative Problem Solving?
2. What factors led to the development, teaching, and publication of Disciplined Creativity for Engineers?
3. What can be learned from the experiences of Robert L. Bailey's pioneering efforts in developing and teaching a creativity process to engineers?

In addition to answering the above questions, the completion of this project served an auxiliary purpose, which was to capture Robert L. Bailey's pioneering efforts and accomplishments and make them a permanent part of the work kept at the International Center for Studies in Creativity at Buffalo State College.

### *Project Significance*

Very few universities taught creative problem solving, especially to engineers. Robert L. Bailey's book Disciplined Creativity for Engineers was novel in that it described a creative problem solving process developed especially for engineers. It was unique in that it was partially developed and written by an engineer who both practiced and taught engineering, and it was used over the course of two decades to teach a required course in creative problem solving to engineering students at a major university. Although an annotation of the book was available in the Creativity Based Information Resources (CBIR) database, it was not well known in the creativity field in general, and no known comparison to Creative Problem Solving had been made. Researching the creative problem solving process that Robert Bailey developed and taught and comparing it to the Creative Problem Solving process added insight into creative problem solving in the engineering domain.

Furthermore, this project included a biographical portion that captured the experiences, thoughts, and reasons behind Robert Bailey's development of the creative process. Capturing the "person" aspects behind the "process" added richness that gave added insight and information about the process.

Finally, one of the products of this project, the videotaped interview of Robert L. Bailey discussing his life, his work, his teaching, and his love of creativity, captured a significant piece of history for both the engineering and creativity fields. Understanding the process of creativity in engineering was important, but capturing and recognizing the work of a pioneer was necessary and the right thing to do.

## Section 2: Methodology

### *Concept Development*

I used the Creative Problem Solving (CPS) process (Vehar, Miller & Firestien, 1999) to develop the concept for this project (see Appendix A). Although I could have directly entered the Generate Ideas component to generate ideas for project topics, I decided to enter the Explore the Challenge component and begin at the stage Identify Goal, Wish, or Challenge. A thorough review of my goals and selection of those most important to me helped to ensure that my final project selection would have significance and meaning to me. With the effort, expense, and sacrifice it takes to complete a Master's thesis or project, I did not want my project to be just something I did because it was a requirement to graduate. I wanted my project to be meaningful to me and to be an integral part of attaining my goals and vision. I exited the Explore the Challenge component with the challenge statement "What might be all the great theses topics?" The real value to this problem statement was the understanding of my goals and the state of my current situation that was behind it.

I generated sixty-two ideas relative to project or thesis topics by using personal Brainstorming and compressed them to six topics using the converging tool Highlighting (Vehar et al., 1999, p. 39). I entered the stage Select and Strengthen Solutions with these six options. I generated criteria to be used for the evaluation of the various options and then selected and prioritized the criteria to allow for a comparison of the options. By using an evaluation matrix and Paired Comparison Analysis I further converged to the point of having two options that I felt would be meaningful to me. To analyze these two options I used the affirmative judgment tool PPCo (Vehar, et al., 1999, p. 40).

In the final decision of which topic to choose as my project, one statement that I made in the PPCo analyses was critical. It was "If I don't do it, it will not get done," which referred to the option of recording the pioneering work of R.L. Bailey. Once I met Mr. Bailey and recognized the potential for unrealized opportunities to the creativity community if his work was not recorded in the International Center for Studies of Creativity, I knew that was the project I was meant to do. This realization was like the illumination described in Graham Wallas' model of creativity (Isaksen, et al., 1994, p. 21). Working through the CPS process was an intense preparation such that with some incubation the "right thing to do" came to me as an illumination. Finally, my concept paper was then written as the output of the Prepare for Action component of the CPS process (Pettitt, 2001).

In summary, the application of the CPS process to the development of my project concept was crucial for ensuring alignment of the chosen concept to my own goals and vision. This helped to ensure that the project would be meaningful throughout its completion and thereafter. Never have I felt dread, disenchantment, or lack of enthusiasm toward working on this project because of the intense preparation that ensured its importance in my life.

### ***Project Design***

Once the topic of "recording the pioneering efforts of Robert L. Bailey" was chosen, the project had to be designed such that it met the needs of the International Center for Studies in Creativity and would be a worthwhile addition to the field of creativity. This effort was really an exercise within the Select and Strengthen Solutions

stage of CPS (Vehar, et al., 1999). The project had to be designed (strengthened) to meet the criteria related to usefulness for the International Center for Studies of Creativity.

Since Robert Bailey made a significant contribution to the field of creativity through the development, publication, and teaching of a creative process, I felt that the project could be made to fit best within the theme "Developing or Improving Our Understanding of CPS." I met this objective by comparing Bailey's (1978) process to CPS. In addition, since Bailey's (1978) process was developed within and for the domain of engineering, a comparison of CPS to the disciplined process for engineers naturally fell within the initiative "Linking CPS to Other Areas or Constructs." Finally, to keep the project focused and on target to meeting the goal of usefulness for the Center and for myself, the basic questions that I would answer had to be formed. As stated previously, the research questions were:

1. How does the disciplined creativity process for engineers compare to Creative Problem Solving?
2. What factors led to the development, teaching, and publication of Disciplined Creativity for Engineers?
3. What can be learned from the experiences of Robert L. Bailey's pioneering efforts in developing and teaching a creativity process for engineers?

Answering these questions in a documented form would fulfill the original chosen topic of "recording the pioneering work of Robert L. Bailey" in a manner consistent with the needs of the Center and the field of creativity.

### *Information Collection*

To answer the aforementioned questions, I needed to collect information relative to the Creative Problem Solving process (Isaksen et al., 1994) and Bailey's (1978) disciplined creativity process for engineers. For the direct comparison of the problem solving models, I collected this information by reviewing Creative Approaches to Problem Solving (Isaksen et al., 1994) and Disciplined Creativity for Engineers (Bailey, 1978).

To learn about the factors behind the development of the process and about Robert Bailey's experiences, I talked with Mr. Bailey and recorded almost six hours of his recollections of a lifetime devoted to creativity. The videotaped interview took place in Mr. Bailey's home in which I was a guest in Gainesville, Florida. I videotaped Mr. Bailey as he recollected his experiences and demonstrated several of his creative products. I made copies of many of Bob Bailey's papers related to his work in the field of creativity. Additionally, I accepted many gifts of Mr. Bailey's papers, books, and artifacts to help me understand more about his accomplishments and experiences. Although I technically collected much information captured on videotape and paper I learned much about Mr. Bailey by just being a guest in his home for three days. The project would not have been quite the same without the "information" I collected from that experience.

### *Analysis of the Information*

I reviewed the creative problem solving processes described in Creative Approaches to Problem Solving (Isaksen et al., 1994) and Disciplined Creativity for



Engineers (Bailey, 1978). I first analyzed the information to determine how the processes were developed. This involved understanding the history behind the processes and how they were developed. For the CPS process, the development history was taken as described by Isaksen et al. (1994). For the disciplined creativity process for engineers, I determined the history partly from interviews with Mr. Bailey and from reading Professional Creativity by Von Fange (1959).

The structures and operations of the creativity processes were analyzed using the models of structural and operational analysis described by Upton and Sampson (1961). This required first researching the work of Upton & Sampson (1961) and then applying it to the analysis of the creativity processes. These comparisons answered the first research question.

Furthermore, to answer the remaining two research questions, I watched the videotaped interview several times and took notes (see Appendix F). In addition, I reviewed the artifacts collected from Mr. Bailey, some of which are included in the Appendix to this report to glean further information. Finally, I accessed my own feelings and thoughts concerning Bailey since the opportunity to meet him and have him personally guide me through his home, workshop, study, and life's work was invaluable.

### Section 3: Synopsis of Bailey's Disciplined Creativity for Engineers

In his 1978 textbook, Disciplined Creativity for Engineers, Robert L. Bailey explained the disciplined creative problem solving process for engineers. Although the textbook represented the culmination of the development of the creative process, its roots most clearly began when Mr. Bailey received creativity training at General Electric (GE) in 1950. At General Electric, the creative process began with four steps, which were *Investigate Direction, Goal Setting, Determine Means, and Build and Test Solution*. Eventually, the process developed to the point of having six steps (videotaped interview, May 27, 2001, 0:12.50 - 0:24.23). Mr. Bailey developed the process further through practice, research, and teaching it to engineering students for over two decades at the University of Florida in Gainesville. In addition to the General Electric training, Mr. Bailey researched and compared problem solving and creativity models in other areas such as "research, discovery, invention, design, manufacture, and management" to determine commonality in order to develop a practical approach (Bailey, 1978, p. 67). As a result of finding that the students needed specific guidance, he made significant improvements by adding depth and detail to the steps of the process (videotaped interview, May 27, 2001, 0:47.00).

In addition to specific detail, Mr. Bailey added the dimension of discipline to the process especially through its name. Bailey (1978) explained the title as follows:

The title choice, "DISCIPLINED CREATIVITY for engineers," should be defended, especially in light of the view held by many that the creative process is chaotic and unstructured. We now know enough about the creative process to see

that some *order* does exist and that tentative steps can be taken toward 'hardening' this area for repetitive applicational use. Finding this order and disciplining ourselves to use it appears more apt to enable engineers to deal with *new* future problems than if we take the wholly unrestrained chaotic view. We basically are orderly thinkers and can proceed best when some loose orderly thought structure is manifest (p. xii).

As the title suggested, the process was structured and ordered and was meant to produce creatively engineered results through its disciplined application. Mr. Bailey's process then was meant to organize the process of creativity so that new ideas, products, and solutions could be systematically created. The process was meant to eliminate the need or belief that new solutions are the result of random variables but rather could be developed at will.

### *Process Overview*

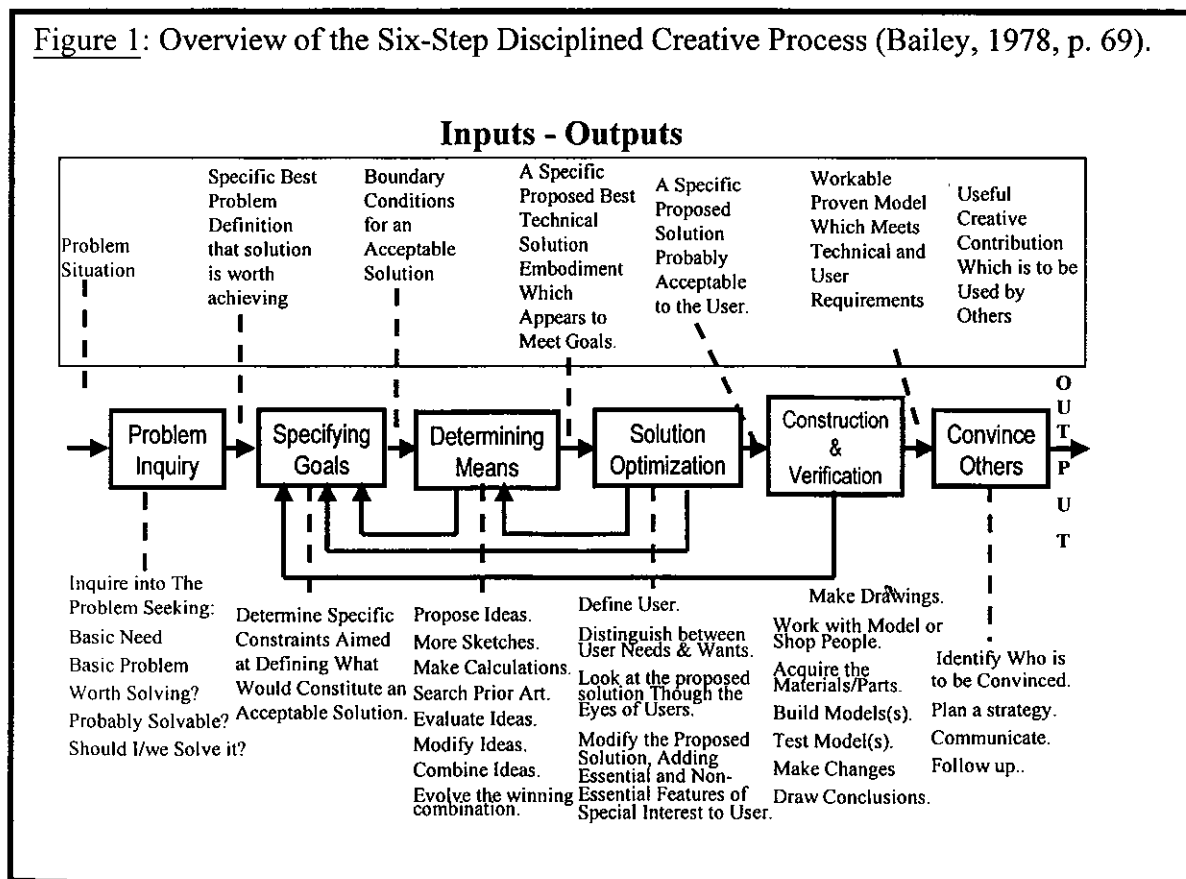
Bailey's disciplined creative problem solving process for engineers consisted of six well-defined steps:

1. Problem Inquiry
2. Specifying Goals
3. Determining Means
4. Solution Optimization
5. Construction & Verification
6. Convincing Others

The process generally began at the onset of a problem situation requiring creative solution. The first step of Problem Inquiry was to determine the "basic need" to satisfy

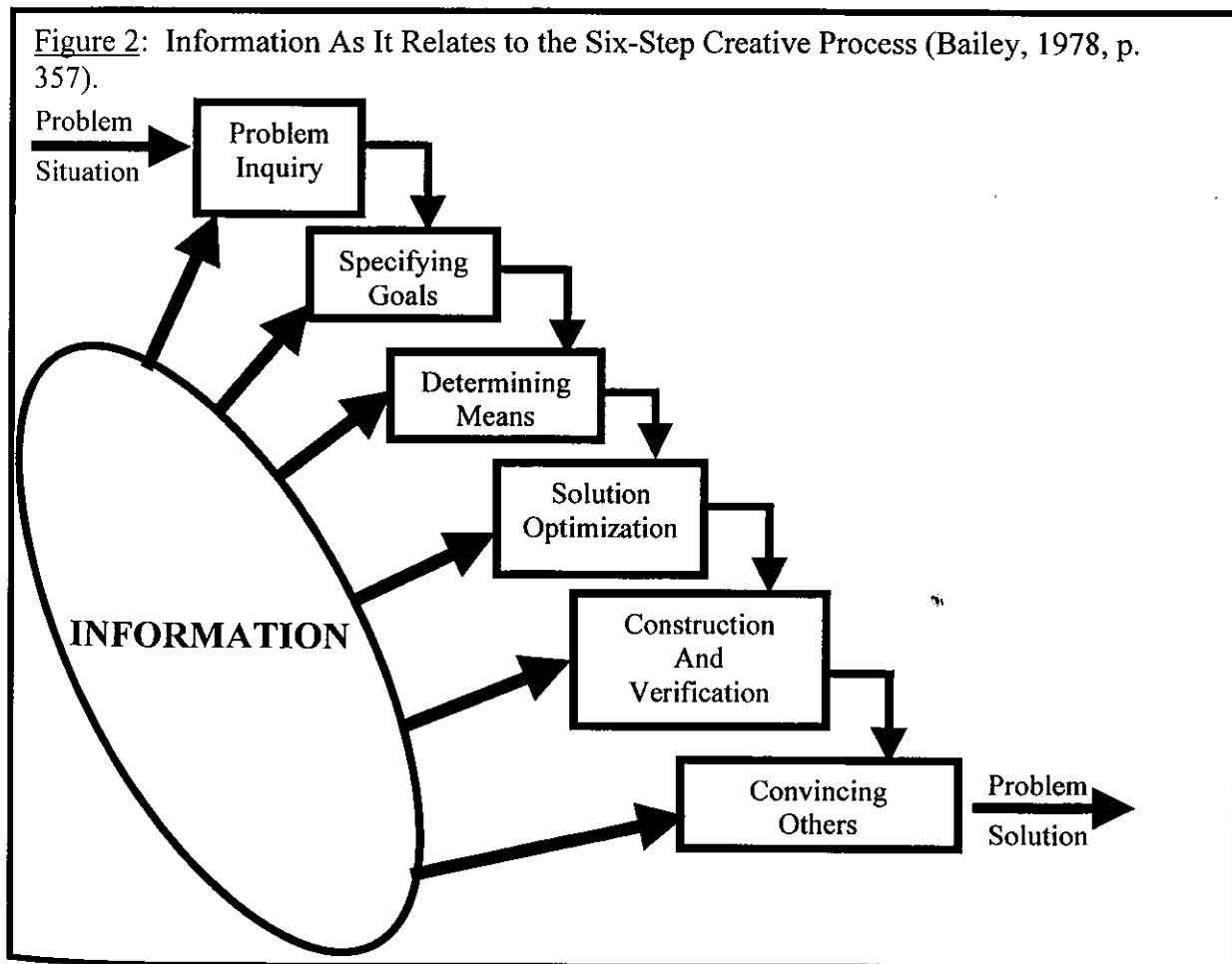
or what the “true problem appears to be when extracted from the complex situation” (Bailey, 1978, p. 80). Then specific requirements for the solution were determined and stipulated in the Specifying Goals step. Ideas and options for solving the problem were then generated with the best “means to a solution of the problem” being defined in the Determining Means stage (Bailey, 1978, p. 159). The best means was then optimized from the users point of view in Solution Optimization (Bailey, 1978, p. 206). This proposed solution was then constructed as a prototype or scaled model and tested to verify its applicability to solving the problem in the Construction and Verification stage. Finally, the Convincing Others step helped others to accept and use the new creatively engineered solution. The following figure (Figure 1) is useful as a brief overview of the process and the purpose of each step.

Figure 1: Overview of the Six-Step Disciplined Creative Process (Bailey, 1978, p. 69).



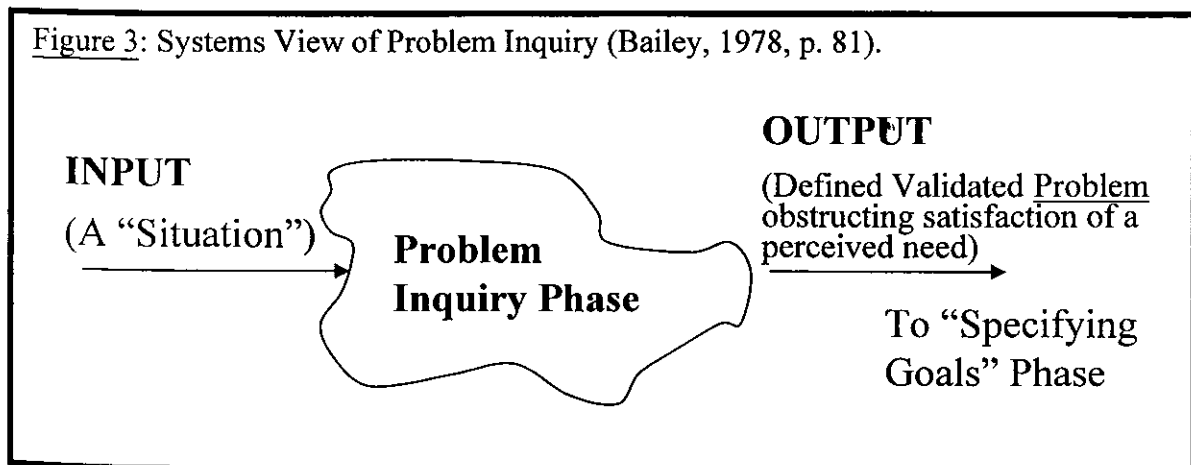
As shown in Figure 1, the process was not strictly linear. There were options for retreating back to previous steps based on new information or the need to repeat a step to achieve a successful result. The model shown in Figure 1 was meant to be a brief overview of the process. In the sections to follow each step will be explained in further detail.

Information fed each step of the process but was not handled as a specific step within the process. In creative problem solving for engineers information was defined as “intelligence, facts, data, or knowledge, particularly as these relate to the problem and its solution being created” (Bailey, 1978, p. 355). Figure 2 is a model of how information related to the six-step disciplined creativity process.



### *Problem Inquiry*

The Problem Inquiry phase consisted of actions to understand the problem at hand. It began when a situation arose that required a problem to be solved. Engineers were highly trained in solving problems that were generally well defined with simplifications and boundary conditions such that fairly simple textbook solutions applied. However, problems requiring creative solutions were generally not simple. These problems were often vague, in a complex situation, conflicting, not well defined, or crossed disciplines or fields (Bailey, 1978, p. 78). The Problem Inquiry step guided the problem solver through the situation towards a well-defined statement of the problem to be solved. In light of the vast commitment of time, resources, energy, or opportunity costs that were involved in solving complex problems, the problem solver must ask, "Can I possibly justify not being sure I am working on the right problem by not executing a thorough examination of all plausible definitions of the problem?" (Bailey, 1978, p. 79) One must have determined the best definition of the problem in this initial phase. Bailey (1978) stated that the purpose of the Problem Inquiry step was "to determine and validate the best problem definition for the given initial situation" (p. 80). A simple systems view of the Problem Inquiry phase is shown in Figure 3.



In the Problem Inquiry phase of the problem solving process, the focus was totally on the situation and the problem to be defined. Some questions that should be asked during this step are (Bailey, 1978, p. 85):

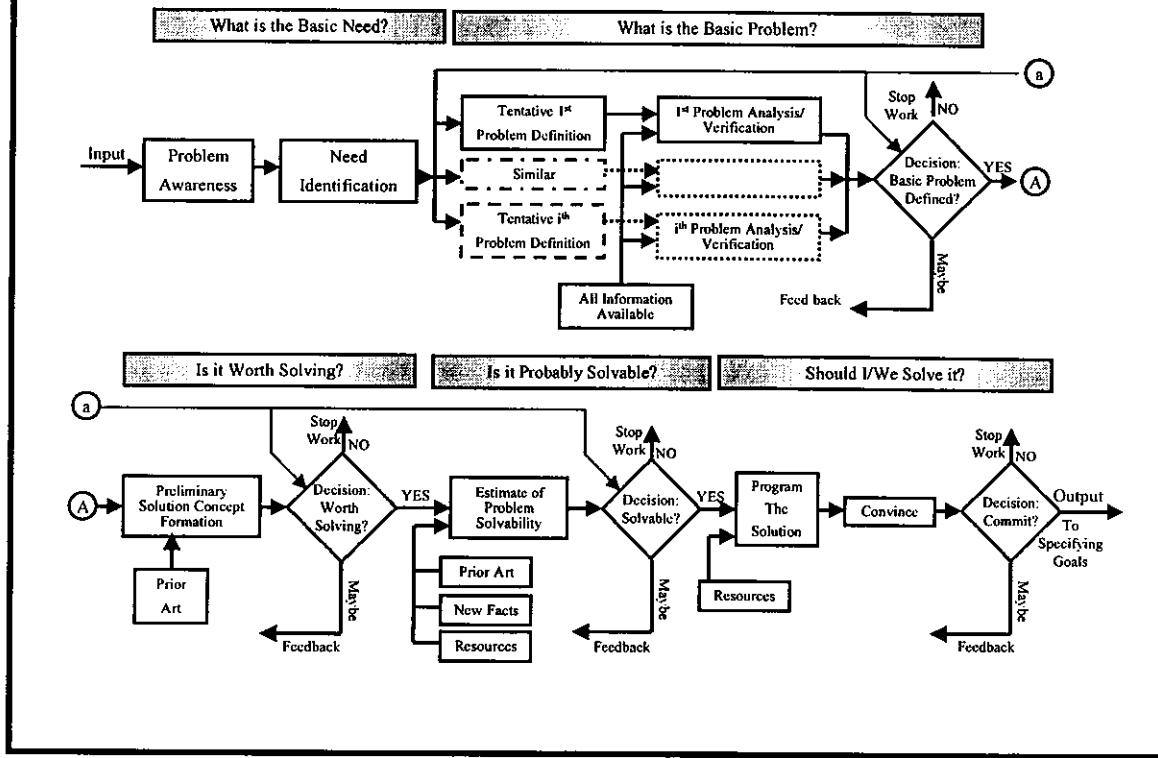
- What is the basic need?
- What is the basic problem?
- Is the problem worth solving?
- Is it probably solvable?
- Should I / we solve it?

The Problem Inquiry phase consisted of a number of sub-steps that were basically organized to answer the above stated questions. Within Problem Inquiry the sub-steps were:

- Problem Awareness
- Need Identification/ Verification
- Tentative Problem Definition
- Problem Analysis/ Verification
- Decision: Basic Problem Defined?
- Preliminary Solution Concept Formation
- Decision: Worth Solving?
- Estimate of Problem Solvability
- Decision: Solvable?
- Program the Solution
- Convince
- Decision: Commit?

These steps were organized to show a detailed Problem Inquiry process as shown in Figure 4.

Figure 4: Morphological Model Guide for Problem Inquiry (Bailey, 1978, p. 86-87).



Problem Awareness was the start of the creative thought process and was where the problem solver became immersed in the situation and became aware of the significant problems. It was at this point that a problem solver or engineer might have exhibited "constructive discontent" which occurred when dissatisfaction with the current situation motivated the engineer to action in a constructive way to deal with the situation (Bailey, 1978, p. 88).

In Need Identification/Verification the engineer sought to determine the true need posed by the situation. Bailey (1978) warned that in this step "it is very easy for the problem solver to slip into fuzzy, unstructured thinking at this point and confuse 'the need' with 'the problem definition' or 'the solution' or other factors" (p. 91). By



understanding the true need, the problem solver opened up the number of possible creative solutions for bettering the situation. A written statement of the true need posed by the situation then completed this step.

After the need was identified, Tentative Problem Definitions were proposed. In this stage the engineer considered many problem statements that when solved would fulfill the basic need. Bailey (1978) identified this step as one that required hard work;

It usually requires hard creative thinking to strip off non-essentials, to generalize the problem in its full scope--itself an act of divergent thinking--, to work my imagination to the point where I can identify the desired step-function change by the tentative problem definition, and finally experience beauty and a sense of loneliness by glimpsing the possibilities latent in a truly new definition of the problem--a definition perhaps not perceived by those preceding me (p. 93).

Each of the definitions was then analyzed in the Problem Analysis/Verification step. It was important that the problem statements were worded such that they were "not worded in terms of an implied solution. Thus our creative abilities can be given full range in the later major step, determining means" (Bailey, 1978, p. 99).

At this point, a Decision on Defining Problem occurred in the Problem Inquiry sub-process. To have successfully exited this step, a well-defined problem statement must have been chosen from the many that were developed and considered.

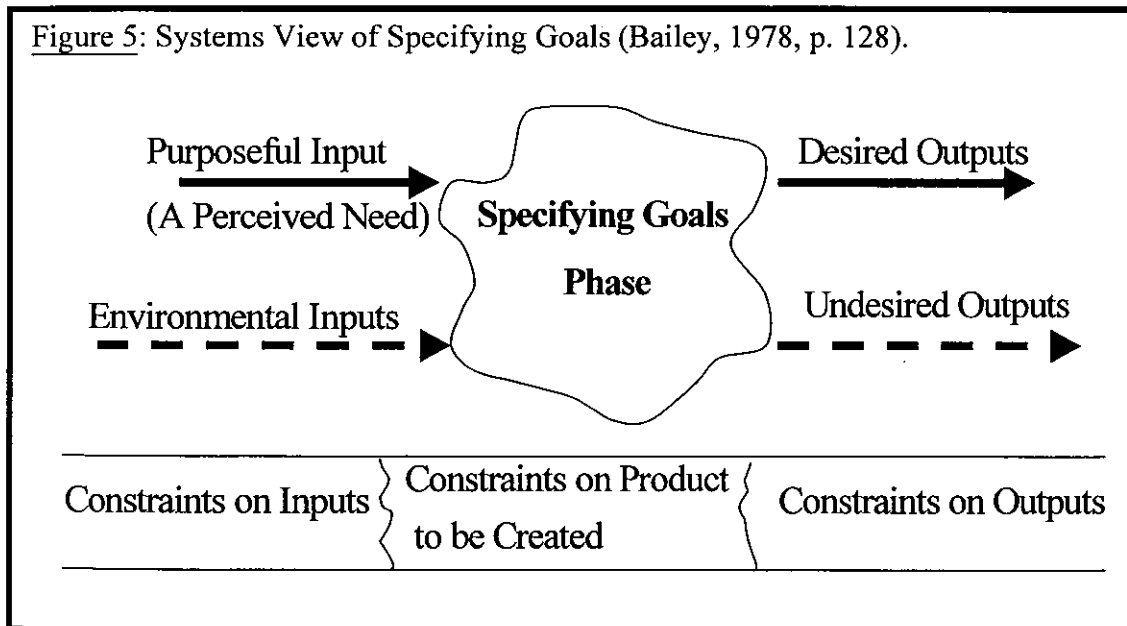
Now the process turned to determining if the problem was worth solving. To begin this, the Preliminary Solution Concept Formation step identified what might be created to determine if there were any chance of developing a worthwhile contribution should the process continue. One might have imagined what the ideal solution might be

or look like. Once a reasonably clear vision statement of what the solution might be was written, the problem solver proceeded to the next step, Decision on Worth Solving. If the problem statement was decided to be worth solving, an Estimate of Problem Solvability was performed. The step was especially critical for determining if critical resources should be devoted to solving the problem. One may have estimated the people, money, materials, facilities, and experience that may be needed to solve the problem (Bailey, 1978, p. 108). One may have looked into relevant prior art, performed rough order of magnitude calculations, or at least verified that no laws of physics were violated. At this point, the process entered another decision step, the Decision on Solvability. If the Decision was yes, that the problem was probably solvable, then the next step was to Program the Solution. This was the first part of answering the question, "Should I/we solve it?" Basically, in this portion of Problem Inquiry the focus was on determining if there was commitment to solve the problem or to develop the commitment. An action plan was put together which would show the number of people, cost, resources needed, and some estimate of timing. Also, in the Program the Solution step, "it is wise to think deliberately about the timing of the proposed creation by asking, 'Is this the right century/decade/year for a solution to be created?' " (Bailey, 1978, p. 113). At this point, the problem solver entered the Convince step and worked to sell the need to solve the problem and that it was worth solving based on time and resources it would take to solve it. Once the right people were convinced to support solving the problem, the Problem Inquiry stage could be exited with the decision to commit the resources and time, and thus the problem solver could move to the next major step in the six-step process, "Specifying Goals."

### *Specifying Goals*

The Specifying Goals phase had the purpose of defining the goals, constraints, or limits of acceptability for solving the problem (Bailey, 1978, p. 126). It defined what a proposal must do or have, at a minimum, in order to be considered a viable solution. In this phase, one might also have defined what features or parameters in a proposal would disqualify it from being a viable or acceptable solution. One entered the Specifying Goals phase after having defined the problem clearly in the Problem Inquiry phase. Below is a graphic representation of Specifying Goals.

Figure 5: Systems View of Specifying Goals (Bailey, 1978, p. 128).



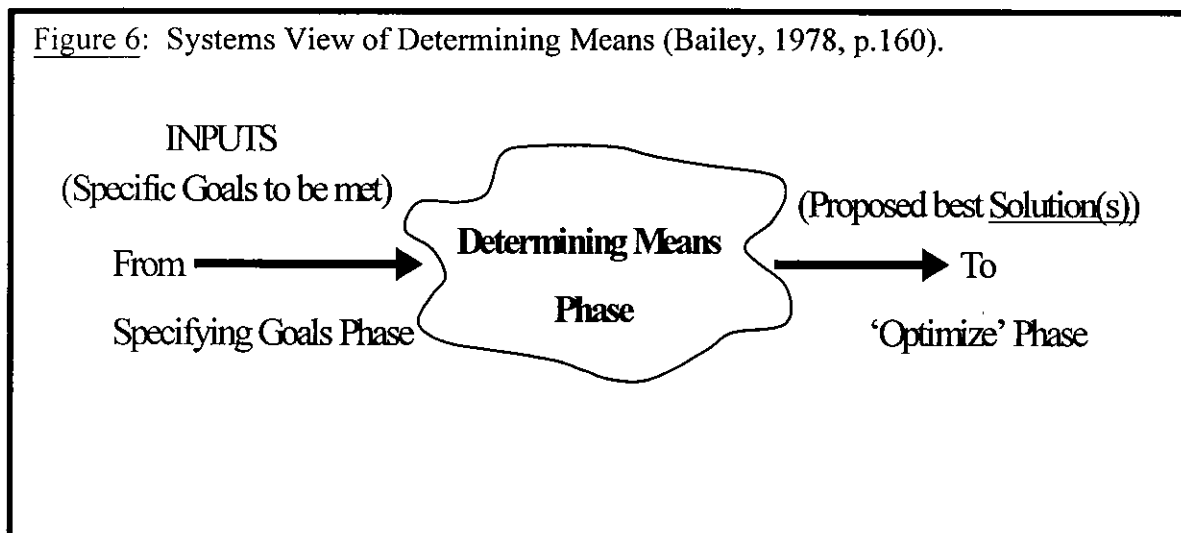
Bailey (1978) defined a specified goal as, "The specific detailed statement defining the aim, purpose, end result, or constraint which the problem solver believes the

created problem solution must meet” (p. 130). There were two classes of goals that existed. A *primary goal* was one that the solution must meet or achieve in order to be considered successful. A *secondary goal* was lesser in importance, and if not met, did not mean the solution would not be usable. In engineering especially, these goals were further classified as *idealistic* or *realistic*. Idealistic goals or specifications were those that were the absolute upper limit of achievability under idealistic conditions, whereas realistic goals were more modest as they factored in known inefficiencies and experience. Idealistic goals were generally not achievable but stretched the solution, whereas realistic goals were more likely achievable but ran the risk of preventing the solution from being developed to its full capability.

In this phase it was important that the goals were written clearly and specifically, and in many cases this would become an engineering specifications or requirements document. The written goals should have described what the creation was to do and how many were to be generated. Wherever possible, attributes of the creation should have been specified in defined measurable numerical goals. This minimized the subjectivity in assessing the completeness or success of the creation. Verification tests or performance tests that could be used to verify that the solution was acceptable may have been included in the goals document. Goals or specifications relative to physical characteristics of the solution like size, dimensions, color, etc. should have been considered. Once the problem solver felt that satisfactory inclusion of all pertinent goals had taken place, the Specifying Goals phase was completed. As a result of completing Problem Inquiry and Specifying Goals, a clear definition of the problem was gained, thus the process moved to “Determining Means.”

### *Determining Means*

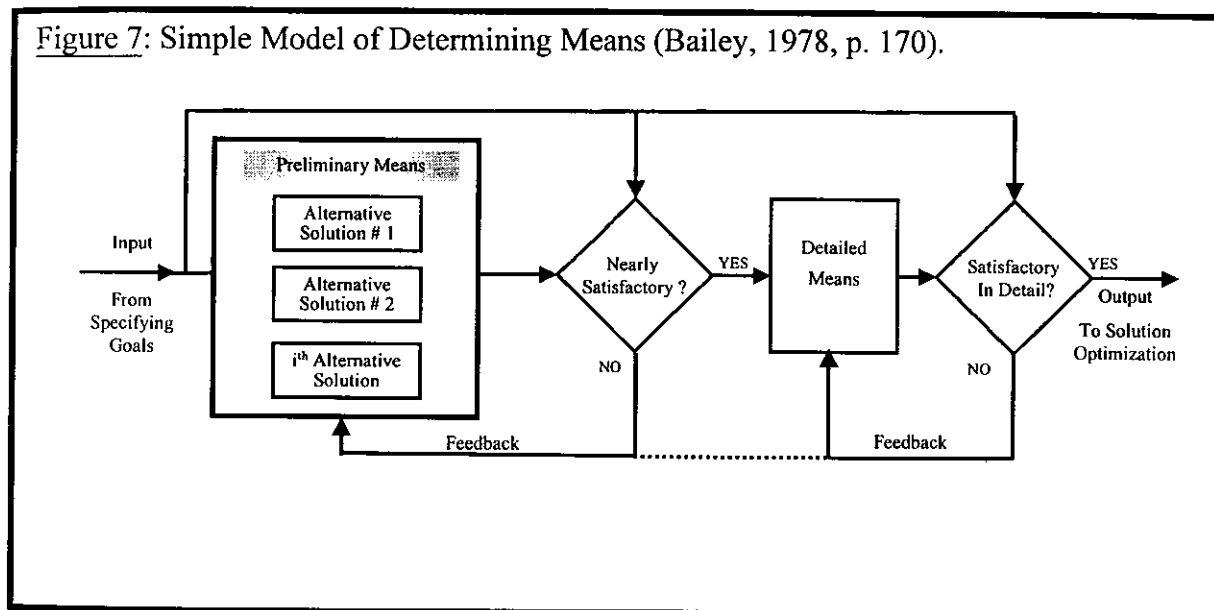
The Determining Means phase was where a proposed solution or solutions were identified for solving the problem. “It is here that we are to focus on the apparent best way of solving the problem, particularly in a new or unique fashion” (Bailey, 1978, p. 159). The purpose of the Determining Means stage was “to define to the satisfaction of the problem solver the tentatively best ‘means’ to a solution of the problem being solved” (Bailey, 1978, p. 159). A simple systems view of the Determining Means phase is shown in Figure 6.



The input to this stage was a set of specific goals or requirements. Bailey (1978) asserted, “Without the goals no solution output would be forthcoming. It is generally essential in a mature creative problem solving approach to have goals clearly identified before expending the problem solver’s precious resources to create a new solution” (p. 159).

The output of this stage was a proposed best solution. It could have been in the form of a sketch, drawing, or schematic. The proposal at this point is not the complete developed solution but the best option that appeared to satisfy the goals. It was the idea that appeared to be worth developing further in Solution Optimization.

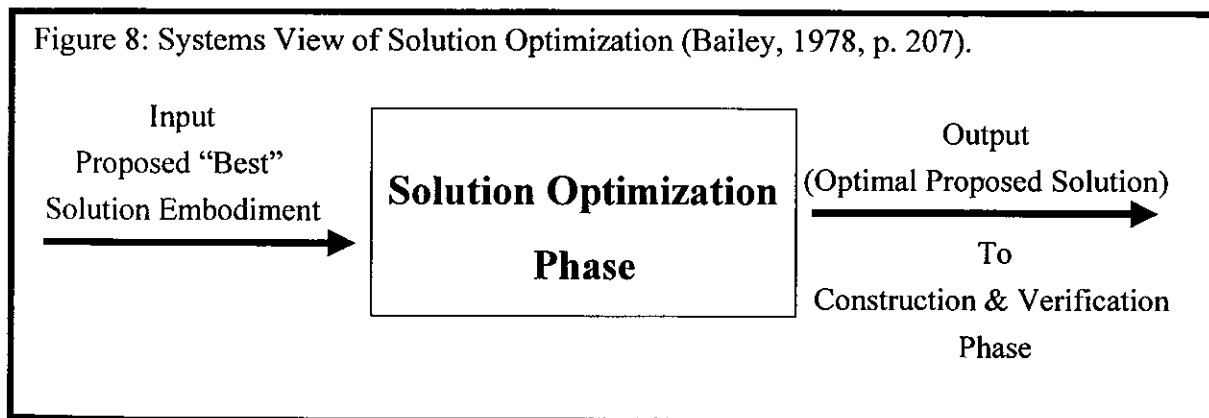
Within the Determining Means phase, the process related to the identification or development of various alternative solutions and then the selection and detailing of the best proposal. Figure 7 displays the process within Determining Means.



In Figure 7, it is worth noting that the goals from the previous step were used in the decision steps for choosing the preliminary options and for deciding when appropriate and sufficient detail had been added to the proposed best means. When sufficient detail was achieved and the proposed best solution was symbolically represented in a sketch, schematic, or some paper form, the problem solver moved on to the Solution Optimization phase.

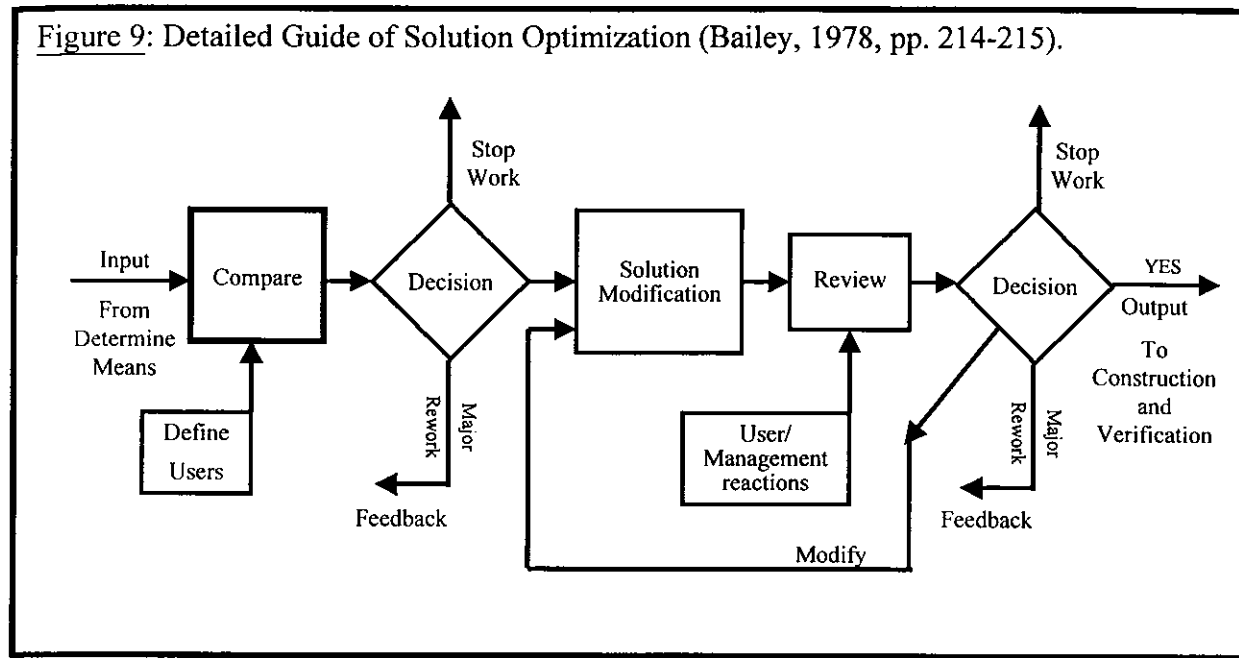
### *Solution Optimization*

The purpose of the Solution Optimization phase was “to optimize the proposed solution embodiment from the user(s) viewpoint” (Bailey, 1978, p. 206). In this phase, the proposed best means from the Determining Means phase was considered from the users’ point of view to determine and account for any design deficiencies that could then be corrected. Detailed drawings or sketches were made that had incorporated changes based on a thorough consideration of the users’ needs and requirements. These drawings were then the output used for the construction of a model in the Construction and Verification phase. A first order graphic of the Solution Optimization process is shown in Figure 8.



It was important to note that the output of Solution Optimization was basically the same solution as proposed in the output of Determining Means. However, the solution had been modified to incorporate details and further information based on a careful consideration of how it affected the end user.

A more detailed flowchart of the Solution Optimization step is shown in Figure 9.



Referring to Figure 9, the problem solver began by defining who the users and what their characteristics were. The problem solver should then have compared the proposed solution with the users' characteristics and looked for weaknesses in the proposed solution. The comparison may have focused on such things as appearance, features, cost, and safety (Bailey, 1978, p. 219). A list of specific weaknesses should have resulted from the comparison. Next, a decision step occurred where the problem solver determined whether to proceed based on incorporating modifications to the design to overcome the identified weakness, or if the weaknesses were significant, whether to revert to an earlier stage in the process and try again or to just stop. In the case for proceeding, the solution was modified to overcome its initial weakness and then a review was held. In the review, inputs from users or their representatives as well as management was sought. Bailey (1978) stated, "since construction of the proposed solution may occur



in the next phase, management may want to be a party to deciding if the proposed solution should be constructed” (p. 223). At this point, another decision step was entered which if successful ended with an optimized solution going into the Construction and Verification phase.

### *Construction and Verification*

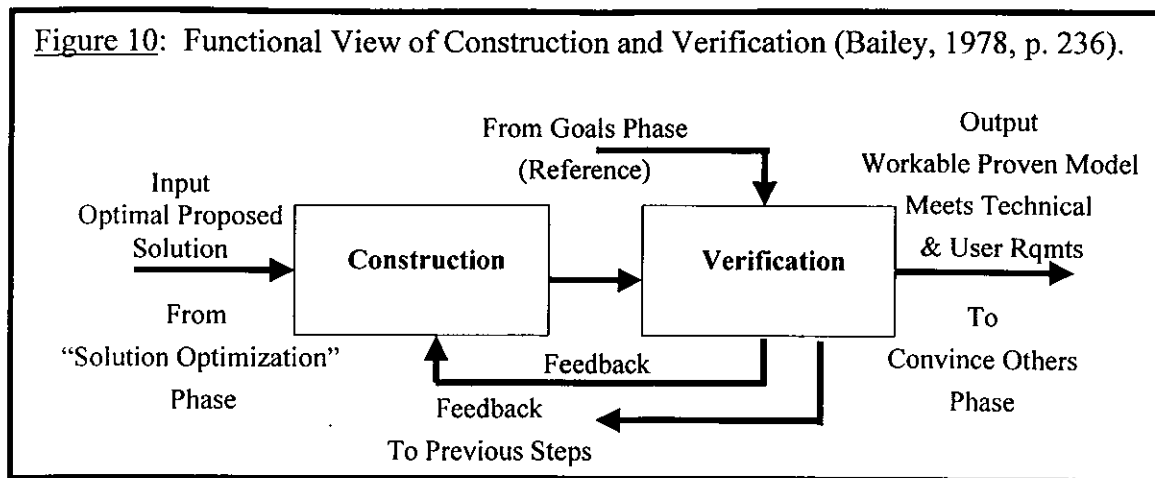
Up until this point in the disciplined creative engineering process, the solution had been in paper or symbolic form. It may have largely been based on theory and had likely been checked against theory especially in Problem Inquiry and Determining Means. This phase, however, determined if the solution would work in practice. The purpose of the Construction and Verification phase was to:

- Physically create the proposed new solution embodiment
- Demonstrate its reduction into practice
- Use it as a vehicle for acquiring factual information (Bailey, 1978, p. 234).

In Construction and Verification, one should have developed a physical model (Construction), and tested it to determine if it met the specified goals (Verification).

Figure 10 is a graphical representation of this phase.

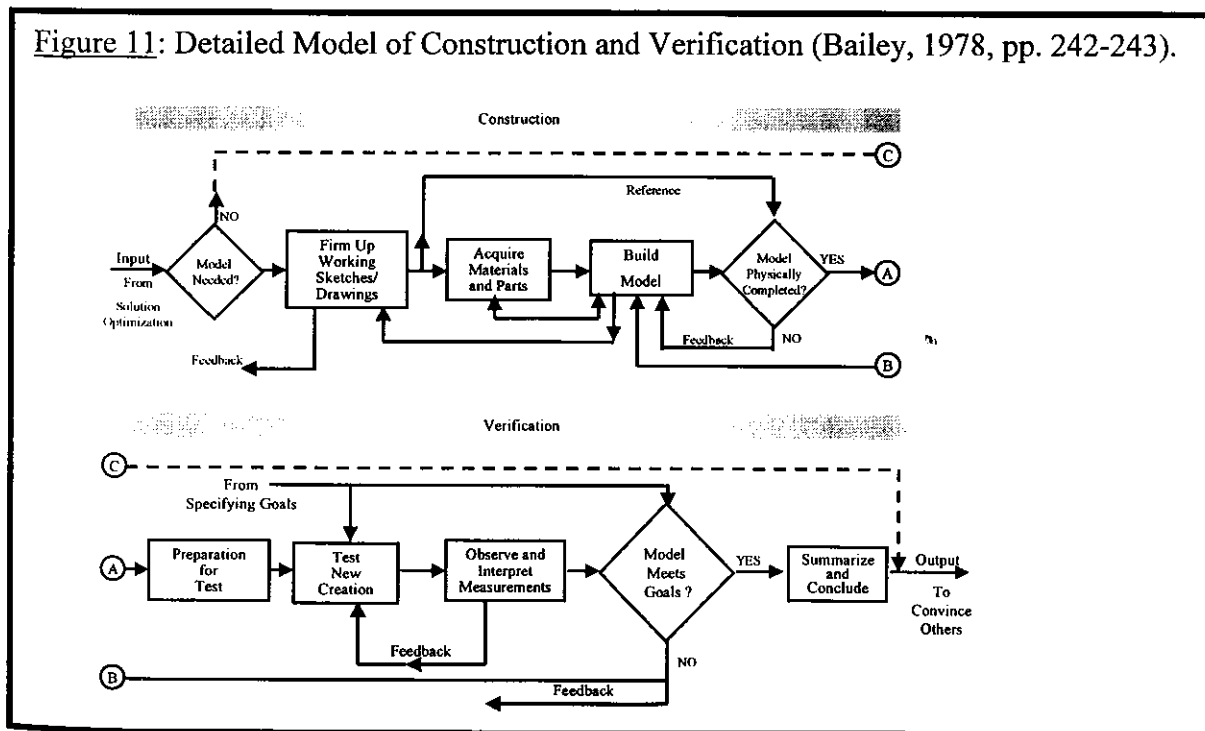
Figure 10: Functional View of Construction and Verification (Bailey, 1978, p. 236).



During testing of the physical model much was learned about the solution such that it was common to use the test information as feedback to the construction step or to earlier phases of the six-step process. Bailey (1978) stated, "Thus 'Construction' and 'Verification' are intimately linked, and we may iterate this loop many times for a complex major new engineering creation" (p. 237).

Figure 11 represents a more detailed view of the Construction and Verification portion of the process.

Figure 11: Detailed Model of Construction and Verification (Bailey, 1978, pp. 242-243).



The first step within the Construction and Verification phase was to decide whether or not a physical model was needed. Many reasons existed for creating a physical model such as demonstrating its use to others, uncovering technical issues or problems in practice, checking for mistakes, checking for unwanted side effects, acquiring experience in building the product, reducing the idea to practice for patent submission, and testing for unanticipated user uses and abuses (Bailey, 1978, p. 233). If a physical model was not required, then the problem solver could proceed to the Convincing Others phase. Otherwise, the next step was to firm up the working sketches or drawings. The sketches or drawings may have needed modification based on the type of physical model needed. Bailey (1978) identified several types or categories of physical models:

- Proof of Principle Model: Elementary model to show proof of principle;
- Scale Model: A dimensionally larger or smaller model used for visualization or testing;
- Experimental Model: A functioning representation of the proposed solution; and
- Prototype Model: A full-scale working model in its most complete form (p. 244).

The Proof of Principle model would generally be the lowest in cost and complexity while the Prototype model would be the most complex and costly to produce.

The problem solver would then proceed through the steps of acquiring parts and components for the model and then building or having the model built. In practice these activities could be difficult and time consuming. Once it was determined that the

physical model was complete, final preparations for verification testing could be done such as finalizing the test plan and obtaining or scheduling test equipment and resources. The verification testing was then accomplished and the results were analyzed and interpreted. At this point a decision must be made as to whether the model performed as required. If so, the problem solver could then proceed to the Convincing Others step in the six-step process.

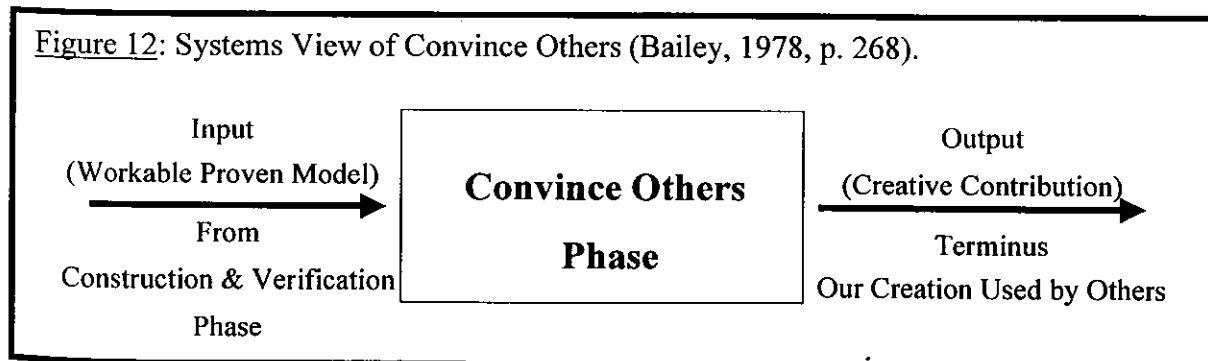
### *Convincing Others*

Once the solution was proven to satisfy the original requirements, the problem solver needed to consider how to get the solution into use so that its benefits were realized. It was not enough to just have identified the need and have created and verified the solution. The problem solver must have convinced others to adopt the solution.

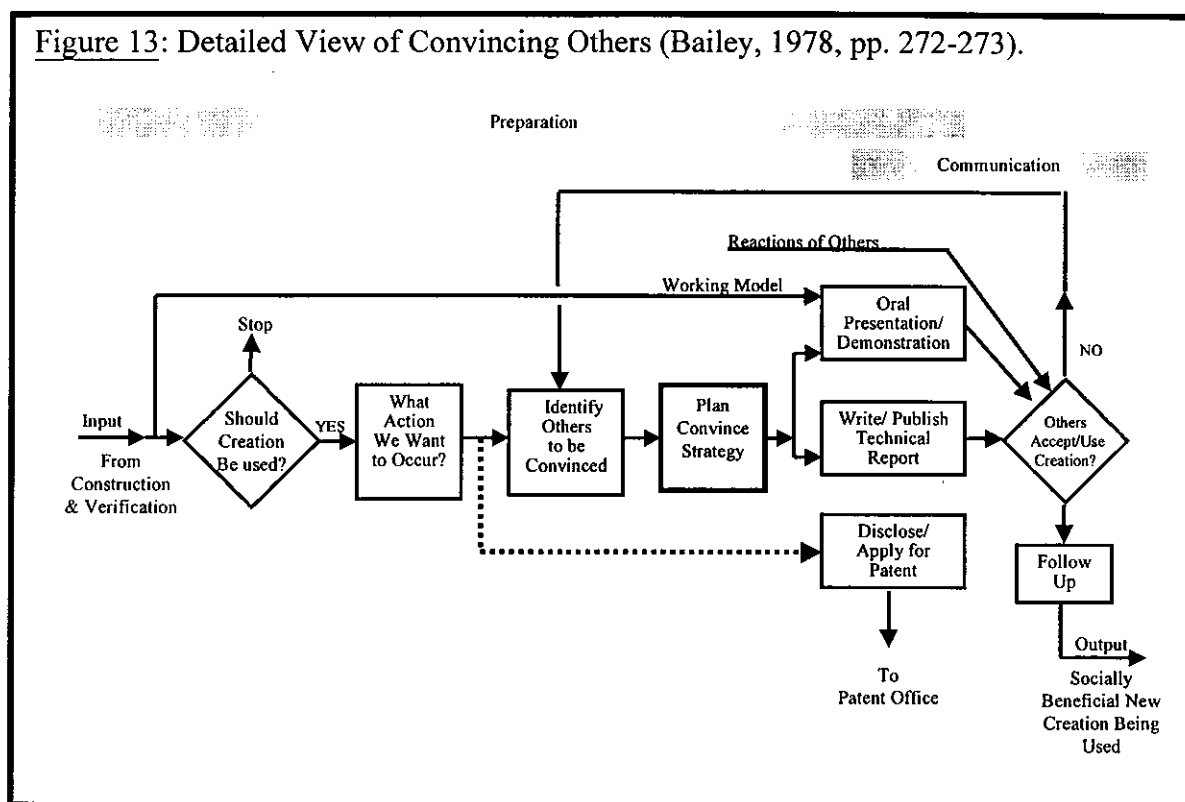
Bailey (1978) stated,

Most experienced engineers, inventors, managers, and other creative people know it is not enough to successfully build and test a new apparatus and stop. To stop, assuming it will automatically get transferred to wide scale implementation by some complex process unknown or little understood by us, is to commit a serious judgment error (p. 265).

The purpose of the Convincing Others phase was then to “get others to accept, act on, and use our new creation” (Bailey, 1978, p. 266). This step is shown in Figure 12.



The Convincing Others phase of Disciplined Creativity basically consisted of preparation and communication. In preparation, the problem solver would get ready to effectively communicate his new creation to others. In communication, the problem solver disclosed the solution to others for consideration of acceptance and use (Bailey, 1978, p. 271). Following is a detailed diagram showing the steps involved in the Convincing Others phase.



Referring to Figure 12, the first step within Convincing Others<sup>3</sup> was to decide if the creation was to be used. If the answer was yes, the next step became determining what actions needed to occur. In this step the problem solver determined how the creation was to be used by the end users. This was not a trivial step because sometimes there could be more uses for a creative product than what was originally intended. At

this point perhaps intellectual property protection was sought. In addition, the problem solver must have determined who needed to be convinced or sold on the creation or product. Many people might need to be convinced from the problem solver's manager to the ultimate end user. Next the task of preparing a strategy for convincing others was accomplished. This could have included presentations, publications, or demonstrations to those whose support was needed to put the new creation in use. The problem solver then would hope to get a definite affirmative decision such that the six-step creative engineering process was exited successfully with a new creation, invention, or product that was beneficial to the end user.

## Section 4: Synopsis of the Creative Problem Solving Process

There are several versions of the Creative Problem Solving (CPS) process, the roots of which began with Alex Osborn's book Applied Imagination written in 1953. Alex Osborn developed his thoughts on creative process as an executive in the advertising field. Osborn's first process consisted of seven steps (Isaksen, Dorval & Treffinger, 1994, p. 53):

1. Orientation: Pointing up the problem;
2. Preparation: Gathering pertinent data;
3. Analysis: Breaking down the relevant material;
4. Hypothesis: Piling up alternatives by way of ideas;
5. Incubation: Letting up to invite illumination;
6. Synthesis: Putting the pieces together; and
7. Verification: Judging the resultant ideas.

Through further research and consideration, Osborn consolidated his Creative Problem Solving process in 1963 to consist of three steps (Isaksen, Dorval & Treffinger, 1994, p. 53):

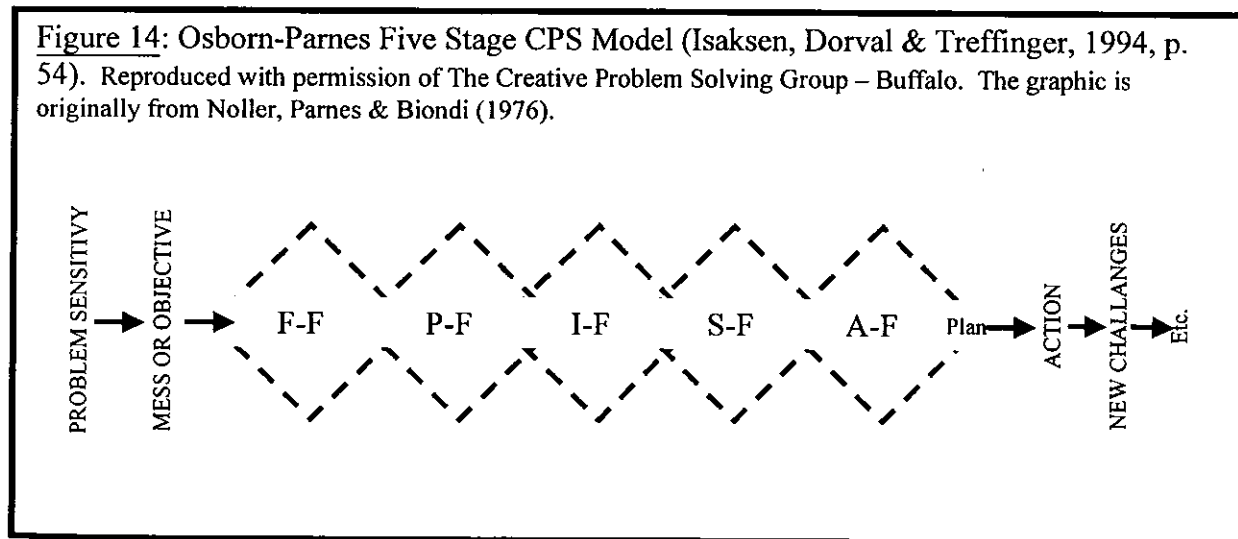
1. Fact-Finding: Problem definition (picking out and pointing up the problem) and Preparation (gathering and analyzing the pertinent data);
2. Idea-Finding: Idea production (thinking up tentative ideas) and idea development (selecting, reprocessing, modifying, and combining); and
3. Solution-Finding: Evaluation (verifying tentative solutions) and Adoption (deciding on and implementing the final solution).

Further modifications to the Creative Problem Solving process came as a result of the work of Sydney Parnes, who teamed up with Osborn to bring the creative process to

education. In 1967, Sydney Parnes modified the CPS process to consist of five steps (Isaksen, Dorval & Treffinger, 1994, p. 54):

1. Fact-Finding: Discovering relevant facts;
2. Problem-Finding: Determining the real problem;
3. Idea-Finding: Generating options;
4. Solution-Finding: Evaluating ideas with criteria; and
5. Acceptance Finding: Preparing to put an idea into affect.

In the 1970's further work and refinement of the CPS process led to the depiction of the Osborn-Parnes Five-Stage CPS Model shown in Figure 14. In this model, the phases of divergent and convergent thinking were shown for the first time (Isaksen, Dorval & Teffinger, 1994, p. 55).



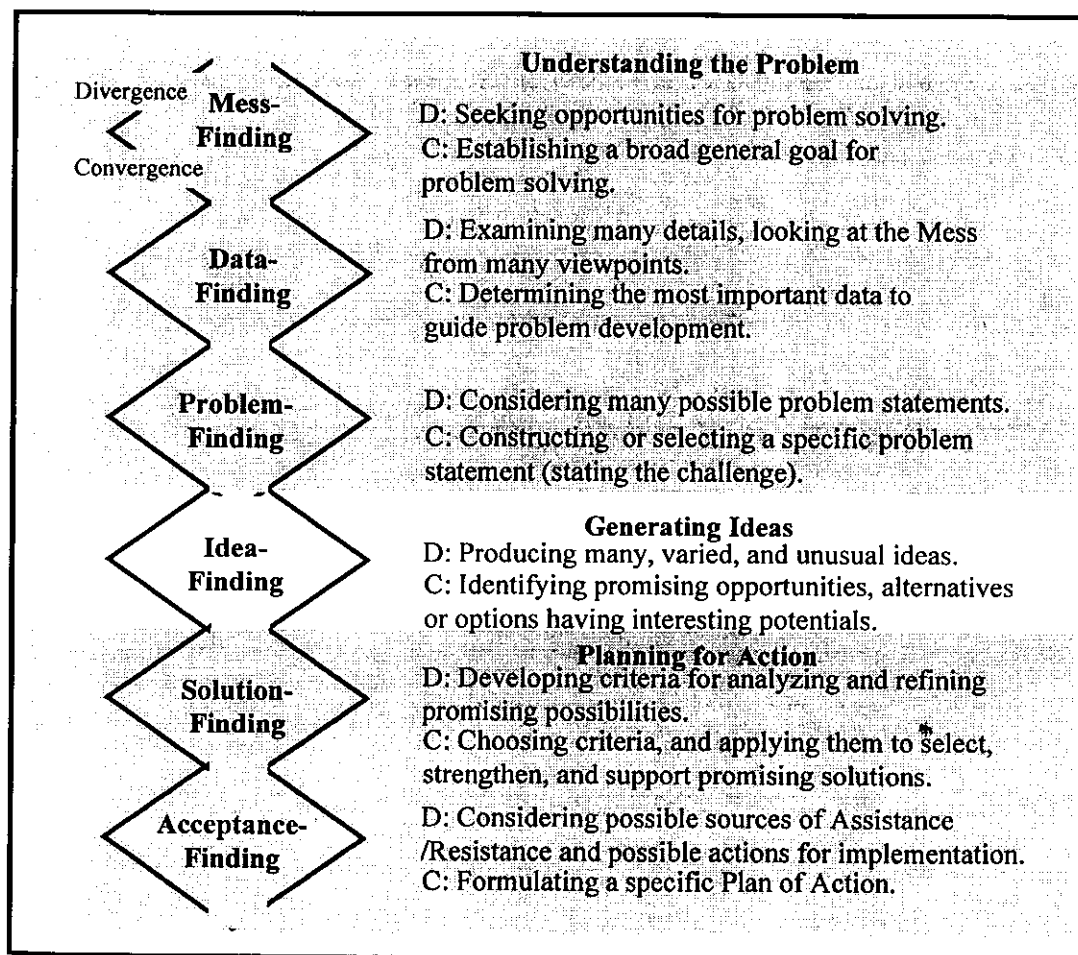
From this point, the Creative Problem Solving process as depicted by Isaksen, Dorval and Treffinger, in their 1994 book, Creative Approaches to Problem Solving was reviewed. Their model was basically a continuation of the CPS model as begun by Osborn and further developed by Parnes and others.



## Process Overview

The Creative Problem Solving process model that was reviewed for later comparison with the disciplined creativity process for engineers was Isaksen and Treffinger's 1987 CPS model as described in Creative Approaches to Problem Solving (1994) by Isaksen, Dorval, and Treffinger. This version of CPS incorporated three components, six specific stages, and two phases. Figure 15 displays the model developed by Isaksen and Treffinger.

Figure 15: CPS With Three Components and Six Stages (Isaksen, Dorval, & Treffinger, 1994, p. 58). Reproduced with permission of The Creative Problem Solving Group – Buffalo.



Isaksen and Treffinger identified three components, *Understanding the Problem*, *Generating Ideas*, and *Planning for Action* based on observations of how people applied CPS in real life problem-solving situations. They noticed that people tended not to apply all six stages together at one sitting. People used the process to clarify their understanding of problems, generate ideas and/or to develop an action plan (Isaksen, Dorval & Treffinger, 1994, p. 58). The stages were then divided into the three main components thus giving the model greater dimension and flexibility for componential use.

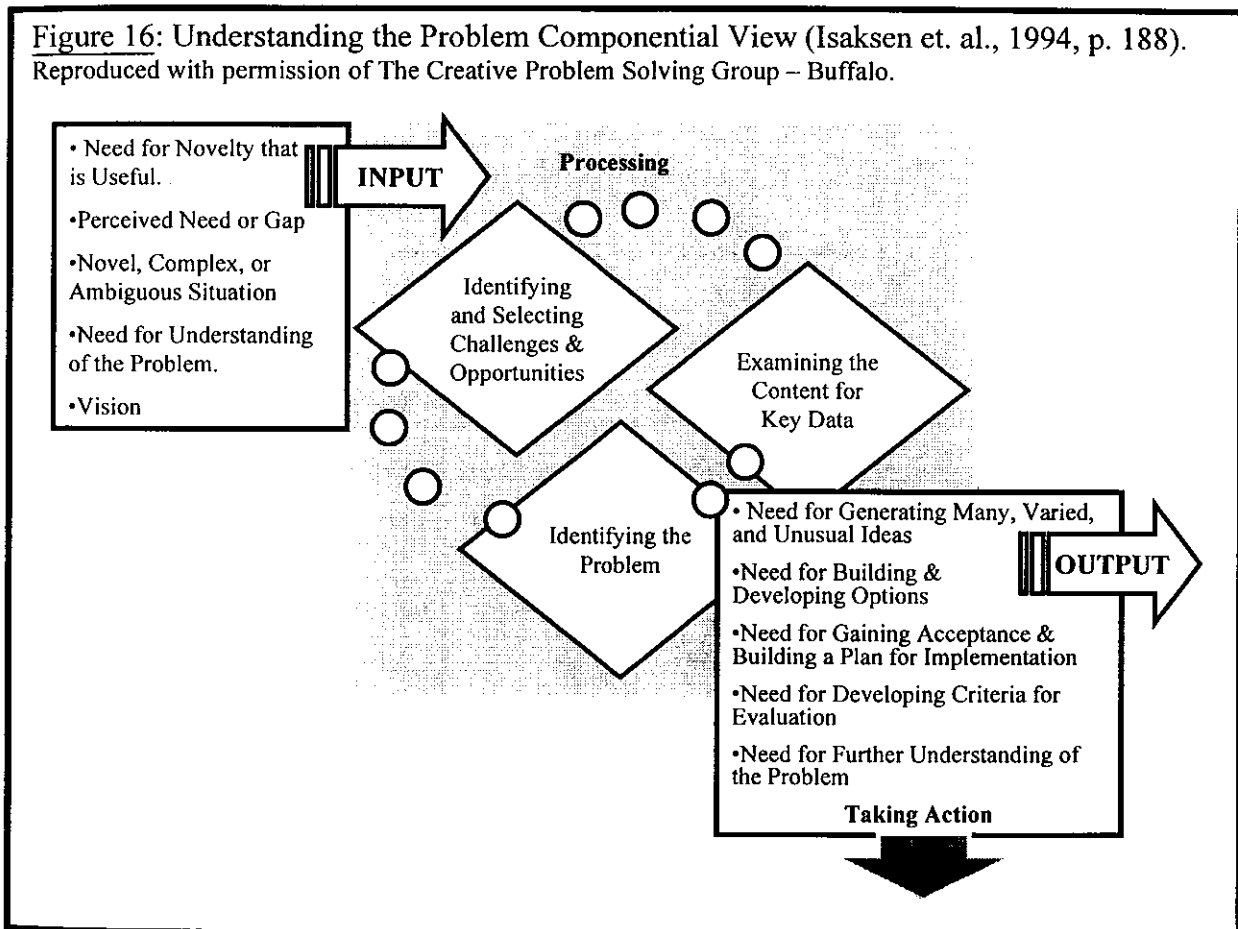
The Isaksen – Treffinger CPS model continued to undergo revisions, but the basic structure that consisted of three main components, six specific stages, and two phases remained. For the sake of later comparison with Bailey's six-step approach to disciplined creative problem solving for engineers, this CPS model will be examined here in detail.

### ***Understanding the Problem***

The purpose of the Understanding the Problem component was to bring clarity and focus on the challenge and results for the problem solver. It also attempted to bring identification to and understanding of the gaps that existed between the current state and the desired future state. It began when one was in an ambiguous situation and desired to understand the problems, opportunities, needs, or challenges resulting from the situation. It ended with a specific understanding of a problem or problems that must be resolved to achieve movement towards a desired goal or objective (Isaksen, Dorval & Treffinger, 1994, p. 187). Understanding the Problem contained three stages that moved the problem solver from the ambiguous situation to clear understanding of specific challenges. The stages were Mess Finding, Data Finding, and Problem Finding as shown previously in

Figure 15. However, Isaksen et al. (1994) explained that the problem solver could begin at any of the stages within Understanding the Problem, depending on his/her circumstances. Also, there was no specific order that must be followed for the stages. The starting point and sequence depended on the need of the problem solver (p. 189). A graphical view of the Understanding the Problem component is shown in Figure 16.

**Figure 16: Understanding the Problem Componential View (Isaksen et. al., 1994, p. 188).**  
 Reproduced with permission of The Creative Problem Solving Group – Buffalo.



### ***Mess Finding***

Mess Finding was the first stage of Creative Problem Solving and was within the Understanding the Problem component. Isaksen et al. (1994) defined a *mess* as “a broad, fuzzy and ill-defined challenge, opportunity, concern or goal” (p. 191). As the first stage in Understanding the Problem, Mess Finding had the purpose of identifying broad and general goals, wishes, or challenges within the context of a new or ambiguous situation (mess). Like each stage within the CPS process, Mess Finding had a divergent phase and a convergent phase. Within the Divergent phase of mess-finding, one would have used various tools to create many statements identifying opportunities, needs, wishes, goals, and/or challenges. In essence, these would have indicated broadly defined directions that one might pursue from the current situation or context. In the next phase, the Convergent phase, one would then apply a convergent tool to narrow down the options, such that one goal or challenge was chosen for pursuing.

### ***Data Finding***

Data Finding was the second stage of Creative Problem Solving and was also within the Understanding the Problem component. The purpose of Data Finding was to collect, identify, and expose the key information concerning the situation or the context of the challenge or goal. This stage contained two phases as well, the Divergent and Convergent phases. In the Divergent phase, various tools may have been utilized to generate a great quantity of information or data. This was then followed by the Convergent phase where various convergent tools may have been used to sort, narrow down, and identify the key or crucial information needed to achieve the goal or challenge.

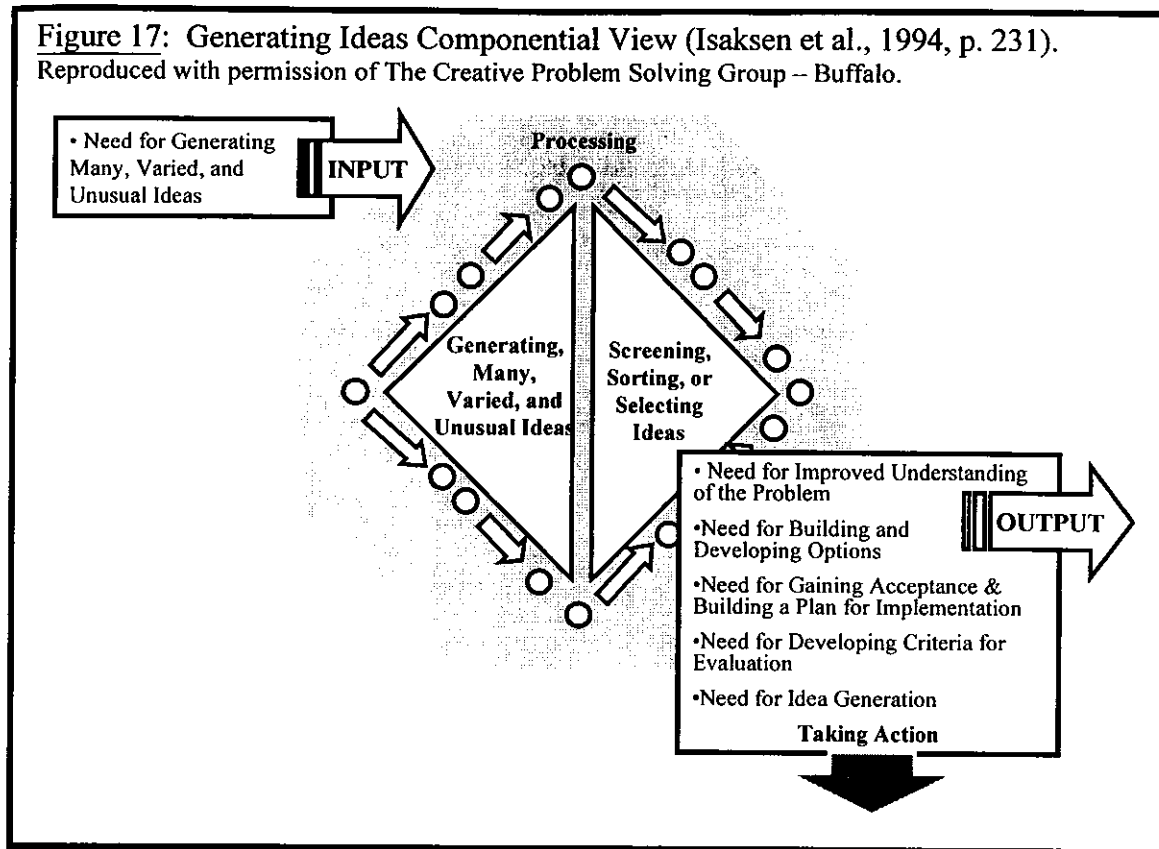
### ***Problem Finding***

The Problem Finding stage was the third stage of CPS, and was the last stage within the Understanding the Problem component. The purpose of problem finding was to identify the key problem or problems to solve in order to achieve the goal. "A problem identifies a specific gap between the opportunity you want to create in the future state and the context or situation as it exists currently" (Isaksen et al., 1994, p. 209). In this stage and in the divergent phase, many problem statements were generated based on viewing the problem from many different vantage points. In the convergent phase a specific problem statement would be identified for solution.

### ***Generating Ideas***

As shown previously in Figure 15, Generating Ideas was the second component of Creative Problem Solving. It began when one had a clear focus on the problem that was to be resolved and needed to have novelty in its solution. One can successfully exit when a few promising options for solving the problem were identified. Figure 17 is a schematic of the Generating Ideas component that demonstrates the input, process, and output.

**Figure 17: Generating Ideas Componential View (Isaksen et al., 1994, p. 231).**  
 Reproduced with permission of The Creative Problem Solving Group – Buffalo.



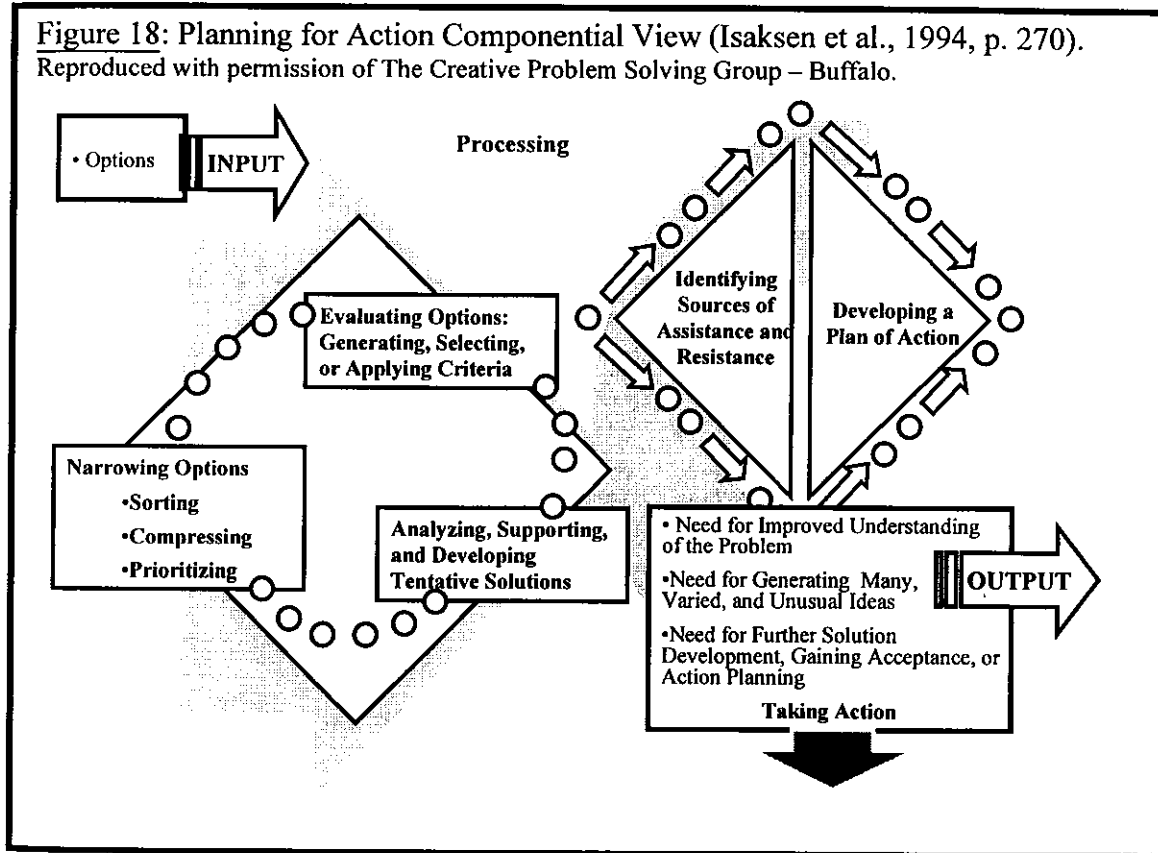
### *Idea Finding*

Idea Finding was the fourth stage of CPS and the only stage within the Generating Ideas component. In this stage, one diverged to obtain many ideas, options, or ways to solve the problem. The major focus was to provide new, unique, and novel ideas. In converging, one or a few promising ideas were selected for further refinement.

### *Planning for Action*

Planning for action was the third component of Creative Problem Solving. It contained the two stages of Solution Finding and Acceptance Finding. Planning for Action had the primary purpose of "transforming ideas into action" (Isaksen et al., 1994, p. 269). Planning for Action began when one had options for solving the problem and

there was a need to “make decisions; develop or strengthen; identify forces that have an impact on implementation; or develop a specific plan for gaining acceptance and use” (Isaksen et al., 1994, p. 270). Successful conclusion of the Planning for Action component resulted in a specific action plan that was ready to be put into use. Figure 18 graphically depicts the Planning for Action component of Creative Problem Solving.



### *Solution Finding*

Solution Finding was the fifth stage of CPS and was the first stage within the Planning for Action component. Solution Finding somewhat depended on the outcome of Idea Finding but basically in Solution Finding the idea or ideas were refined into a viable solution. The divergent phase of Solution Finding involved identifying criteria to

be used to evaluate the idea or ideas that emerged from the Idea Finding stage. In the convergent phase, the key criteria were identified and used to prioritize or narrow down the options.

### *Acceptance Finding*

Acceptance Finding was the sixth and final stage of CPS and was the second and last stage of the Planning for Action component. In the divergent phase one identified all of the possible assistors and resisters relative to affecting the implementation of the plan for enacting the solution. Assistors were “anything that will help improve your chances of successful action” (Isaksen et al., 1994, p. 296). Assistors were key or influential people, important resources, or possible key events or times that helped with transforming the solutions into actions. Resisters were those things that could hurt or hinder the successful implementation of the solutions. “Resisters were people, places, things, times, or actions that might go wrong, create difficulties, or operate against your desired changes” (Isaksen et al., 1994, p. 297). The successful conclusion of Acceptance Finding during the convergent phase was an identification of the key assistors and resisters and a specific action plan that ensured the successful solution implementation.



## Section 5: CPS Compared to Disciplined Creativity for Engineers

### *Development History*

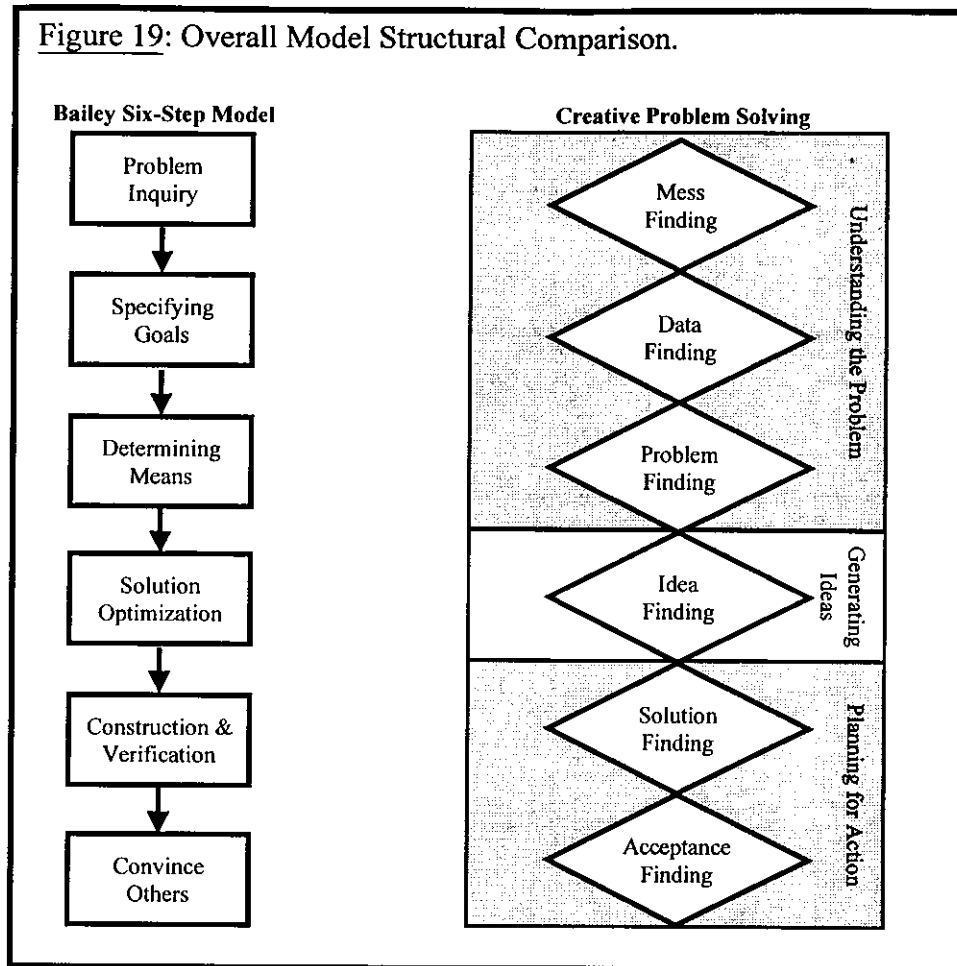
Although the primary focus of a comparison of Robert L. Bailey's six-step disciplined creativity process for engineers to the Creative Problem Solving process was at the structural and operational level, a brief discussion comparing the development of each model is worthwhile. While the disciplined creativity model had its roots with Robert Bailey's training in creativity at General Electric (videotaped interview, 2001, 0:06.27), the CPS model had its roots with Alex Osborn. The CPS model was developed from Osborn's initial concept to the model presented earlier by Parnes, Isaksen, Treffinger, and others (Isaksen et al., 1994, pp. 52-63). One comparison that can be made is that the disciplined creativity process for engineers was developed primarily within the technical domain for the purpose of product invention and development, whereas the Creative Problem Solving process was initiated in the business and advertising field and further developed primarily by academicians. Robert Bailey (1978) indicated that his process "may be applicable to research, invention, development, design, manufacture, or operations when properly applied" (p. 68). Robert Bailey was educated as an engineer, practiced engineering, and taught engineering and specified that his process was for engineers in the title of his book. In comparison, Isaksen et al., indicated that CPS has been field tested and empirically validated in a number of applications covering many fields such as education, business, not-for-profit organizations, new product and service development, etc. (p. 62). Based on the developmental history of both processes, one might conclude that the disciplined creativity process for engineers

was most useful or applicable in the technical fields while CPS had broader application across many disciplines due to its development and validation.

### *Structural Analysis*

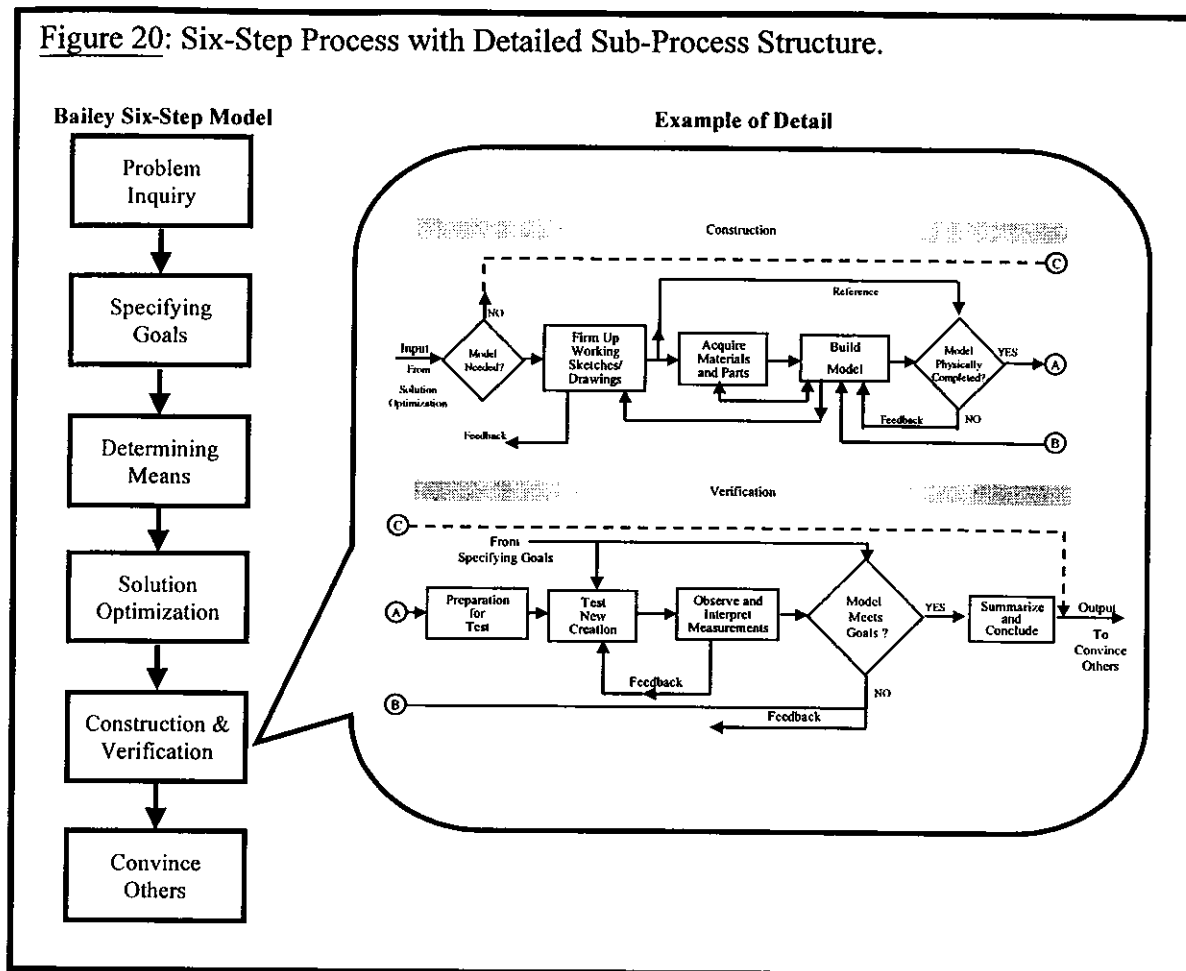
According to Upton and Samson (1961) when a structural analysis is performed the questions "What is this a part off?" and "What are the parts of this?" are answered (p. 51). According to Samson (1965) the definition of structural analysis is, "We observe how things are made: break structural wholes into component parts" (p. 17). The structural analysis of the two creative problem solving models looked at the graphical representation of the processes, i.e. the models. The structure of the CPS model consisted of three main components, six stages that guided the activities within the components, and two phases that guided the actions within each stage. Each stage within the CPS model was represented in the form of a diamond to signify the phases of divergent and convergent thinking activity.

The disciplined creativity process was structurally built as six distinct activities referred to as steps, stages, and phases during its description. Using CPS as the baseline, a comparison of Bailey's six-step process to CPS was made. The intent was to determine if and where the two models contained similar or dissimilar activities or actions. A side-by-side re-creation of the two models is shown in Figure 19 for comparison of overall structure.



Relative to structure, Bailey's model was more in the form of a flowchart, commonly used in computer programming and schematically structuring logic sequence. Each block in the six-step process was a representation of a more detailed sub-process or flowchart. This was somewhat in contrast to the CPS process, which for the sake of maintaining generality in applications, was a conceptual model that was used to guide the problem solver regardless of the application. The Bailey model was displayed as a simple overall flowchart that was supported by detailed process flowcharts as shown in Figure 20.

Figure 20: Six-Step Process with Detailed Sub-Process Structure.



The process flowchart used in the graphical representation of the sub-processes generally used flowchart symbols to represent steps and transition points of the process. For example, the standard symbol of the diamond was used at decision points within the creativity flowchart. Also, arrows represented the paths for progression through the process.

The structural model comparison indicated that the disciplined creativity process was much more detailed than the CPS process. The steps of the processes and sub-processes were more explicitly shown in the structural model of the Bailey process as compared to the CPS process.

### *Comparison of Functions*

The purpose of a structural part was its function according to Upton and Samson (1961, p. 75). The CPS process and Bailey's six-step process operations were analyzed relative to functions of the operations and stages. The Bailey six-step process could have been considered an operation that as a whole had the function of allowing the creation of a solution to a "new problem for which none of the old answers fit" (Bailey, 1978, p. 63). In comparison, the function of the CPS process was indicated by the statement, "Creative Problem Solving is a broadly applicable process that provides an organizing framework for specific tools to help you design and develop new and useful outcomes" (Isaksen et al., p. 31). Like the Bailey six-step process, the CPS process also had the function of enhancing the creation of new solutions. In addition, the CPS process was indicated to have another function of acting as a framework for the application of tools to aid the creation of solutions.

The structure of the CPS model showed components as the next level of parts of the model, whereas Bailey's six-step model showed the steps as the first breakdown of the overall structure. In CPS, the components were basically groupings of stages. The function of the component, Understanding the Problem, was to "clarify your focus on the results you want" (Isaksen et al., 1994, p. 187). In CPS, three stages comprised the operation of Understanding the Problem. Mess Finding, as a stage, had the function of "identifying broad challenges and opportunities that exist in a particular task situation" (Isaksen et al. 1994, p. 188). Data Finding had the purpose of "identifying key data to help pin-point and interpret critical issues" (Isaksen et al., 1994, p. 188). Finally, within the Understanding the Problem operation, Problem Finding had the purpose of

identifying specific problem statements that stimulated new and useful ideas (Isaksen et al., 1994, p. 188).

The Bailey six-step process did not explicitly name components but, as mentioned previously, it did have stages analogous to the stages within the CPS process. The stage Problem Inquiry had the purpose of developing “the best problem definition for the given initial situation” (Bailey, 1978, p. 80). This function was similar to the third stage of CPS, Problem Finding. Also, the function of Problem Inquiry was very close to the overall function of the CPS component Understanding the Problem.

The second component of CPS, Generating Ideas, had the purpose of providing “novel and new ideas for solving the problem” (Isaksen et al., 1994, p. 232). It had one stage, Idea Finding, which was stated to have the same function as the component. However, earlier it was mentioned that a function of the overall operation of CPS was to provide a framework for the application of tools to aid the creation of solutions. The stage Idea Finding may have also had the function of providing for the application of tools for the purpose of providing “novel and new ideas for solving the problem” (Isaksen et al., 1994, p. 232).

In Bailey’s six-step process, the third stage Determining Means had the purpose of defining the best means to a solution of the problem (Bailey, 1978, p. 159). This stage in Bailey’s process had a similar function to the CPS component Generating Ideas and the CPS stage Idea Finding. The Determining Means stage did not explicitly have the added function of providing for the application of tools, as did its CPS counterpart.

The third and last component of CPS, Planning for Action, had the purpose of “transforming thoughts or ideas into action” (Isaksen et al., 1994, p. 270). The two stages

of the operation of Planning for Action are Solution Finding and Acceptance Finding. The function of Solution Finding was to strengthen promising options while the function of Acceptance Finding was to develop actions for implementing the solution (Isaksen et al., 1994, pp. 270 – 271).

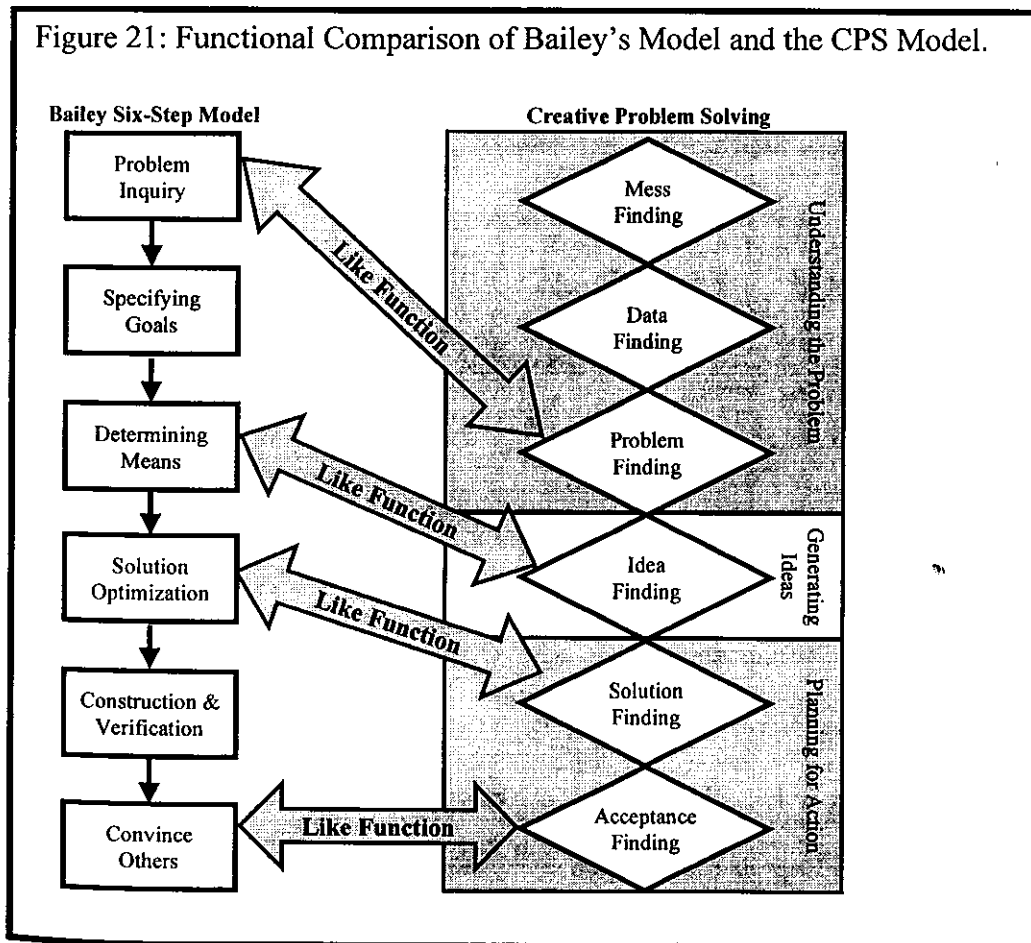
Two stages in Bailey's six-step process had functions related to the CPS component of Planning for Action. First, the stage Solution Optimization had the purpose "to optimize the proposed solution embodiment from the user(s) viewpoint" (Bailey, 1978, p. 206). This was directly analogous to the CPS stage of Solution Finding. Secondly, the stage Convincing Others had the purpose of "to get others to accept, act on, and use our new creation" (Bailey, 1978, p. 266). This was similar to the function of the Acceptance Finding stage in CPS.

In the comparison of purpose or function, the CPS stages of Problem Finding, Idea Finding, Solution Finding, and Acceptance Finding had been shown to have analogous counterparts in the disciplined creativity process. Those comparative stages in Bailey's process were Problem Inquiry, Determining Means, Solution Optimization, and Convincing Others, respectively. However, the CPS stages of Mess Finding and Data Finding did not have like stages in Bailey's six-step process from a purpose standpoint. Likewise, the six-step stages of Specifying Goals and Construction and Verification did not have direct counterparts in the CPS model. One may have concluded that the stage of Data Finding in CPS was similar to Information as Bailey described its relation to the six-step process, however Information was not considered a separate stage but fed each step in the process (see Figure 2).

Specifying Goals had the purpose of “defining the constraints (the limits of acceptability) requisite for successfully solving the problem” (Bailey, 1978, p. 126).

There was no stage in CPS that had a similar purpose although similar criteria were found to be a phase of the Solution Finding stage in CPS. Also, the purpose of Construction and Verification was to validate the solution through the testing of a physical embodiment (Bailey, 1978, p. 234). There was no specific stage in CPS with the same purpose although in Solution Finding one may strengthen a solution through testing of a physical model.

A summary of the portion of the operational analysis that focused on the functional comparison of the stages within the CPS model and Bailey’s disciplined creativity process for engineers is shown in Figure 21.





### *Comparison of Stages*

A comparison of stages relative to their operation and order was made to identify further similarities or differences between the two processes. Both processes began with actions to deal with a "situation" that was ambiguous or complex (Bailey, 1978, p. 80) and (Isaksen et al., 1994, p. 191). However, Problem Inquiry led to the formulation of a specific problem statement whereas CPS consisted of actions in three separate stages (Mess Finding, Data Finding, and Problem Finding) to formulate a specific problem statement.

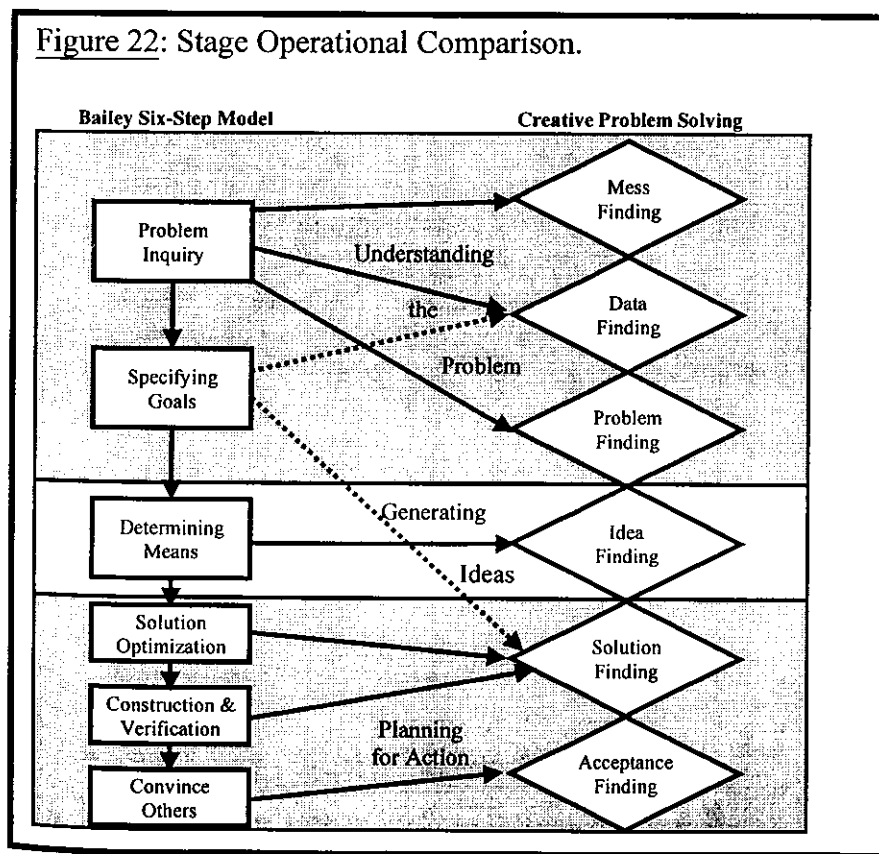
The issue of solution acceptance criteria was dealt with differently between the Bailey six-step process and the CPS process. Immediately after the problem statement was formulated, Bailey's operation specified the goals or criteria that the solution must meet. The CPS operation did not really address solution acceptance criteria until the Solution Finding phase, which was after ideation of possible solutions occurred. In the disciplined creativity for engineers process, the criteria were generated prior to ideation of solutions. In the CPS process, criteria for solution acceptance and strengthening were developed after ideation of options.

Solution development was another area where the operation of Bailey's six-step process differed from the CPS process. In Bailey's process the development of the solution was done in two distinct stages as compared to one stage in the CPS process. Actions to optimize the solution in conceptual form were done in the stage immediately following Determining Means. In addition, the solution was further developed with the Construction and Verification stage. In CPS the Solution Finding stage took the

promising option and turned it into the strengthened solution without specific actions to have created and tested a physical model.

The final stages in CPS and Bailey's process performed slightly differently. Convincing Others in Bailey's process developed the actions necessary to sell or convince others to use the solution. Acceptance Finding contained similar actions but also included construction of a plan to put the solution into action beyond just convincing others to use it.

In summary, the six-step creativity process for engineers identified the problem in fewer stages, identified solution acceptance criteria ahead of ideation, and developed the solution in more stages, as compared to the CPS process. Also, Bailey's process ended with the convincing of the appropriate people to use or accept the solution. An operational comparison of the two processes is shown in the following figure, where operations in the Bailey process point to like CPS stages containing similar actions.

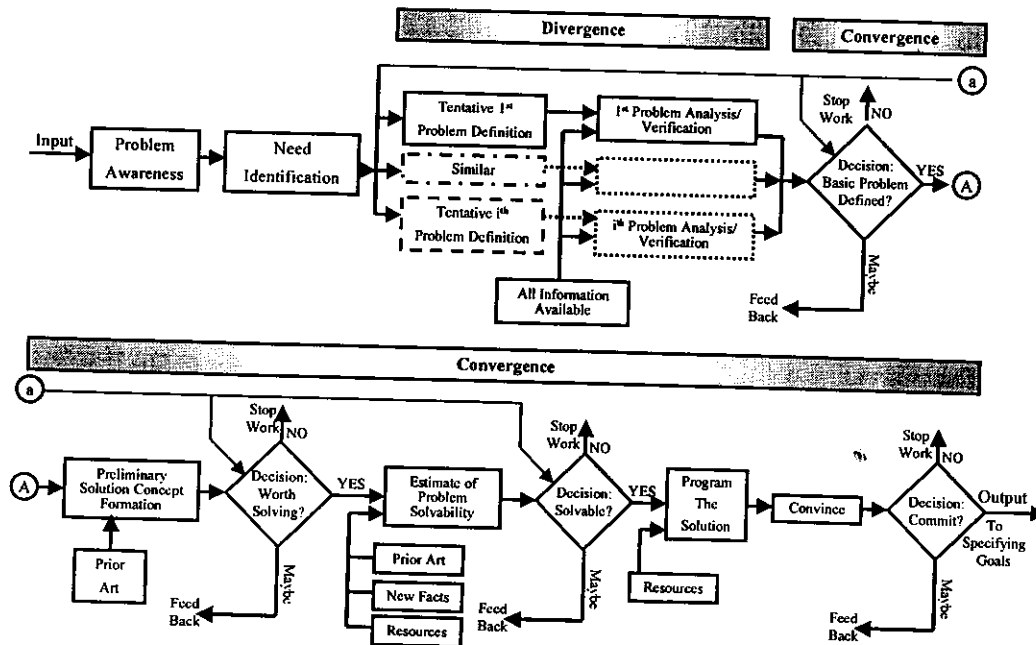


### Comparison of Phases

The CPS model indicated that each stage had a divergent thinking phase and convergent thinking phase. According to Upton and Samson, "A phase is the sub-operation of a part of a structure changing its relation to the other parts for a purpose" (1961, p. 75). Similar phases were not indicated in the Bailey six-step model but further investigation into the sub-operations of the stages revealed some cases of divergence and convergence.

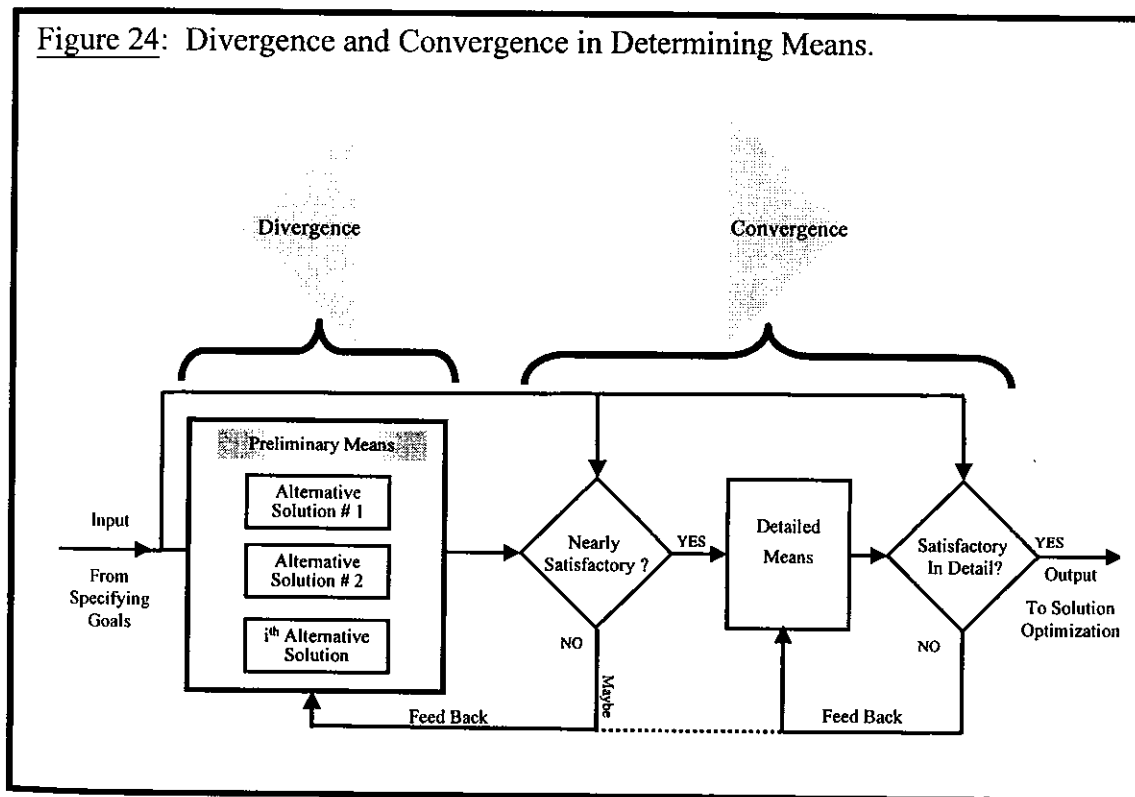
For Problem Inquiry, the problem solver was guided to identify many problem definition statements (divergence) and then was guided through a series of decisions (convergence) to identify the problem definition that would meet the need, was worth solving, was solvable, and finally had commitment to work to its solution.

Figure 23: Divergence and Convergence in Problem Inquiry



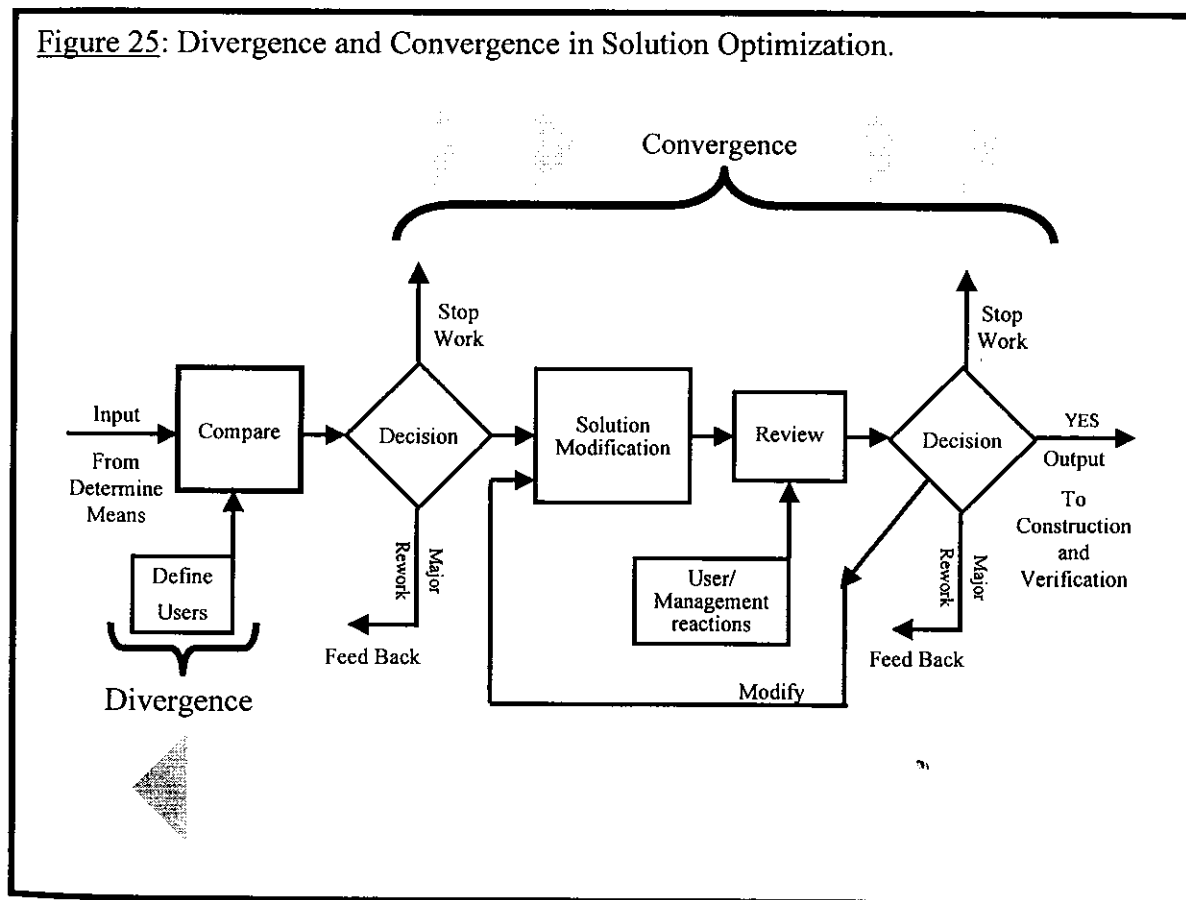
In Specifying Goals, specific references to divergence and convergence were not detailed. In usage one identified possible functions, requirements, and specifications and then developed a sorted list of primary and secondary goals.

In the stage of Determining Means, divergence occurred relative to the generation of alternative solutions for the problem while convergence occurred in the selection and detailing of the solution. As was done for Problem Inquiry, Figure 24 identifies where divergence and convergence occurred in Determining Means.



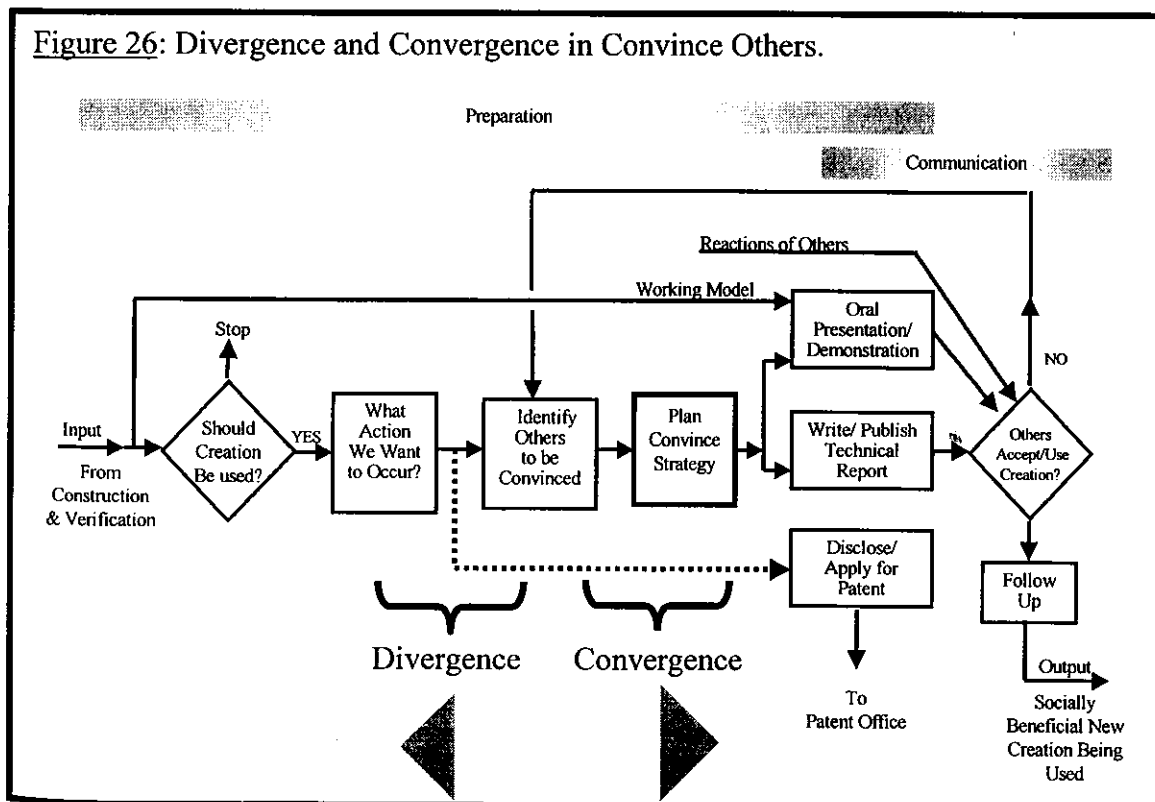
In general, the Solution Optimization step in Bailey's process was convergent in that it took the proposal from Determining Means and refined, strengthened, and optimized it until a decision to build and test it was made. This was very similar to Solution Finding in CPS, which itself had a primary emphasis on convergence (Isaksen et

al., 1994, p. 272). However, in CPS a divergent phase of Solution Finding was specifically built into the model and was used relative to generating criteria used for evaluating the idea(s) proposed from the Generating Ideas component. In Solution Optimization in the disciplined creativity for engineers process, no such distinction for a divergent phase was made in the model, however, a likely place for divergence would be in the identification of users and user characteristics that were utilized to assess the viability of the proposed solution. Figure 25 graphically illustrates where divergence and convergence took place or applied in the Solution Optimization step.



Construction and Verification was also basically a convergent phase within Bailey's six-step process. In comparison to CPS, Construction and Verification compared the proposed solution to requirements by physically testing it. Solution Optimization and Construction and Verification were two steps in the Bailey process that performed a similar operation to Solution Finding in CPS.

In Convincing Others, the final step of Bailey's process, divergence related to identifying how the creation was to be used, who needed to be convinced, and finally identifying the actions needed for the convince strategy. Convergence inherently occurred when the decisions were made and the plan was constructed. This was directly analogous to Acceptance Finding in CPS. As in the other steps, divergent and convergent thinking phases were not specifically indicated, although to some extent they were a part of the process. Figure 26 graphically illustrates where convergence and divergence occurred in Convince Others.



*Summary*

The structural and operational (functional, stage, and phase) analyses supported the contention that the CPS model is a generalized model for creative problem solving whereas the disciplined creativity process for engineers was a more specific and detailed process for problem solving. The two models contained many similarities such as similar stages for problem clarification, ideation of solutions, development of solutions, and solution acceptance. There were differences that related to functions of various stages as well as operations. The differences primarily related to the slight difference in focus that existed between the two models. Although both models had the function of facilitating the creation of a new and useful solution to a problem, the CPS model also functioned as a model for the facilitation of tool usage.

## **Section 6: Robert L. Bailey: A Pioneer in Creativity**

The study of creativity was organized around four interrelated factors: the creative person, the creative product, the creative process, and the creative press (environment) (Isaksen et al., 1994, p. 7). Davis (1999) stated the interrelatedness of the four Ps as, “Creative products are the outcome of creative processes engaged in by creative people, all of which is supported by a creative environment” (p. 41). In the previous sections of this project, we focused on the creative process that was developed and used by Robert L. Bailey. The purpose of this section of the project report was to focus on the creative person Robert L. Bailey and the factors that led to the development of the process. This study established the connection between the disciplined creativity process and the creative person who used it, taught it, and contributed significantly to its development. In addition, examples of products that Mr. Bailey created were discussed thus interlinking some of the four Ps of creativity.

The source of material for this section was primarily from a direct interview with Mr. Bailey as well as from some of his writings. A script of the videotaped interview with Mr. Bailey was included in Appendix F. Also, several artifacts from Mr. Bailey’s life were included in Appendix (G – N) for a better understanding and recognition of the accomplishments of a creative person.

### ***Development as a Creative Individual***

Davis (1999) asserted, “It is hardly surprising that, beginning in childhood, most creative people accumulate a history of building and making things and of literary, artistic, and scientific involvement” (p. 90). A look back into the life of Robert L. Bailey



and how he developed as a creative person revealed cases supporting Davis' assertion. Other traits, characteristics, and events emerged also that indicated that Bailey was to have creative impact in his life.

Robert L. Bailey was born in Demopolis, Alabama on April 6, 1927. His parents were Gladys Harlow Bailey and Francis Leo Bailey. Bob Bailey credited his mother Gladys as the one who encouraged and inspired him as a youth. Bob credited his father Francis Bailey as having taught him the meaning of discipline (Bailey, 1978). As a child he helped his father, who was a craftsman, build and fix things for other people. He remembered first thinking about creativity when he visited Mr. John Copeland's machine shop in Demopolis. He saw local inventors bringing their ideas and designs to Mr. Copeland to have a prototype or model made. Bob asked the inventors how they would think of their ideas. Like many inventors, they usually said they didn't know or it just came to them. Bob thought at the time that there must be more to it than that (videotaped interview, May 27, 2001, 0:03.30). Thus began a lifelong pursuit of the understanding of and application of creative process.

Growing up in Demopolis, especially during the Great Depression, Bob Bailey and his father had to make many of the things they could not afford or that just weren't available. Making things by combining bits and pieces of other things was a creative act that caused him to exercise creative thinking. One such endeavor nearly led to tragedy. Bob and his father were attempting to make a refrigerator, which was fairly uncommon at that time for people to have. In salvaging an evaporator core from another refrigeration system, they did not know that it was charged with Sulfur Dioxide and was under pressure. While cutting the lines to the core, the pressurized refrigerant was released and

struck Bob Bailey in the eyes. He was blinded by the refrigerant for several weeks and remembered his mother praying over him that she knew God had a purpose for Bob in life, but that he would need his sight to fulfill it. Shortly thereafter, Bob recovered his sight along with a sense of purpose in his life. This story is recounted in his retirement speech contained in Appendix H. Bob's determination to not waste God's gift was a likely impetus for his prolific creative production since it likely affected his intrinsic motivation to create.

Bob's father Francis made some of his own tools and equipment which Bob had sketched and donated copies of to the Marengo County Historical Society in Demopolis, Alabama. One day as Francis Bailey was working with a belt driven saw-planer-sander, his sweater was caught in the equipment, thus putting him in extreme peril. Bob, though very young at the time, had the presence of mind and practical knowledge to cover the intake of the engine to shut down the equipment. This act saved his father from serious injury and maybe death (videotaped interview, 2:40.41). Bob's ability to understand how things worked was another factor related to his creative production later in life. Amabile (1998) related knowledge, such as technical expertise in one's field, as a key component of creativity.

As a youth, Bob's hobbies included those requiring hands-on skill and knowledge. One such hobby was model airplanes. One of the treasured photographs from his youth was of him with his model airplane (videotaped interview, 5:20.18). Perhaps this hobby led to his endeavor, later in life, to rebuild, improve, and fly a private airplane, which had previously been crashed. He knew that a major redesign of the plane presented at once risked a rejection by the Federal Aviation Administration (FAA). Bob

purposefully arranged and segmented his design improvements to gradually upgrade and improve his plane with piecemeal FAA approval (videotaped interview, 2.44.51). Experience in creative problem solving allowed him to put his ideas into use. He effectively completed the Convincing Others stage by garnishing FAA approval in sequential steps of his design changes. In this case, the most important part of the disciplined process that was used was "Convincing Others."

Mr. Bailey was educated at Alabama Polytechnic University - now Auburn University - as an electrical engineer. Looking back on his engineering education, he realized that it did not include creativity or design synthesis at all. The focus of engineering schools was on analysis. However, it did prepare him with the knowledge and skills that later allowed him to make significant contributions at General Electric and to the fields of engineering education and alternative energy sources.

Robert L. Bailey's formal introduction to creativity, and more specifically to the creative process, began at General Electric in 1950. While working one day on a washing machine project at General Electric, Bob Bailey's supervisor Cliff Reitz summoned him to an interview with two men concerning a potential selection into a creativity program. Bob was wearing coveralls that were covered with grease at the time. He asked to change first but was told he did not have time and that it was not necessary. In the interview Bob was asked his opinion of General Electric's products. Figuring that he did not have a chance of being selected because of his appearance, he decided to give them the truth. He said the GE toaster was the sorriest toaster on the market. He then went on to explain how he would make it better. The interviewers said that was what they were looking for. Someone with "constructive discontent" was exactly who they

wanted in their selective “creativity” program. Constructive discontent was dissatisfaction with the current state combined with the desire and suggestions to change it for the better. General Electric felt that those in the creativity program would be the future product inventors and designers in the company (videotaped interview, 0:09.00).

### *Creativity Training and Practice at G.E.*

Bob Bailey was one of approximately twenty students chosen to attend the Creative Engineering Program beginning in September of 1950. Being chosen for the program was both an honor and recognition of a student’s creative potential. Since the training took place in Schenectady, NY, Bob took a train one day each week from Syracuse to Schenectady to attend the creativity class. For the remainder of the week, he worked at his regular job in Syracuse. The students were exposed to the subject of personal creativity and to GE’s creative problem solving process (videotaped interview, 0:06.27 – 0:11.42).

General Electric began the Creative Engineering Program in 1937, and it was initially an effort to apprentice hopeful inventors to experienced inventors. The intent was to develop an intuitive creative approach in the students based on working with their mentors. (Von Fange, 1959, p. 117). After a few years, GE recognized a pattern for problem solving existed which could be used as a common approach. GE then began using a four-step process, *Define, Search, Evaluate, and Study*, which they used for several years since it was a short and easy process (Von Fange, 1959, pp. 117-118). One of Alex Osborn’s books, most likely Applied Imagination, was used for the class while Bob Bailey was at GE, but some found that it was not specific enough relative to product

development. However, Osborn's brainstorming technique and deferment of judgment were found to be valuable. Eventually, the process at GE developed into six steps (videotaped interview, 0:12.50 – 0:24.23).

The students were exposed to presenters from throughout General Electric. Especially important were the discussions of projects that experienced failures and problems. By discussing the failure from a process view, the students learned why each step of the creative process was important and how it contributed to successful product creation. Also, the students took on challenges presented to them from various programs and departments within General Electric.

Mr. Bailey worked on a project to design a rotational positioning device for a mirror to be used for television. The challenge was to move the mirror quickly and accurately without breaking it. By applying the creative process, Bob Bailey came up with a design that performed well and met the initial specifications. Bob chose to work on the mirror project in order to work with a mechanical engineer and thus gain experience solving mechanical problems. Even though the project was successful, RCA later came out with another way to solve the problem that did not require repositioning a mirror. Bailey's lesson from this project was, "When you create, there is usually some competition somewhere" (videotaped interview, 1:21.43).

In addition, there were projects from many other parts of General Electric that the students worked on. The refrigerator group brought many problems to be solved. Mr. Bailey also worked on an oven smoke problem while another classmate worked on a problem related to optimizing the rate of climb for aircraft depending on the length of the overall flight. Another project that Mr. Bailey worked on which taught him a valuable

lesson was the development of a mechanical color transmitter. The camera worked so well that it was featured at a conference. Unfortunately, the motor burned out due to insufficient airflow. It was easily corrected by opening up more ventilation to the motor. As Bailey stated, "One little detail can sabotage a creative project" which affirms the necessity of Specifying Goals, Optimize Solution, and the Construction and Verification stages in the six-step process (videotaped interview, 2:19.43 – 2:24.16).

The General Electric process eventually developed into six steps. The six steps were likely those described by Von Fange (1959), which were *Investigate Direction*, *Establish Measures*, *Develop Methods*, *Optimize a Structure*, *Complete the Solution*, and *Convince Others*. Bob Bailey recounted an incident that may have contributed to the last step of Convince Others. Mr. Bailey was given the task of presenting one of the ideas that had been developed in the creativity class to the chief engineer of the product to which the idea related. The idea was a mechanical automated insulation-wrapping device that would have saved many labor hours of manual insulation wrapping. In addition, it would have resulted in significant cost savings. Thinking that the attributes of the idea were so self evident and significant, Mr. Bailey was surprised when the chief engineer rejected the idea because they had been manually wrapping the insulation the same way since Thomas A. Edison set up the process years earlier. Bob Bailey realized at that moment that it was not enough to just have a good idea, even if it was proven to work, but that the process did not end until the idea was accepted and used." Mr. Bailey discussed his experience with his boss and others. Sometime after, General Electric added the Convince Others step to the process possibly as a result or partially as a result of Bob's experience. (videotaped interview, 0:19.50).

### *About Teaching Creativity*

Bob Bailey left General Electric in 1960 to pursue an interest in teaching at the University of Florida at Gainesville. Mr. Bailey taught creativity seminars during the later years of his career at GE and believed it should be taught to undergraduate engineers. One day Mr. Bailey was asked if he would be interested in taking over the problem-solving course that was taught for senior engineering students. There was enough flexibility in the focus of the class that it could be taught as a creative problem-solving course. Bob Bailey jumped at the opportunity saying, "This is like asking a rabbit, would he like to jump in the briar patch" (videotaped interview, 0:43.00). He then taught Creative Problem Solving for Engineers for 22 years. In the beginning he used the book Professional Creativity, by Eugene Von Fange (1959), as the text for the class. Mr. Bailey worked at developing more detail for the various stages of the process, and through trial and experiences with teaching to the students, further developed the creative process. In 1969 Mr. Bailey began writing Disciplined Creativity for Engineers, which built on the GE process by adding more detail and depth to the various steps. In addition, it incorporated a much broader research base into the material on creativity. This book, published in 1978, was used as the text for the class until Mr. Bailey retired in 1982.

When Mr. Bailey first started teaching the creativity course for the engineering students, he focused on personal creativity in the first half of the semester, and then group creativity for the second half of the semester (videotaped interview, 3:35.48). Projects were a mainstay of the course to give the students practical experience with the process. The students worked on a creative project individually for the first part of the semester then on another project in teams of four or five. Many unique projects were tackled. One

such project was the development of a radio-controlled parasail as a way to guide supply drops to the correct location. This was a problem that came out of the Vietnam conflict when airplanes would drop supplies by parachute, only to have some get lost in the jungles or even carried over to enemy locations. The students built models and tested them in the stadium at the University of Florida.

After several years of teaching the class, it became apparent that the time and effort required to complete a project well, while learning the creative process at the same time, was too much to do in the time available in one semester. At that point Mr. Bailey decided that it was fundamental that the students learned and practiced personal creativity. So the group work was eventually dropped from the class. Mr. Bailey found that teaching a creative class was much different than the traditional analytical class. In an analytical class, there was usually one right method or one right answer. It was relatively straightforward to grade homework or tests in analytical classes. However, in the creativity program much time was spent assessing students' projects, guiding and counseling the students, and grading submissions. As Mr. Bailey said, "It is imperative that any teacher, in my view, spend a lot of time grading" (videotaped interview, 4:00.38). The students must be encouraged when they get depressed which takes availability and time from the teacher. This was not a burden for Professor Bailey based on his comment, "The main business of a university, as I see it, is to educate the students. The most effective teacher is one who loves the students" (videotaped interview, 3:38.38). Mr. Bailey believes that to teach creativity well, you must really love the students.



### *Creative Products of a Creative Individual*

Robert Bailey has produced many creative products through his lifetime as a result of his personal creativity, discipline, and approach. He exemplified the model of creativity discussed by Amabile (1998). Amabile (1998) identified three factors affecting creativity: expertise, motivation, and creative thinking skills. His products resulted from a deep understanding of the technology combined with his intrinsic motivation to create and his application of creative process. Some of these products were discussed here as a humble attempt to demonstrate the sincerity of Bailey's belief in and use of the creative process.

During his career at General Electric, Mr. Bailey applied his problem solving approach and developed many unique solutions to problems with which he was exposed. He worked on the development for maintaining the balance in a washing machine that allowed washing machines to run freestanding. This meant that the washing machines could be installed without being bolted to a large in-ground concrete base. Few people today even knew that washing machines at one time required such measures for installation. The product was produced for over 45 years and has undoubtedly been used by millions worldwide.

While working on a project for the National Aeronautics and Space Administration Mr. Bailey invented an electromagnetic wave energy device. He received a patent, shown in Appendix B, which is an official recognition of novelty and usefulness. At least four subsequent patents by other inventors have referenced this patent thus serving as further testament to its value and originality. This device had the

potential of harnessing portions of the Sun's energy in a clean and safe way for the benefit of mankind.

Finally, Mr. Bailey was prolific at creating many products from his imagination at home in his study and workshop. His house was decorated and furnished with exquisitely designed and expertly crafted furniture, toys, and a beautiful mural depicting his life. Appendix N depicts some photographs of Bob Bailey's creations, and further discussion of a few of these will follow. First of all, when entering Mr. Bailey's home through the front door, one immediately sees a large mural, simply designed and deep in character. At first glance one would mistakenly think it was only a simple landscape painting. However this mural tells the story of Bob Bailey's life, and I've had the honor of having Mr. Bailey personally guide me through the deceptively simple picture and into the deep and detailed life's work subtly encased within the view. Live oak trees in the mural represent Bob's favorite tree, under which he recovered from illness as a young man, shielded from the hot Florida sun. His house was constructed under such a tree and thus his family has also been raised under the protective gift from God, which all of nature is to Man. The landscape was generally one that was typical of Florida, the state in which Mr. Bailey made his home and raised his family. There were clouds in the sky, and one was a dark storm cloud to represent that not all life was "good weather." There were storms, at times, through everyone's life. The storm cloud was strategically placed so that when sitting in the best seat in the living room the storm cloud was hidden by the partial wall between the living room and foyer, and thus only the bright, fair weather portion of the landscape was in view. Such detail, minute in appearance and magnificent in meaning, was typical of Bob Bailey's work. Also in his mural were representations of

electricity, airplanes and flying, and students, which represented his life's work and endeavors. Additionally, included were representations of the three women in his life, his wife Betty and their two daughters. The painting was sketched by Bob and painted by an artist friend. The painting was a part of the home and the house. It served as a window for all visitors to look through, except they were looking out into the landscape of Bob Bailey's life. It was a window to the inside of the Bailey's home, not the outside. It was a part of the house, for without its strategic location within that very house, it would lose a part of its uniqueness with respect to the disappearing storm cloud. Such was the simple complexity of the creation. Torrence and Safter (1998) discussed the ability of creative people to elaborate, but not excessively. The details in Bob's mural were magnificent in elaboration. More meaning was cleverly condensed in seemingly minute detail than could have been written in a book.

Another striking example of Mr. Bailey's creativity and disciplined craftsmanship was the entertainment system adorning his family room. It was a large and beautiful structure with hidden secrets and overpowering charm. It was built over the course of eleven years and began with the selection of the pecan trees from Bob's hometown of Demopolis, Alabama. One of the most interesting features was the cabinet doors made from pecan slats woven together in a crisscrossing pattern. Bob grew up in a county in Alabama where a majority of the population were African Americans, and he remembers seeing some make baskets using woven hickory slats. He deduced that such a task would be possible with pecan since it is a close relative of hickory. I was naturally drawn to run my hands over the grid work of the woven pecan slated doors, to Bob's delight. I fell prey to the irresistible charm of the pattern and the three dimensional spatial and visual

complexity of the woodwork, and had to run my hands over it as though it helped me to see it better. He designed it with that intention, and I would have to guess it works on everyone who sees it for the first time. Included within the cabinet was what appeared to be a book titled Power Control I, but it was really a metal box housing all of the switches controlling the lighting in the entertainment system. Bob had a leather book cover adhered to the box so that it looked like a real book on the shelf. This was another example of the level of detail involved in his creations.

Bob Bailey made most of his creations with a Shopsmith<sup>®</sup>, which was a multi-purpose woodworking tool that can do cutting, turning, and drilling work. Mr. Bailey had created many improvements and attachments to this machine. All of his improvements were documented in engineering notebooks with written descriptions of his ideas, sketches, photographs, and significant data that he had collected. These idea journals were better than any I've seen in industry. Bob Bailey lived creative engineering even at home.

As was shown, Bob Bailey had a creative thread that ran through his life from a small boy to the present. From the influence of his parents and his brush with blindness, to his creativity training and practice of creative process, Bob Bailey consistently had both feet in the creativity field. His creative personality and disciplined approach to creative production added dimension to his most germinal creative product – his book Disciplined Creativity for Engineers.

## Section 7: Conclusions and Recommendations

For me, this project was the epitome of a capstone project for the degree of Master of Science in Creativity, Creative Problem Solving and Change Leadership. Through the course of this project I touched all of the areas of creativity: person, product, process, and even press. I had the truly great fortune of meeting and getting to know the creative person Bob Bailey who contributed much to both the fields of creativity and engineering. Bob's creative products such as his book, the mural of his life, and his many expertly crafted works of wooden wonders touched me. I autopsied two creativity processes and gained valuable insights of each through comparison with the other. Although I did not expect to delve into the topic of creative press, it was there all along. Creative environment was in Bob Bailey's recounts of his experiences at General Electric and at the University of Florida. Creative climate affected me when my wife and I were guests in Bob and Betty Bailey's home in Gainesville, Florida. Creative pressure in many forms kept me focused on the goal of producing a work that was worthy of the subject and the person of which and whom it was about.

I learned much from the work entailed in answering the question, "How does the disciplined creativity process for engineers compare to Creative Problem Solving?" I concluded that CPS was a broad general model for problem solving and that this was a good thing. It filled a need for guidance in the method of creative problem solving and the use of thinking tools. CPS's generalized stages and common language made it applicable for myriads of people and all parts of an organization. Partly based on my own industrial experience included with the better understanding gained through this work, I reconciled that an organization should use a broad model of creative problem

solving, like CPS. A broad model allowed for everyone in the organization to “speak” the same creative problem solving language. Additionally, a broad model facilitated better cross-functional creative problem solving teamwork.

A comprehensive model had limitations or weaknesses uncovered by comparison with the strengths of a more specific process like the disciplined creativity process for engineers. Some people or functions were better served with specific process steps and directions. A conclusion I came to as a result of this realization was that a broad model like CPS could be strengthened with supplemental task specific application or process guides. For example, in a company the broad model could be used and understood by all departments, but engineering could also have a specific product development process since it may require steps like Specify Goals and Construction and Verification. These process steps fall within certain stages in the broader model but are somewhat specific to the task of product development. Baer (1988) argued that creativity was domain specific where domains related to cognitive, task, or content domains. In this case, the differences noted between Bailey’s process and CPS might indicate that there is need for task specificity in the creative process for product invention. Based on my experience in product development, I believe one can successfully develop creative products and inventions with the CPS model but certain tools or guides such as building and testing a physical model within the Solution Finding stage will be specifically helpful.

I had an insight concerning the Solution Finding stage of CPS.” The divergent phase of Solution Finding was for generating criteria to allow comparison of several promising ideas exiting the Idea Finding stage. However, it seemed that less importance was put on generating criteria if only one idea exited the Idea Finding stage. It appeared

to me that criteria in CPS were only used in the comparison of options. From studying Bailey's process, I realized that every idea before it can be considered a solution to a problem must meet certain criteria. Even though some criteria can be generated prior to ideation, the remainder of the criteria can only be generated after the idea has been formed. In the case of a product idea, criteria identified prior to ideation may relate to how the product must perform to satisfy the problem. On the other hand, after a product idea is formed, one must also consider how that product may perform in unintended use situations. My main conclusion regarding this issue was that in CPS the divergent phase of Solution Finding related to generating criteria was just as important for selecting and strengthening a single option as it was for consideration of multiple options.

I had many insights related to the question, "What factors led to the development, teaching, and publication of Disciplined Creativity for Engineers?" The answer to this was probably the same as "Why is Bob Bailey Bob Bailey?" I have developed, at least in my own mind, some conclusions as to the important factors behind the development of the process, the teaching, and the book. I believe the encouragement that Bob received from his mother along with the discipline, work ethic, and creativity that his father displayed were key ingredients to his lifetime of creative production. These factors related to the three basic creativity components that Amabile (1998) discussed.

Bob Bailey's introduction to a formalized creativity process at GE was another determinant that contributed to his accomplishments. I was sure that Mr. Bailey would have had a life of producing creative products because of his natural inclinations, but getting exposed to a process created a powerful combination. The creativity course at GE made him aware of the shortcomings of the engineering education and honed his problem

solving understanding and capabilities. His constructive discontent with engineering education and love of teaching were the final factors that led to his greatest contribution, the teaching of creativity to engineering students and the writing of his book.

I learned much about teaching creativity from Mr. Bailey. The teaching of creativity required patience, time, and a love of students. I have concluded it was more than just a transmission of knowledge; it was the development of a person. Teaching creativity was the cultivation of a creative individual that encompassed the teaching of the process, the development of personal characteristics through advice and encouragement, the building and maintenance of a creative climate and the guidance to completion of a creative product for the sense of accomplishment that then fuels the desire to do it again. After meeting Mr. Bailey, I was more convinced than ever that creativity was a necessary subject matter for teaching in engineering school. At the beginning of my interview with Mr. Bailey he said, "Creativity is a very important subject for the nation" (videotaped interview, 0:00.00). It was also a very important subject for our engineering students as well.

Meeting Bob Bailey was a terrific experience that left me with a couple of impressions. Creativity was a way of life for Mr. Bailey who stills exercises it with the vigor that I'm sure he always had. I thought it was a foregone conclusion that creativity diminished as one ages. That was wrong thinking. Creativity can be and should be a lifelong endeavor and way of life. This is supported by the work of Simonton (1988, 1997) who found that factors other than age account for variance in creative production.

Finally, based on what I learned, I have formulated some recommendations for the future. There were two decades worth of engineering students taught the creative



process by Mr. Bailey who are now nearing the end of their careers. A study to determine the impact of creativity training on their careers would be useful in determining the future direction of creativity education in the field of engineering. In addition, even without the study, engineering programs should incorporate creativity education to produce engineers with better problem solving skills. With creativity education in the engineering schools our society can create more Bob Bailey's contributing a lifetime of creativity to the world.

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## Appendices

- A. Concept Development Using CPS
- B. Concept Paper for this Project
- C. Human Subjects Form
- D. Consent Form
- E. Permission from CPSB to Reproduce Graphics
- F. Script of Videotaped Interview
- G. Résumé of Robert L. Bailey
- H. Robert L. Bailey's Retirement Speech
- I. Nomination to the Solar Hall of Fame
- J. GE Creative Engineering Program Certificate – 1951
- K. GE Creative Approach Seminar – 1956
- L. NASA Certificate of Recognition
- M. Patent 3,760,257 "Electromagnetic Wave Energy Converter"
- N. Products Created By RL Bailey
- O. PowerPoint Presentation Handout

**Appendix A: Concept Development Using CPS.**

## EXPLORE THE CHALLENGE

1. Identify the Goal, Wish, or Challenge. *It Would Be Great If...*(IWBG I), or *I Wish* (IW).
  - Come up with a series of goals and converge to one for which you have Ownership, Motivation, and a need for Imagination.
  1. **IWBG I had a great master's thesis topic.**
  2. IWBG I my master's thesis is widely recognized and respected.
  3. IWBG I my master's thesis research could be expanded to be a PhD dissertation.
  4. IW to be a creativity expert.
  5. IW to be a great new product development manager.
  6. IW to be a much more prolific inventor.
  7. IWBG I my master's thesis was the beginning of a new career for me.
  8. IWBG I discovered something new in the field of creativity.
  9. IWBG I could use my master's thesis to get a PhD in Engineering.
  10. IWBG I my master's thesis helped the WNY community.
  11. IWBG I could turn my master's thesis into a new business idea.
  12. IWBG I my master's thesis helped the Centers for Creative Studies at Buff State.
  13. IWBG I my master's thesis created demand for my advice and consultation.
  14. IWBAI no one uses my Master's thesis after I graduate.
  15. IWBAI my master's project did not impact anyone.
  16. IWBAI my work were a waste of time.
  17. IWBG I my work was the start of a teaching/writing career.
  
2. Gather Data. Facts, Feelings, Questions, and Data that need to be considered
  - Ask Who, What, Where, When, Why, How, then identify the most important, interesting, or intriguing data.
  - My values are good health, learning, support family well, have other's respect, feeling of achievement, financial security, and creating.
  - Vision: To be a person who has made life better for his family and others through the use of his talents and drive and has brought change for the better along the way.
  - I have a Bachelor and Master of Science in Mechanical Engineering from U.B.
  - I like inventing and have several patents.
  - I have been a manager of product engineering since 1995.
  - My MBTI profile is INTJ & My KAI score is 111.
  - My BCPI scores are Implementer (4.57); Ideator (4.11); Clarifier and Developer are both (4.0).
  - I like product design and management of new product development.
  - I like understanding how to lead creative people or to create an environment for innovation and creativity.
  - I want to finish by January 2002.
  - I may want to continue for a Ph.D. relating creativity to Mechanical Engineering.
  - Stanford University seems to be the most active in combining creativity with engineering. Dr. Rolf Faste & David Kelley
  - Dr. Jami Shah at Arizona State University is working in the field of product innovation.
  - Dr. Woodie Flowers at M.I.T. is interested in combining creativity with Mechanical Engineering.
  - Georgia Tech and George Mason University (Dr. Tomasz Arciszewski) have may have some interest in combining creativity and engineering.
  - Dr. Andres Soom, Associate Dean at U.B. suggested using my Creativity Studies Masters as a lead-in to a Ph.D. dissertation at U.B.
  - Dr. Kemper Lewis at U.B. has interest in product design innovation.
  - I think Delphi would see value in topics related to how to improve corporate organizational creativity and product innovation.
  - I see myself in the future as a product innovation leader at Delphi, an internal Delphi creativity consultant, a professor of creativity related to product and product development, or as an entrepreneur.
  - I don't want to be a facilitator only.
  - I want my career to always be one in which I am learning and growing, have respect, and making things better.
  - My advisor and the Creative Studies department needs must be met by my thesis.
  - I could do a study utilizing the Delphi Organization.
  - I could possible do a study utilizing the UB Mechanical Engineering.
  - I have taken the Creativity and Problem Solving class at Stanford, taught by Rolf Faste and Bernard Roth.
  - I don't want to move from Western N.Y.
  - I have interest in how the "tools" work.
  - I have interest in knowing which tools work best for product design.
  - I want to develop a great product development process.
  - I would eventually like to teach part time.
  
3. Clarify the Problem. How To (H2), How Might (HM), In What Ways Might I (IWWMI), What Might Be All The.. (WMBAT)
  - Use Divergent tools; e.g. Ladder of Abstraction, Word Dance, and Brainstorming, to get 25 to 30 problem statements.
  - Use Convergent tools like highlighting to end up with a single well-defined statement of the problem.
  1. **WMBAT great theses topics?**
  2. **WMBAT unique creativity theses topics?**
  3. **HM I find a great thesis topic?**
  4. **WMBAT creativity questions I have?**

## GENERATE IDEAS

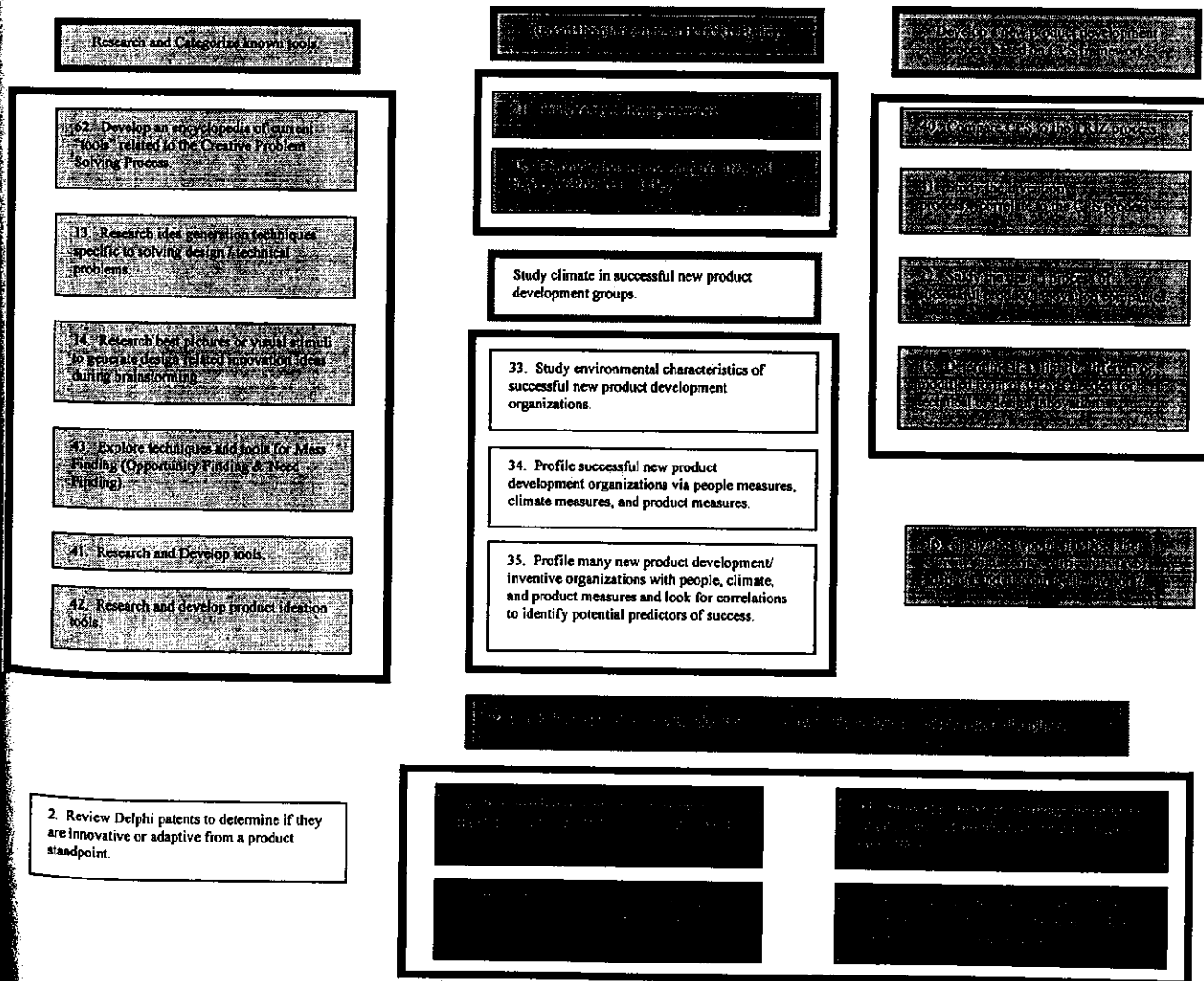
4. Generate Ideas.  
Diverge to get as many Ideas as possible using Brainstorming, Brainwriting, Forced Connections, SCAMPER, etc. Try to get at least 100 ideas.

### What Might Be All The Great Thesis Topics?

1. Study Delphi Innovator Hall of Fame Inductees to determine KAI distribution.
2. **Review Delphi patents to determine if they are innovative or adaptive from a product standpoint.**
3. Develop a theory to determine how to make Delphi environment more conducive to creating product improvements and/or innovations.
4. Develop computer based innovative product development tools for Delphi.
5. Develop Web based creativity enhancement tools to allow multi-cultural and worldwide creative problem solving.
6. Do a study at Delphi to determine personality and/or creativity make up of the various departments and cultures.
7. Develop a Theory to determine if there are better ways to encourage creativity.
8. Research the TRIZ method.
9. Research optimum team formation in Delphi for developing creative solutions for problems.
10. Research methods and ways to help Delphi inventors be more inventive.
11. Research methods to develop creative and innovative designs.
12. Research / study creative product designers.
13. **Research idea generation techniques specific to solving design / technical problems.**
14. **Research best pictures or visual stimuli to generate design related innovation ideas during brainstorming.**
15. **Determine if a slightly different or modified form of CPS is needed for technical/design innovation.**
16. **Study the hypothesis: Does the current engineering curriculum favor adaptors and discourage innovators?**
17. **Research the impact of teaching CPS to engineering students i.e. do they perform better in graduate school or on the job.**
18. Research the best way to teach creativity to engineering students.
19. Research artificial creativity (intelligence).
20. Research genetic impact on creativity – Are there creativity genes? Maybe UB is doing genetic research.
21. **Study famous living inventors.**
22. **Study the design process of successful product innovation companies.**
23. Research impact of CPS on companies that received training 1 year, 5 years, & 10 years ago.
24. Research current level of corporate leadership understanding of creativity concepts.
25. Research creativity level of engineering incoming freshmen versus graduating seniors, versus graduate students.
26. Research level of product innovative-ness to degree of acceptance.
27. Focus on New Product Development
28. Focus on Inventing.
29. Research characteristics of people best suited to work in a New Product Inventing group.
30. Study differences in successful New Product Development groups vs unsuccessful groups.
31. **Study the invention process...correlate to the CPS process.**
32. Study characteristics of successful new products.
33. **Study environmental characteristics of successful new product development organizations.**
34. **Profile successful new product development organizations via people measures, climate measures, and product measures.**
35. **Profile many new product development/ inventive organizations with people, climate, and product measures and look for correlations to identify potential predictors of success.**
36. Start an E-team at Buff State with a grant from the NCIIA.
37. Develop a business model for re-incorporating entrepreneur-ship within an established bureaucratic organization.
38. **Study the impact of creativity education on engineering undergraduates on future creative production.**
39. Study the Climate for Creativity Dimensions in successful and non-successful product development / design organizations.
40. **Compare CPS to the TRIZ process.**

41. Research and Develop tools.
42. Research and develop product ideation tools.
43. Explore techniques and tools for Mess Finding (Opportunity Finding & Need Finding).
44. Determine KAI distribution of engineering freshmen and compare with engineering seniors.
45. Compare TTCT scores of incoming engineering freshmen with seniors.
46. Research the current level of creative training in the major U.S. engineering schools.
47. Research the history of creativity training in engineering schools.
48. Chronicle the creative impact, life, and history of Robert L. Bailey.
49. Survey creativity training of top U.S. companies.
50. Research G.E.'s 1950's creativity training program and impact on creative achievements.
51. Vision of creativity 100, 200, or 500 years from now.
52. Genetic engineering impact on creativity.
53. How computers can be used to improve group/ organizational creativity.
54. Virtual Reality as creativity tool.
55. The use of computer technology in CPS.
56. Creativity for Senior citizens.
57. Creativity classes as a way to put synthesis back into engineering education.
58. Assess well-known inventions/ new products and relate development to CPS model.
59. Benchmark all current undergraduate creativity classes for engineers.
60. Benchmark the product innovation process at successful companies.
61. Compare creative engineering class climate to standard / traditional engineering class.
62. Develop an encyclopedia of current "tools" related to the Creative Problem Solving Process.

Converge to an idea or selected list of ideas that will solve the problem by highlighting the hits, cluster, and restate.





## PREPARE FOR ACTION

### 5. Select & Strengthen Solutions

1. State solution: *What I see myself doing is ...*
2. Use Praise First, Pluses Potentials, Concerns & Overcome Concerns one at a time.
3. Restate solution: *What I NOW see myself doing is ....*

#### Options: What I see myself doing is:

- a. Researching and categorizing known tools, or
- b. Recording the pioneering work of Robert L. Bailey, or
- c. Developing a New Product Development Process based on the CPS Process., or
- d. Researching the impact of creativity education on creative achievements in the technical disciplines.

#### Generate Criteria for evaluation of the options:

- |  |   |   |
|--|---|---|
| 1. Will it cost less than \$2,000?                     | 9. Will test subjects (people) be needed?     | 15. Will it make me an expert?                    |
| 2. Will it be important to my advisor?                 | 10. Can it be accomplished by December 2001?  | 16. Will others want to know about my findings?   |
| 3. Will it be resisted by anyone?                      | 11. Will it apply to new product development? | 17. Will it require many weekends in the library? |
| 4. Is it important to me?                              | 12. Will it apply to engineering management?  | 18. Will it have a definitive end?                |
| 5. Is it important to Delphi management?               | 13. Will it apply to engineering education?   | 19. Will it make me famous?                       |
| 6. Will it be important to future creativity scholars? | 14. Will it apply to a dissertation?          | 20. Will it appeal to a broad audience?           |
| 7. Is information available in CBIR?                   |   |   |
| 8. Will live interviews be needed?                     |   |   |

#### Select Criteria:

- Hits: See Bolded criteria above.
- Prioritize criteria with PCA.

	Option	Total	% Importance
A	Will it cost less than 2000?	3	4
B	Will it be important to my advisor?	13	18
C	Will it be important to future creativity scholars?	12	17
D	Is information available in CBIR?	6	8
E	Will live interviews be needed?	0	0
F	Can it be accomplished by December 2001?	8	11
G	Will it apply to New Product Development?	10	14
H	Will it apply to Engineering Education?	10	14
I	Will it apply to a dissertation?	2	3
J	Will it make me an expert?	8	11
<b>Total</b>		<b>72</b>	

Paired Comparison Analysis

**PCA TITLE: Master's Project Topic Criteria.**

A B	A C	A D	A E	A F	A G	A H	A I	A J
3	3	1	1	2	2	2	1	1
B C	B D	B E	B F	B G	B H	B I	B J	
1	3	3	2	1	1	2	1	
C D	C E	C F	C G	C H	C I	C J		
2	3	2	1	1	1	1		
D E	D F	D G	D H	D I	D J			
1	2	1	1	1	1			
E F	E G	E H	E I	E J				
2	3	2	2	2				
F G	F H	F I	F J					
1	2	1	1					
G H	G I	G J						
1	2	1						
H I	H J							
2	1							
I J								
								2

Fill in Diagonally

**Instructions**

- 1 Compare options indicated in each box.
- 2 Click on the cell under the option you prefer.
- 3 Enter the degree of preference as per the scale below.

Scale	
1	SLIGHTLY More Important
2	MODERATELY More Important
3	MUCH more Important.

Evaluation Matrix:

**Matrix Title: CRS690 Master's Project Topic Options Evaluation.**

Rating Scale: 3 - Excellent 2 - Good 1 - Fair 0 - Poor		Criteria							Totals
		Will it be important to my advisor?	Will it be important to future creativity scholars?	Will it apply to New Product Development?	Will it apply to engineering education?	Can it be accomplished by December 2001?	Will it make me an expert?	Criteria X.	
Weighting Factor		1.8	1.7	1.4	1.4	1.1	1.1	1	
Options									
1	Research & Categorize Known Tools.	3	3	2	2	3	3	2	21.4
2	Record the Pioneering work of RL Bailey.	2	2	2	3	3	0	2	19.3
3	Study climate in successful New Product Development Groups.	3	1	3	2	0	2	1	15.1
4	Develop a New Product Development Process based on CPS.	1	2	3	3	1	2	0	14.7
5	Research the impact of creativity education on achievements in the technical disciplines?	1	2	0	2	0	3	0	8
6	Study the question, "Does the current engineering discipline favor adopters and discourage innovators?"	2	1	0	2	0	1	0	8.1
7									
8									
9									
10									

Paired Comparison Analysis:

**PCA TITLE: Master's Project Topic Prioritization.**

Option	Total	% Importance
A Research & Categorize Known Tools	9	29
B Record the pioneering work of RL Bailey.	10	32
C Study climate in successful new product development groups.	6	19
D Develop NPD process based on CPS.	4	13
E Research the impact of creativity education on creative achievements in tech disciplines.	2	6
F Does current engineering curriculum favor adopters and discourage innovators?	0	0
G	0	0
H	0	0
I	0	0
J	0	0
<b>Total</b>	<b>31</b>	

**Fill in Diagonally**

A B 1 1	A C 2 2	A D 3 3	A E 3 3	A F 3 3	A G 3 3	A H 3 3	A I 3 3	A J 3 3
	B C 2 2	B D 3 3	B E 2 2	B F 3 3	B G 3 3	B H 3 3	B I 3 3	B J 3 3
		C D 3 3	C E 2 2	C F 1 1	C G 3 3	C H 3 3	C I 3 3	C J 3 3
			D E 1 1	D F 1 1	D G 3 3	D H 3 3	D I 3 3	D J 3 3
				E F 1 1	E G 3 3	E H 3 3	E I 3 3	E J 3 3
					F G 3 3	F H 3 3	F I 3 3	F J 3 3
						G H 3 3	G I 3 3	G J 3 3
							H I 3 3	H J 3 3
								I J 3 3

**Instructions**

- 1 Compare options indicated in each box.
- 2 Click on the cell under the option you prefer.
- 3 Enter the degree of preference as per the scale below.

**Scale**

1	SLIGHTLY More Important
2	MODERATELY More Important
3	MUCH more important.

## What I Now See Myself Doing Is:

**A. Researching and Categorizing Known Tools, OR**

**B. Recording the pioneering work of RL Bailey.**

### PPCo of Researching and Categorizing Known Tools.

#### Pluses:

- Great way to learn all of the current tools and what they are used for.
- The information is readily available.
- Excellent way to compare tools and select the best for my own use.
- I can include tools related to new product development.
- I can find where tools are lacking and eventually develop my own for publication.
- It would be of interest to all the creativity professors at Buff State.
- I could use the knowledge gained for application to new product development and developing an engineering creativity class.

#### Potentials:

- It could lead to a book / encyclopedia of tools that could be published.
- It might become a popular reference in the CBIR, used by future students and faculty.
- It might be the basis for developing a book related to CPS and New Product Development.
- It might lead to me developing a broad range of tools for specific disciplines.

#### Concerns:

- It may be too broad of a topic.
  - How to select an appropriate amount for the project write-up?
  - How to determine the criteria for selection of tools to include in the compendium?
- It may become expensive getting all of the books needed for the research.
  - How to get authors to donate books?
  - How to get Buff State to buy books for inclusion in the CBIR?
  - How to get interlibrary loans?

#### Overcome Concerns:

- How to select an appropriate amount for the project write-up?
  - Determine all possible categories and converge.
  - Review categories with Dr. Murdock at Concept paper time.
  - Do Data-Finding Divergence ASAP for tools and Converge.
- How to determine the criteria for selection of tools to include in the compendium?
  - Review Targeted Strategies for Divergence and Convergence in CAPS book.
  - Identify other authors/researchers in CAPS book related to tools.
  - Research Gryskiewicz, Geschka, Eberle, and other tool developers.
  - Research CBIR using keywords related to tool development.
  - Talk to psychiatrists about the way thinking tools work in the mind as related to divergent and convergent thinking.
  - Use Generating Criteria technique to diverge and converge on tool criteria.
  - Use a brainstorming session to generate tool category criteria.

**PPC of recording the pioneering work of RL Bailey.**

**Pluses:**

- Great way to learn from a pioneer in teaching creativity to engineers.
- He deserves a spot in creativity history.
- I could use the knowledge gained for application to new product development and developing an engineering creativity class.
- If I don't do it, it will not get done.

**Potentials:**

- It could lead to an interesting human-interest style article for popular magazines like Popular Mechanics, Scientific American, etc.
- It could lead to enhancing the CSC department through broadening into the technical domain.
- It might be useful in pursuing a Ph.D.
- It might lead to incorporating Bailey's library into the CBIR.

**Concerns:**

- It may be too narrow of a topic.
  - How to get more people interested in creativity as applied to engineering?
- It may become expensive travelling to Florida for the interviews.
  - How to plan the interviews for maximum coverage and recording?
- Robert L. Bailey may feel it is too much of an intrusion.
  - How to get acceptance from Mr. Bailey?
- Future CSC students may not use it.
  - What might be all the interesting titles?
  - What might be all the ways to get future CSC student interested in my project?

**Overcome Concerns:**

- What might be all of the interesting titles?
  - Pioneer of Creativity for Engineers.
  - Biography of Robert L. Bailey.
  - Robert L. Bailey and Disciplined Creativity for Engineers.
  - Development of a Structured Creativity Process for Engineers.
  -



## 6. Plan for Action.

### 1. Diverge to get a list of all the actions that might help to make the solution happen.

#### Assistors

- Who
  - Robert L. Bailey
  - Lisa (Wife)
  - Eddie (Son)
  - Mary Murdock (Advisor)
  - Dr. Lewis at UB for opinions.
  - Creative Studies Library.
  - Book binders
- What
  - Video Camera for recording interviews.
  - Still picture camera for photographing Bailey and his products.
  - Microsoft PowerPoint for presentation.
  - "Disciplined Creativity for Engineer's" Book
  - "Creative Approaches to Problem Solving" Book
  - Digital camera.
  - Slide Projector.
  - Digital Movie camera.
  - Website for posting presentation for getting reviews.
  - Tape recorder for recording telephone interviews with Robert L. Bailey.
  - Copies of Bailey's patents.
  - Pictures of some of Bailey's creative products.
  - Course book / teaching for the text.
- Where
  - Gainesville, Florida for interviewing Bailey.
  - Demopolis, Alabama – Bailey's hometown.
  - Syracuse, NY – Where Bailey worked for G.E.
  - Schenectady, NY – Another G.E. site where Bailey worked.
  - Office at home for writing project.
  - Camper for secluded working spot.
  - CBIR for further research.
  - Patent Office Website for getting copies of Bailey's Patents.
- When
  - Concept paper : May 2001
  - Interview Bailey: May 26 – 28, 2001
  - PowerPoint Presentation (Initial): October 8, 2001.
  - Presentation to Creative Studies Students and Faculty: October 8 – 29, 2001.
  - Project (Rough Draft): December 20, 2001.
  - Visit Robert L. Bailey: Christmas Vacation
  - Project Final Copy: April 2002.

### 2. Converge to form a specific plan.

*See Concept Paper*

**Appendix B: Concept Paper for this Project**

**Theme:**  
**Developing or Improving Our Understanding of CPS**  
**Initiative:**  
**Linking CPS to Other Areas or Constructs**

**Project Title: Robert L. Bailey's Disciplined Creativity Process for Engineers Compared to the Creative Problem Solving Process**

**Rationale and Questions:** The purpose of this project is to research the creativity process that Robert L. Bailey developed and taught specifically for engineers. In addition this project aims to capture the events, thoughts, and experiences of Mr. Bailey that resulted in a major development in the field of creativity.

- How does the disciplined creativity process for engineers compare to Creative Problem Solving?
  - What factors led to the development, teaching, and publication of Disciplined Creativity for Engineers?
  - What can be learned from the experiences of Robert L. Bailey's pioneering efforts in developing and teaching a creativity process to engineers?

**Statement of Significance:** Very few Universities teach creative problem solving, especially to engineers. Robert L. Bailey's book "Disciplined Creativity for Engineers" is unique in that it describes a creative problem solving process developed especially for engineers. It is unique in that it was developed and written by an engineer who both practiced and taught engineering, and it was used over the course of two decades to teach a required course in creative problem solving to engineering students at a major university. Although the book is available in the Creativity Based Information Resources library, it is not well known in the creativity field in general and no known comparison to Creative Problem Solving has been made. Researching the creative problem solving process that Robert Bailey developed and taught, and comparing it to the Creative Problem Solving process will likely add insight into creative problem solving in the engineering domain.

In addition, this project will include a biographical portion that will capture the experiences, thoughts, and reasons behind Robert Bailey's development of the creative process. Capturing the "person" aspects behind the "process" will add richness that will likely give added insight and information about the process.

**Description of the Method or Process:** An in depth review of the book "Disciplined Creativity for Engineers" written by Robert L. Bailey (1978) will be conducted. The creative process developed by Mr. Bailey will then be compared with the Creative Problem Solving Process model. Both a structural and functional comparison will be made. In addition, interviews with Mr. Bailey will take place to understand and capture the events, thoughts, and circumstances that led him to the development, teaching, and publication of the disciplined creative engineering process.

**Learning Goals:** My learning goals that drive me to pursue this project are as follows:

- To understand how Bailey's disciplined creativity process for engineers compares to CPS
- To understand how and why Robert L. Bailey developed his creativity process
- To learn how teaching creativity to engineers should be approached based on Robert L. Bailey's experience.

**Outcomes:**

- Video and audio recordings of interviews with Robert L. Bailey capturing the history around the development and teaching of Disciplined Creativity for engineers.
- Executive summary and ten Creativity Based Information Research (CBIR) annotations.
- PowerPoint presentation.
- Project write-up

**Timeline:**

- April 2001:
  - Meet with Dr. MC Murdock to get input and alignment on project
  - Initial meeting with Robert L. Bailey
  - Research literature
  - Draft of concept paper
- May 2001:
  - Revise and finalize concept paper
  - Begin collecting information from Robert L. Bailey
- September 2001 – November 2001:
  - Review CPS and Disciplined Creativity for Engineers
  - Begin PowerPoint presentation
- December 2001:
  - Complete the Human Subjects form
  - Get consent form signed by Robert L. Bailey and continue interviews.
- January 2002:
  - Consolidate interview videotapes
  - Begin writing draft
- February 2002 – March 2002:
  - Refine and Finalize draft
  - Finalize PowerPoint presentation
- April 2002:
  - Submit project for approval
- May 2002:
  - Graduate



**Principal Investigators:**

- Dr. Mary C. Murdock
- Edward D. Pettitt

**Related Literature:**

Bailey, R.L. (1978). Disciplined creativity for engineers. Ann Arbor, MI: Ann Arbor Science Publishers.

Fabian, J. (1990). Creative thinking and problem solving. Chelsea, MI: Lewis Publishers, Inc.

Isaksen, S.G., Dorval, K.B., & Treffinger, D.J. (1994). Creative approaches to problem solving. Dubuque, Iowa: Kendall/Hunt Publishing Company.

Isaksen, S.G. & Treffinger, D.J. (1987). Creative problem solving: Three components and six specific stages. Unpublished instructional handout.

Osborn, A.E. (2001). Applied imagination: Principles and procedures of creative problems solving. Buffalo, NY: Creative Education Foundation.

**Appendix C: Human Subjects Form**

The Research Foundation of SUNY  
State University College at Buffalo  
PROPOSAL ABSTRACT FOR RESEARCH  
INVOLVING HUMAN SUBJECTS

Request for Expedited Review 

Request for Full Board Review \_\_\_\_\_

Researcher/Project Director	<u>Edward D. Pettitt</u>	Ext. _____	Room # _____
Faculty Sponsor (for student projects)	<u>Dr. Mary C. Murdock</u>		
Project Title	<u>Robert L. Bailey's Disciplined Creativity Process for Engineers Compared to the Creative Problem Solving Process.</u>		
Project Dates	<u>5/1/2001</u>	to	<u>4/15/2002</u>
Date of Submission	<u>April 15, 2002</u>		
Sponsoring Agency	_____		

Briefly describe the project: (attach a copy of grant application (if applicable), and consent form)

This project will compare the Disciplined Creativity process for engineers with Creative Problem Solving. In addition, information about Robert L. Bailey, the author of "Disciplined Creativity for Engineers" obtained from personal interviews will be included. See attached concept paper.

Do the potential subjects of this study include any of the following:

Children (under the age of 18) No  Yes \_\_\_\_\_Prisoners No  Yes \_\_\_\_\_Pregnant No  Yes \_\_\_\_\_Cognitively Impaired Persons No  Yes \_\_\_\_\_Is the research to be conducted in the U.S.? No \_\_\_\_\_ Yes Degree of Risk None  Minimal \_\_\_\_\_ Greater than Minimal \_\_\_\_\_

(Minimal risk means that the probability and magnitude of harm or discomfort anticipated in the research are not greater, in the research are not greater, in and of themselves, than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests.)

Written consent required? No \_\_\_\_\_ Yes  (attach copy of consent form)Questionnaire to be administered or Interview to be conducted? No \_\_\_\_\_ Yes  (attach copy of questionnaire)SUCB students involved as subjects? No  Yes \_\_\_\_\_Does the project involve deceptions? No  Yes \_\_\_\_\_Are you conducting interviews or surveys on sensitive topics? No  Yes \_\_\_\_\_

The Federal Regulations require that the protocol meet certain criteria before IRB approval can be obtained. Describe in detail how the following requirements will be satisfied.

- A. Insure that the risks to the subject are minimized.
- B. Justify the degree of risk involved (if any) in relationship to the potential benefit of the project to the subject matter.
- C. Insure that the selection of subjects is equitable.
- D. Guarantee that informed consent will be obtained from each prospective subject or the subjects, legally authorized representative, and that consent forms will be adequately documented.
- E. Monitor the data collected to ensure the safety of the subject.
- F. Protect the privacy of subjects and maintain the confidentiality of data.
- G. Provide for extra safeguards to protect the rights and welfare of "vulnerable" subjects (e.g., children, prisoners, pregnant women, mentally disabled persons, or educationally disadvantaged persons).

The project identified above may be approved through an expedited review procedure because the research activities involve no more than minimal RISK as defined above, and the involvement of human subjects will be limited to one or more of the following:

- 1) Clinical studies of drugs and medical devices only when condition (a) or (b) is met.
  - a. Research on drugs for which an investigational new drug application (21 CFR Part 312) is not required. (Note: Research on marketed drugs that significantly increases the risks or decreases the acceptability of the risk associated with the use of the product is not eligible for expedited review.)
  - b. Research on medical devices for which (i) an investigational device exemption application (21 CFR Part 812) is not required; or (ii) the medical device is cleared/approved for marketing and the medical device is being used in accordance with its cleared/approved labeling.
- 2) Collection of blood samples by finger stick, heel stick, ear stick, or venipuncture as follows:
  - a. From healthy, nonpregnant adults who weigh at least 110 pounds. For these subjects, the amounts drawn may not exceed 550 ml in an 8 week period and collection may not occur more frequently than 2 times per week; or
  - b. From other adults and children, considering the age, weight, and health of the subjects, the collection procedure, the amount of blood to be collected, and the frequency with which it will be collected, and the frequency with which it will be collected. For these subjects, the amount drawn may not exceed the lesser of 50 ml or 3 ml per kg in an 8 week period and collection may not occur more frequently than 2 times per week.
- 3) Prospective collection of biological specimens for research purposes by noninvasive means.
- 4) Collection of data through noninvasive procedures (not involving general anesthesia or sedation) routinely employed in clinical practice, excluding procedures involving x-rays or microwaves. Where medical devices are employed, they must be cleared/approved for marketing. (Studies intended to evaluate the safety and effectiveness of the medical device are not generally eligible for expedited review, including studies of cleared medical devices for new indications.)
- 5) Research involving materials (data, documents, records, or specimens) that have been collected, or will be collected solely for nonresearch purposes (such as medical treatment or diagnosis). (NOTE: Some research in this category may be exempt from the HHS regulations for the protection of human subjects. 45 CFR 46.101(b)(4). This listing refers only to research that is not exempt.)
- 6) Collection of data from voice, video, digital, or image recordings made for research purposes.
- 7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies. (NOTE: Some research in this category may be exempt from the HHS regulations for the protection of human subjects. 45 CFR 46.101 (b)(2) and (b)(3). This listing refers only to research that is not exempt.)
- 8) Continuing review of research previously approved by the convened IRB as follows:
  - a. Where (i) the research is permanently closed to the enrollment of new subjects; (ii) all subjects have completed all research-related interventions; and (iii) the research remains active only for long-term follow-up of subjects; or
  - b. Where no subjects have been enrolled and no additional risks have been identified; or
  - c. Where the remaining research activities are limited to data analysis.
- 9) Continuing review of research, not conducted under an investigational new drug application or investigational device exemption where categories two (2) through eight (8) do not apply but the IRB has determined and documented at a convened meeting that the research involves no greater than minimal risk and no additional risks have been identified.

Project Director's Certification  
Program Involving HUMAN SUBJECTS

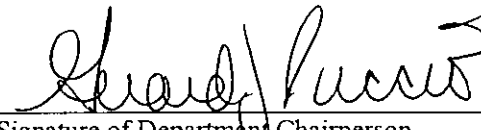
The proposed investigation (*research or training program*) involves the use of human subjects and I am submitting the complete application form and description of the project to the Institutional Review Board for Research Involving Human Subjects.

If the Board grants approval of this application, I agree to:

1. Abide by any conditions or changes in the project required by the Board.
2. Report to the Board any change in the research plan which affects the method of using human subjects before such change is instituted.
3. Report to the Board any problems which arise in connection with the use of human subjects.
4. Seek advice of the Board whenever I believe such advice is necessary or would be helpful.
5. Secure the informed, written consent of all human subjects participating in the project.
6. Cooperate with the Board designated in its effort to provide a continuing review after investigations have been initiated.

I have reviewed the Federal and State regulations concerning the use of human subjects in research and training programs and the guidelines of the State University College at Buffalo. I agree to abide by the regulations and guidelines aforementioned and will adhere to policies and procedures described in my application. I understand that changes to the research must be approved by the IRB before they are implemented.

  
\_\_\_\_\_  
Signature of Project Director

  
\_\_\_\_\_  
Signature of Department Chairperson

ACTION OF REVIEW BOARD

The Institutional Review Board for Research Involving Human Subjects has reviewed this application to ascertain whether or not the proposed project:

1. provides adequate safeguards of the rights and welfare of human subjects involved in the investigations;
2. uses appropriate methods to obtain informed, written consent;
3. indicates that the potential benefits of the investigation substantially outweigh the risk involved.

BOARD DISPOSITION:

\_\_\_\_\_  
Chairperson, Institutional Review Board

\_\_\_\_\_  
Date

## **Interview Questions**

1. How did you become interested in the subject of creativity?
2. What factors led you to develop Disciplined Creativity for Engineers?
3. What were some of your experiences in teaching creativity to engineers?
4. In what ways do you demonstrate your own creative production?

## Appendix D: Consent Form

RCVD  
12/29/01  
RJB

**Robert L. Bailey's Disciplined Creativity Process for Engineers  
Compared to the Creative Problem Solving Process**

**Introduction:** As the author of "Disciplined Creativity for Engineers" and the developer and teacher of the creativity process described in the book, you are being asked to participate in a research study comparing your creativity process to the Creative Problem Solving Process.

**Procedure:** If you decide to participate in this study, you will be asked to discuss your thoughts, experiences, and the events that led to the development of the disciplined creativity process for engineers. In addition, you will be asked to discuss your experience with regards to teaching creativity to engineers during your career as a professor at the University of Florida. Also, any discussion you are willing to share with regards to personal demonstrations of your creativity will be welcome. These discussions will be videotaped for future reference. In addition, correspondence, photographs of creative products, or other artifacts and articles relating to your creative development and production would be welcomed and may be included in the research.

**Risk/Side Effects:** There should be no risks or side effects to you as a result of participating in this research study.

**Benefits:** There are no specific benefits to you as a result of your participation, other than the knowledge that you have contributed to the advancement of the study of creativity and helped to improve the curriculum with your comments.

**Voluntary Participation:** Your participation in this study is completely voluntary. You may quit at any time you want without penalty.

**Confidentiality:** The information you choose to share i.e. letters, videotaped interviews, memorandums, photographs, and all other records relating to your creative development and production is not intended to remain confidential. It is intended to be used in presentations and a Masters project write-up. In addition, some or all of the material collected will be made available for future students of creativity to access as part of their research. Finally, the information obtained may be used in the discussion of engineering creativity within and outside of academia.

**Please note:** You must be 18 years of age or older to participate in this study.

**Consent to Participate in Research Study:** If you wish to participate in this study, please sign below:

Signature: Prof. Robert L. Bailey 12/29/01  
Name (Print): Robert L. Bailey



**Appendix E: Permission from CPSB to Reproduce Graphics**

# REPRODUCTION & DUPLICATION REQUEST FORM

**To:** K. Brian Dorval, Director of Programs  
 Creative Problem Solving Group, Inc.  
 1325 North Forest Road, Suite 340, Williamsville, NY 14221  
 Phone: (716) 689-2176 Fax: (716) 689-6441

**From:** (Type your name, title, affiliation, address, phone, fax and E-mail):

*Edward J. Pettitt  
 5604 Idle Rd.  
 Quapt, NY 14028*

**Today's Date:** 4/10/02

**RE:** Request for permission to reproduce or duplicate CPSB material  
**DATE HANDOUTS NEEDED BY:** ASAP

I am working with the following group (Include name and purpose of the group):

*Master's Thesis/Project. Request is to electronically produce the following and use them in his thesis/project. Permission is granted*

This is a (please circle one):    for-profit Activity    not-for-profit activity

**I would like permission to reproduce or duplicate the following handouts:**

Handout Title	Description	Quantity	Administrative Use	
			Accepted (✓)	Fee
<i>From CAPS:</i>				
<i>Fig 2.13</i>	<i>p. 54</i>	<i>5-15</i>	<i>α</i>	<i>-0-</i>
<i>Fig 2.17</i>	<i>p. 58</i>	<i>5-15</i>	<i>α</i>	<i>-0-</i>
<i>Fig 4.1</i>	<i>p. 189</i>	<i>5-15</i>	<i>α</i>	<i>-0-</i>
<i>Fig 7.1</i>	<i>p. 231</i>	<i>5-15</i>	<i>α</i>	<i>-0-</i>
<i>Fig 8.1</i>	<i>p. 270</i>	<i>5-15</i>	<i>α</i>	<i>-0-</i>

**Administrative Use Only**

Request Approved.

Duplicate those handouts identified above.

Request rejected. (Reason):

No Charge

Total Fee \_\_\_\_\_

Signature: *Kenneth Dorval*

Date: *4/10/02*

**Appendix F: Script of Videotaped Interview**

## Interview with Robert L. Bailey Videotape Script

Following is a script of the interview with Robert L. Bailey that took place at his home in Gainesville, Florida on May 27 and 28, 2001. Other than responding to a couple of direct questions, this taped interview is basically a monologue by Mr. Bailey discussing his work, experiences, teaching, personal projects, creations, and other tidbits and stories relative to his life involvement with creativity.

The time noted in the following script should be considered as approximate since video playback equipment will vary slightly in time measurement. The time is given in the format h:mm.ss, where h= hours from the beginning, mm= minutes, and ss = seconds. Any quotes in the script are those by Mr. Bailey.

<u>Time</u>	<u>Subject / Comments / Quotes</u>
0:00.00	Start of the interview on Sunday 5/27/01 at 9:30 am in Robert L. Bailey's study in his home in Gainesville, Florida. <i>"Creativity is a very important subject for the nation."</i>
0:01.50	Begins discussing the creative process. Mentions early work by Wallas and Osborn.
0:03.30	His early remembrance of his interest in a creative process was when he visited Mr. John Copeland's machine shop in Demopolis, Alabama and saw creative people coming to the shop to have prototypes of their inventions made. He thought, even as a little boy, that there must be a process for coming up with the ideas.
0:05.13	He attended Alabama Polytechnic University, which is now Auburn University.
0:05.45	He mentioned that creativity was absent in undergraduate engineering.
0:06.27	In 1950, Mr. Bailey was selected to General Electric's Creative Engineering program. The program started about 1935. Twenty students were selected out of approximately 1200 new engineers for 1950.

- 0:07.30 These students were to be the future designers and inventors for General Electric.
- 0:08.00 Mr. Bailey worked on washing machine design with Cliff Reitz (sp?).
- 0:09.00 Mr. Bailey discusses the interview he had for selection into the creativity program. He told the two interviewers that the General Electric toaster design was the "sorriest toaster" on the market, but then explained what could be done to improve it. Mr. Bailey explains he was selected to the creativity program because of his statement that showed he had "constructive discontent".
- 0:11.42 Mr. Bailey then went to work in Syracuse and took creativity classes in Schenectady, N.Y. in 1950.
- 0:12.50 General Electric had a four step creative process which was Investigate Direction, Goal Setting, Determine Means, and Build and Test Solution.
- 0:13.56 Mr. Bailey discusses Alex Osborn. General Electric used one of Osborn's books in their class.
- 0:15.00 G.E. used brainstorming and deferment of judgment from Osborn. Osborn had useful information, but they felt it was not well organized.
- 0:16.34 Mr. Bailey discusses how they saw the creativity process as being flawed. The creativity program at General Electric was getting criticism from the "Analytikers". The "Analytikers" had the ABC program, which was a very prestigious program at G.E.
- 0:18.35 The "Analytikers" didn't realize, before you can analyze, someone has to create the circuit or model.
- 0:19:50 Mr. Bailey discusses how the "Convince Others" step began. He was asked to take a report generated in the creativity class to the Chief Engineer of generators in Schenectady to "sell" the idea to him. The idea would have been a major labor and cost savings idea for wrapping the wire insulation. The Chief Engineer rejected the idea since what they were doing had worked since the time of Edison. This was the pivotal event that led to the understanding that the creative process needed a "Convince Others" phase.
- 0:24.23 The Optimize step was added sometime thereafter. Bailey was not a part of that. An example at G.E. at the time that identified that the Solution Optimization step was needed was when Admiral Rickover demanded a control panel be designed and built in about 3 weeks for a nuclear submarine in Groton, Connecticut. At the point of putting the G.E. control

panel in the submarine, the panel would not fit through the hatch. A panel needed to be cut out of the submarine to install the control panel, and then re-welded. They realized they needed to optimize the design from the users viewpoint before building. They now have 6 steps to the process.

- 0:29.02 Mr. Von Fange was in the creativity class one year ahead of Mr. Bailey. Mr. Von Fange later wrote, "Professional Creativity", published by Prentice Hall.  
G.E.'s 6-step approach was pretty well evolved by the early 1950's. Every division brought problems to the class to be solved.
- 0:31.30 The G.E. clock division brought the "Mystery Clock" problem. Mr. Bailey discusses the mechanical-digital clock proposal.
- 0:34.55 G.E. Jet Engine Division proposed the problem of a variable area exhaust nozzle. Mr. Bailey suggested something like the camera iris.
- 0:37.04 People came to the class from all over G.E. to discuss experiences and some of the mistakes that were made.  
The Research lab usually came with solutions they had invented but needed problems to solve with them! This troubled Mr. Bailey who felt you should start with the need.  
The more logical approach is to start with a human need.
- 0:40.50 Mr. Bailey discusses that he noticed that the recent engineering graduates couldn't think clearly relative to problem solving so he taught the Creative Approach Seminar for about one year.  
He used Von Fange's book.  
The engineers wanted more detail within the steps.  
Bailey saw weaknesses in Von Fange's book.
- 0:43.00 Mr. Bailey discusses coming to the University of Florida in 1960.  
He mentioned to Bruce Matthews that he would like to teach creativity to the undergraduate engineering students.  
Merlin Larson (sp?) was the department chairman and offered EE472 - Problem Solving to Bailey for him to teach.  
*"This is like asking a rabbit would he like to jump into the briar patch."*
- 0:44.37 In the Fall of 1961, Creative Problem Solving started being taught at the University of Florida.  
He used Von Fange's book as the textbook from 1961-1969.  
The course was based on believing that a person's creativity could be enhanced.  
Bailey mentions that some faculty believed you are either born creative or not.

- 0:47.00 Charts were developed to detail the steps. Students tried them out. Students needed fairly specific guidance. Problem Inquiry is very difficult.
- 0:48.40 Mr. Bailey discusses giving students the challenge of helping blind people. The students initially thought that the solution involved helping them to see. After talking to blind people as part of Problem Inquiry, the biggest need for the blind people was to not get "ripped off" during money exchanges. The students learned that you need to talk to the people who have the need.
- 0:51.51 In 1969 Mr. Bailey wrote the prospectus (nature and scope) for Discipline Creativity for Engineers. He wrote it from 1969 – 1978. He received a grant from a utility company that financed some of the writing.
- 0:54.20 Mr. Bailey gave all of his creativity references to the University of Florida.
- 0:56.50 Mr. Bailey discusses the internalization of the process that comes with practice. After time, you don't need to refer to the book.
- 0:58.40 Mr. Bailey explains why he called the book Disciplined Creativity for Engineers.  
Mr. Bailey relates a Sunday sermon where the preacher said discipline has many meanings, one of which is right thinking.
- 1:00.00 Tape stops for a rest break.  
Interview still takes place in Mr. Bailey's study.  
Begins again with the subject of the G.E. creativity class from September 1950 to May 1951.  
Students were forced to create on a weekly basis.  
Mr. Bailey reviews examples from the 1950 creativity class.
- 1:02.14 Several students addressed the copy machine problem, for example indexing the pages.
- 1:03.17 Mr. Bailey tells the story of one man who flew with the air national guard out of Rome, NY, and worked on the problem of optimizing the rate of climb depending on several factors. He devised a mechanical computer to tell you what altitude you should climb to depending on your input variables.
- 1:05.48 Discussed other projects related to working on an automatic camera and several materials problems, like working with liquid sodium for nuclear power plants.

- 1:09.50 Mr. Bailey describes his own project. He shows his report from his 6-week project. He was working with Mr. Ed Lederer (sp?) in Syracuse, who was a mechanical engineer, to devise a device for the rotational positioning of a mirror.  
The students had a shop that they could work in to build their models.
- 1:21.43 RCA came out with another way to solve the basic problem that Mr. Bailey was working on which did not require positioning a mirror.  
*"When you create there are usually some competition somewhere."*
- 1:23.30 The refrigerator people brought a lot of refrigerator problems.
- 1:24.13 Mr. Bailey worked on the oven smoke problem for the electric stove.
- 1:26.19 Mr. Bailey discusses the issue of building models.  
A weakness in creative education was that there were no funds to build the models of the idea.  
Nobody wants to build models anymore. People believe that everything can be computer modeled.  
You have to build a model and test it under realistic conditions.
- 1:29.30 They learned about failure in the class.
- 1:30.00 Mr. Bailey discusses various work assignments he had.  
June 1949: Worked as a junior engineer for a senior engineer in the test program.  
First assignment in Philadelphia, PA, switch gear for Paul Schneider (sp?).  
The switches were aircraft circuit breakers for AC or DC.  
There was a lady engineer who was very kind and patient with junior engineers.
- 1:34.00 The lady engineer taught him that there are many variables in reality so that testing is required to understand how a design will perform. You can't calculate all problems exactly.
- 1:35.20 Discussed 3 phase to DC rectifier problem. Mechanical switches wore out very quickly.
- 1:36.50 Also worked in Pittsfield, MA, on a gun fire control system for the Navy.
- 1:39.26 Mr. Bailey tells when he was leader of a test group, which had to inspect a device with 5,000 connections. When one of the connections was missed, the unit failed.
- 1:43.39 In 1949 Mr. Bailey worked in Bridgeport, CT, in the appliance business on automatic electric blanket testing. He was nearly trapped in the test chamber by a fire that had started outside the chamber. He escaped



through the fire and literally fell into the arms of a company V.P. who initially thought Bailey caused the fire. The V.P. was then told that the fire occurred when another engineer was testing a flight suit.

- 1:50.27 When you do creative work, you worry about someone coming along and solving your problem in a more clever way.
- 1:52.19 Mr. Bailey tells the story of when he fell asleep while laying in a bed testing a competitor's electric blanket. His boss was half the way home when he realized Bailey must have fallen asleep so he went back to work and woke up Bailey around 6:30 pm.
- 1:54.00 G.E. worked on a plasma warmer for blood transfusions.
- 1:55.37 Mr. Bailey worked on heated foot mats for elderly people. He remembers that 116 degrees Fahrenheit is the maximum most people can stand. He also worked on electric heating for houses.
- 2:00 This portion of the interview ends.
- 2:00 Next portion of the interview also takes place in Mr. Bailey's study. Mr. Bailey tells the story of developing the porcelain finished washing machine top for General Electric. His "constructive discontent" was paying off. This story exemplifies the need for optimizing the solution from the customer's point of view. Even though he thought the design would work, testing with real customers showed that the porcelain was spalling off the top due to heavy loads, i.e. kids, which were sitting on the machines thus deflecting the top. The tops were strengthened and then the design was released for production.
- 2:07.17 The washing machine suspension system that Mr. Bailey worked on has been in production for 40 to 45 years.
- 2:08.44 In Syracuse, Mr. Bailey worked in television receivers. He worked on the color TV receiver. Peter Golmar (sp?) was the inventor.
- 2:13.30 When G.E. had a strike, Mr. Bailey worked on his projects in his supervisor's basement.
- 2:15.00 Bailey relates another example where a design based solely on analytical calculation did not work.
- 2:16.20 Mr. Bailey tells the story of when G.E. set up the cameras to due a remote site broadcast of the Thanksgiving dinner. It was difficult to do remote broadcasting due partly to the size of the cameras. The fruit colors were not showing right because someone colored them as a practical joke.

- 2:19.06      *"You have a lot of fun in creativity."*
- 2:19.43      Mr. Bailey asked for an assignment with a mechanical engineer to get broader experience. He then worked on a mechanical color transmitter.
- 2:24.16      The camera was featured at a conference, but one of the motors burned out.  
*"One little detail can sabotage a creative project."*  
 The Goals phase and the Optimize phase are very necessary.
- 2:26.00      When the Korean War started, Mr. Bailey was in the naval reserves so General Electric transferred him to Schenectady to work on civilian and military projects on aircraft ordinances. He worked on the autopilot for the delta wing aircraft. He got to study and learn a lot about Thiotrons (sp?).
- 2:31.00      When asked to help work on rudder control, Mr. Bailey discovered the cause of the oscillation in about 30 minutes because of the way he looked at the problem. He designed in a transformer, which worked perfectly the first time.
- 2:35.40      The interview starts again, after a rest break, back in Mr. Bailey's study. The chair and writing board, which Mr. Bailey used in writing Disciplined Creativity for Engineers, are shown.
- 2:37.00      He shows his short-wave radio, which has been a life-long hobby.
- 2:37.30      Mr. Bailey describes the sketches he has made of his father's machinery that his father used in Demopolis, AL.
  - Radio service workbench his father made.
  - Lathe with 3 hp gas engine his father used to make porch columns from trees.
  - 6 hp Gasoline engine.
  - Homemade saw, planer, sander.
- 2:40.20      Mr. Bailey tells of the time he turned off the engine to the saw when his father got caught by his sweater in the equipment.  
 He also shows a sketch of how his father fixed wagon wheels in the 1930's.
- 2:42.41      Copies of the sketches have been donated to the Marengo County Historical Society in Demopolis, Alabama.
- 2:43.28      Mr. Bailey discusses the model engine his father made in the 1920's while taking night classes in machining.

- 2:44.51 Mr. Bailey discusses his flying hobby and when he rebuilt and improved a crashed plane. He later used the plane for flying and traveling the eastern U.S.
- 2:45.38 View of the Japanese Dolls.
- 2:45.52 Mr. Bailey describes the bookcase he made, starting with a piece from an armoire that his father owned.  
The bookcase took 2 ½ years to build.
- 2:47.00 Modular sections of the bookcase are held together with nuts and bolts made from plum wood.
- 2:50.00 Describes how he used vacuum to put veneer on the doors to his bookshelf.
- 2:50.31 Mr. Bailey discusses the various mementos kept on a shelf in his bookcase.
- Gasoline blowtorch his father used.
  - TV antenna amplifier he designed and built.
  - The long and short sighted tubes given to him by his students representing narrow views of “Analytikers” and the broad view of “Synthetikers”
  - Retirement plaque
  - Slide Rule
  - Solar Hall of Fame trophy
- 2:58:42 Mr. Bailey describes how he made castings for his fence using a pattern from a china dish.
- 2:59.50 Mr. Bailey describes more mementos
- Ceramic tubes
  - Amateur radio devices
- 3:03.00 Mr. Bailey developed a mobile antenna to find a short in an electric power line affecting television reception. In essence, he created a mobile television.
- 3:05.35 Pictures of Robert Bailey’s family – mother, father, brother, sister.
- 3:06.14 Mr. Bailey describes and demonstrates the in house intercom set he designed and built. It connects the study, kitchen, bedroom, and workshop.
- 3:09.00 Mr. Bailey has been researching chemical allergies and shows his vast card file. He plans to write a book, Bob’s Allergy Helps.

- 3:10.00 The interview now takes place on May 20, 2001 in Mr. Bailey's family room where he is discussing and showing the pecan wood entertainment center that he designed and built.  
He also describes the grills that he made for the cabinet doors.
- 3:20.06 The coffee table which he also designed and built is described.
- 3:21:05 The Bailey mural is described which is a representation of his life. His life symbols are the live oaks, wife & daughters, electric power lines, airplane, antenna symbol of communication, students, fair weather, and a storm cloud.
- 3:24.38 End of Bailey mural discussion.
- 3:24.38 Monday May 28, 2001 in Mr. Bailey's living room at 3124 NW 16<sup>th</sup> St Gainesville, Florida  
Mr. Bailey discusses the teaching of creativity to engineering students.  
Mr. Bailey retired in 1982 as Associate Professor Emeritus.  
Taught creative problem solving course from 1961 to 1982.  
Many of the teaching aspects are covered in the instructor's workbook.
- 3:27.48 We don't expect to convert students into geniuses or Thomas A. Edisons, but we do expect to increase or enhance their creativity.  
You will encounter people who believe creativity cannot be taught.
- 3:29.38 Students get so excited working on their projects that they sometimes neglect their work in other classes.
- 3:30.38 You need to give students an environment where they have the freedom to work on their projects.  
You find when you teach this subject, students get very excited about their projects.
- 3:32.08 Mr. Bailey begins discussing some of the student projects.
  - How to drop and guide supplies with parachutes in Vietnam. Students were working in a team of 4 or 5, and developed a remote controlled parasail. They made models and tested them in the stadium.
You have to be aware of a problem, which is the first step.
- 3:35.48 Initially the course had a dual focus.
  - First half of semester focused on how to be creative as an individual.
  - Second half of semester focused on working in groups.

- 3:37.08 The teacher of creativity must have open office time to counsel students through the course.  
The teacher must really love the students.
- 3:38.38 *"The main business of a university, as I see it, is to educate the students. The most effective teacher is one who loves the students."*
- 3:39.31 Mr. Bailey discusses a memorable project related to designing a scooter-like device to help a small person to get around the university. The small person was transferring to the University of Florida to work on a Master's degree and came to Mr. Bailey to see if his class could work on a project to help him. One student in the class took the challenge and developed a design proposal that semester. The student came to Mr. Bailey the following semester to see if he could do an independent study to actually build the device. The project received a lot of publicity. Bobby Van Etton (sp?) was the person who the device was developed for and eventually finished his masters and went to work in a government agency.
- 3:48.54 One student explored the problems faced by blind people and came up with an idea for creating an artificial eye by combining Mr. Bailey's electromagnetic wave idea and a new ceramic bone material idea. The student wrote up the design proposal. A few years later, someone from another department came to Mr. Bailey with the same idea and was very surprised and impressed that an undergraduate student had already developed the idea.
- 3:54.58 Mr. Bailey asserts that teaching a creativity course takes a lot more extra time than an analytical class.  
You need to be available and have interest in the student.
- 3:56.18 Mr. Bailey discussed the workload in teaching creativity.  
There is no single right answer to a creative project.  
You need to consider carefully each report. It takes a lot of personal time. Administrators don't understand how much extra time is involved in teaching the creativity course.
- 4:00.38 *"It is Imperative that any teacher, in my view, spend a lot of time grading"*
- 4:01.08 The grades were based 30% for Creativity, 30-40% Presentation, and the remainder on Approach.  
The students must clearly know how they will be graded.
- 4:02.32 Mr. Bailey discusses how he counseled his students.  
Don't discourage the students; try to encourage them.

- 4:04.38 Assign the students problems that are relevant to the world now and in the future. The problems must be suitable for use in the classroom.
- 4:06.08 The teacher must be an inspiration for the student.  
Mr. Bailey used to start each class with a reading from Short Stories of Science and Invention, by Charles F. Kettering in order to inspire the students.
- 4:09.16 Mr. Bailey discusses the important role of colleagues.  
Sometime there need to be several sections of the course and you will need to have colleagues teach some of these.  
Mr. Bailey insisted that teachers of his creativity course have significant industrial experience.
- 4:11.43 Mr. Bailey describes an amusing incident.  
The department chairman asked Mr. Bailey what he was telling his students. Of the 3 – 4 % that even bothered to come back later to give feedback, 85% of them stated that the creativity course was the most important course they took and helped them most in their careers. The chairman asked how Mr. Bailey gets the students to say that. Mr. Bailey replied, "*Some of us have practiced our profession of engineering and know what is important.*"
- 4:14.34 Students from other engineering departments took the creativity class as well. Mr. Bailey tried to expose the students to problems outside their major field of study.
- 4:17.08 Mr. Bailey discusses having a broader view as opposed to a narrow view. His students, at his last day of teaching, gave him a present of a long tube and a short tube to signify having either a long and narrow point of view like "Analytikers" or a broader view like Mr. Bailey.
- 4:18.38 Most of the students in the creativity class got A's or B's. Only rarely and with great heartache did he have to fail a student.  
The creativity course was a senior year class.
- 4:19.38 The real world is structured around the project, while academia is structured around the subject.
- 4:21.38 Mr. Bailey only taught from his published book for his last 4 years.
- 4:23.31 Colleagues can be nefarious, jealous, envious, and even take actions to get rid of your course.
- 4:24.38 Fifteen students is about the optimum size of a creativity class.

- 4:25.21 Mr. Bailey responds to the question of when did the projects start in the semester.  
In early years, students were given a problem to go through on their own for the first half of the semester, then they worked in groups on another problem in the second half of the semester.  
Due to there not being enough time in the semester for two projects, Mr. Bailey decided it was more fundamental to enhance the students' personal creativity so the group work was reduced. He let the students choose their own projects.
- 4:28.00 Mr. Bailey responds to the question concerning offering a follow up course.  
The curriculum was so tight that it was a challenge keeping the one creativity course. He did think it would be helpful to have a follow up course.
- 4:31.01 Mr. Bailey discusses the formula of an engineer's creative efficiency. This formula is not meant to be exact, it only expresses his way of integrating the factors related to one's personal creativity.  
Problem approach is an important factor.
- 4:47.38 Mr. Bailey discusses the 6-step approach which is condensed on page 69 in the textbook.
- 4:48.38 Mr. Bailey discusses how the engineering profession has defaulted on the Problem Inquiry phase of problem solving and has left it up to Marketing people to handle it.  
It should be the role of the engineer to know about a design's marketing potential.
- 4:51.38 The interview now has moved to Mr. Bailey's workshop.
- 4:51.54 Mr. Bailey demonstrates and discusses the lathe he has rebuilt and uses. It's a 1943 Southbend 9 inch lathe with a 4 foot bed.
- 4:57.38 The interview moves into the woodworking area of the shop.  
Many of his hand tools are those his father used. They bring back good memories whenever he uses them.
- 4:59.06 Mr. Bailey discusses and demonstrates the shellac centrifuge he designed and made.
- 5:02.38 Mr. Bailey demonstrates the Shop Smith machine that he uses and has improved.

- 5:03.38 Pictures of how he converted his Shop Smith to a milling machine.
- 5:10.08 Mr. Bailey shows his notebook detailing all of the improvements he has made to his Shop Smith.
- 5:12.28 Mr. Bailey demonstrates his dust collection system he designed and built for his workshop.
- 5:15.53 Mr. Bailey discusses the improvement he made to a dishwasher. This is an example of the difficulty that an outside inventor has in approaching a company with an idea.
- 5:20.16 A picture of Mr. Bailey as a boy with a model plane.
- 5:23.58 Quotes above Mr. Bailey's workbench  
"A man who works with his hands and his brain is a craftsman."  
"A man who works with his hands and his heart is an artist."
- 5:24.28 End of the Interview



**Appendix G: Résumé of Robert L. Bailey**

*This is  
last as +  
before  
in 1982. AJS*

BAILEY, Robert Leo, Associate Professor  
(EE 100%)

ELECTRICAL ENGINEERING

PERSONAL RECORD:

Date of Birth: April 6, 1927

Place of Birth: Demopolis, Alabama

Marital Status: Married, 2 children

EDUCATION:

<u>University/Institution</u>	<u>Degrees</u>	<u>Date</u>
General Electric Co. Courses Taken:		
Orientation		1949
Applications Engineering		1949-50
Test Engineering Program	N/A	1949-50
Creative Engineering Program I		1950-51
Monochrome Television Eng.		1953
Statistical Quality Control		1958
Alabama Polytechnic Institute (Now Auburn University)	BEE	1949
University of Florida	MSE	1962
University of Florida	*	1963-65

FIELDS OF INTEREST:

- Effective Teaching
- Development of Teachable Creative Thinking
- Electric Energy Engineering-General
- Electromechanical and Direct Energy Conversion
- Solar Energy Conversion and Utilization
- Microwaves
- Instrumentation

EXPERIENCE:

- Military  
1945-46 Radar Program, United States Navy
- Industrial (All with General Electric Co.)  
1949-51 Engineer on Test Engineering Program  
and Creative Engineering Program

\* Additional EE and Physics graduate work.

EXPERIENCE (Cont.)

1951-56 Development Engineer, Circuit Development Engineering,  
(Owensboro, Kentucky, Tube Plant)  
1955 Taught Electronic Circuits Course  
1956 Taught Creative Approach Seminar (Owensboro, Kentucky)  
1956-60 Manager, Electronic Systems Engineering  
(St. Petersburg, Florida Plant)  
1959 Taught Creative Approach Seminar (St. Petersburg, Florida)  
1960 Taught Principles and Applications of Transistors

Government

1968(Summer) Faculty Fellow (ASEE-NASA Program), Space Power Technology  
Branch, Goddard Space Flight Center, Greenbelt, Maryland

Academic (All with University of Florida)

1960-61 Research Associate, Electrical Engineering  
1961-63 Teaching Associate, Electrical Engineering  
1965-67 Research Associate, Research Section, EE  
1967-72 Assistant Professor, Electrical Engineering, Electrical  
Energy Engineering Program  
1970 Member UF Graduate Faculty  
1972- Associate Professor

HONORS

*Inducted to Solar Hall of Fame (1993)<sup>†</sup>*

Tau Beta Pi - Honorary Engineering Society (1949)  
Phi Kappa Phi - Honorary Scholastic Society (1949)  
Eta Kappa Nu - Honorary Elec. Eng. Society (1968)  
Sigma Tau - Honorary Engineering Society (1970)  
Selected as one of 20 out 1200 engineers to participate in General  
Electric's Creative Engineering Program (1950)  
Awarded General Electric "Management Award" for outstanding teaching (1960)  
Selected participant in Ford Foundation sponsored "Effective Teaching  
Institute," Penn. State, 1963  
Ford Foundation Teaching Fellow, Electrical Engineering,  
University of Florida (1963-65)  
Selected participant in Ford Foundation's Direct Energy Conversion  
Summer Institute, Washington University (1966)  
Awarded ASEE-NASA Summer Faculty Fellow, 1968  
Listed in Who's Who In Florida, 1973/74 (Names of Distinction, Inc.,  
Lexington, KY.)

MAJOR CONSULTATIONS OUTSIDE UNIVERSITY

1972 Consultant to Solar Energy Panel (NASA-NSF sponsored.  
Administered through Univ. of Md.). Chairman of 'Unique  
Systems' for Solar Energy Conversion. Panel made report  
and recommendations to President Nixon's Office of  
Science and Technology via the Committee on Energy R&D  
goals. Panel formulated first coherent U.S. Solar Energy  
R&D program for 1972-2020.

*I consider this the 'crowning honor' of my professional  
career! RJD 11/17/02*

UNIVERSITY SERVICE

- 1961 Introduced first UF course in Creative Problem Solving, now EE491. This course, unique in the nation and still running successfully in 1979, has acquainted over 2,000 EE students with methodical ways to create the truly new.
- 1962 Member College' Materials Committee. Agitated for and got introduction of U.G. courses in modern engineering materials. IEEE Student Faculty Advisor.
- 1966 Established first U.G. course and laboratory in Direct Energy Conversion at UF. Course-laboratory sequence offered since 1966. Laboratory innovations have attracted numerous domestic and foreign visitors.
- 1966-1972 As Supervisor of Electric Energy Engineering (EEE) Laboratories, initiated, planned, organized, staffed, equipped, and successfully smoothly ran largest modern educational power engineering laboratories in Southeast US.
- Again  
1970-1977 Member EE Department Laboratory Committee, injecting numerous laboratory innovations.
- 1969-1972 Member EE Department Student-Faculty Interaction Committee, helping create harmonious learning environment.
- 1972-1973 Member Engineering Technology Committee (EE Department). Member College's Energy Laboratory. Actively supported UF's Student Recruiting Program (Dec. 1-2, 1972, Florida Baptist Guidance Counselling Conference, Vero Beach, Florida). Actively informally cooperating with ME Department in Solar Energy Research Area.
- 1966-1973 Coordinator for U.G. Courses in Creative Problem Solving (EE491), Elements of Electric Energy Eng. (EE381-382) and Direct Energy Conversion Eng. (EGG550-551-552). Assisted Administering EE Departments Electric Energy Eng. Program.
- 1973 UF representative at NSF RANN 'Research Information Meeting'. University of PA, Phil., March 15-16, 1973.
- 1973-1979 Served on numerous Honors/High Honors Committees.
- 1975 Chairman, EE Department Facilities Committee.
- 1978-1979 Chairman, EE Department Library Committee.

EXTENSION PROGRAM SERVICE

1. UF representative at Florida Power and Light Company's Annual engineers retreat, Horseshoe Lake, Ocala Forest. (Major Solar Energy presentation April 1973).
2. Frequent UF representative at Southeastern Electric Exchange (SEE) meeting held by Utility Companies.
3. Various technical presentations made outside UF (C.F. Professional Activities).
4. Actively engaged in 'Field Trips' taking students to utility installations (in cooperation with other EE faculty).
5. Review solar energy research proposals (Mitre Corporation, etc.).
6. Active participant in EE Departments "visiting committee" - a joint University - Industry group.
7. EE Departments COOP student coordinator, 1976.

MEMBERSHIP AND OFFICES HELD IN PROFESSIONAL ORGANIZATIONS

Institute Electrical and Electronic Engineers (IEEE):  
Member since 1948  
Faculty Advisor, UF Student Branch, 1962  
Former member of Professional Groups:  
    Microwave Theory and Techniques  
    Broadcast and Television Receivers  
Present member of Professional Groups:  
    Education  
Membership Chairman, Gainesville Section, 1970-71.  
Secretary, Gainesville Section, 1976-77.  
American Society Engineering Education (ASEE):  
    Member since 1968.

International Solar Energy Society (ISES):  
    Member since 1973.

OTHER PROFESSIONAL ACTIVITIES

1973      Invited presentation, "Electromagnetic Wave Energy Conversion", NASA Laser Energy Conversion Symposium, Jan. 18-19, 1973, Moffet Field, California. Also presented to AIAA Student Chapter at UF, March 5, 1973.

Invited presentation, "The Government's Solar Energy Panel--An Inside Look", at IEEE Section Meeting, Greensboro, N. C., Feb. 20, 1973. Also presented at UF's Energy-Environment Seminar, March 2, 1973.

Participated, in cooperation with ME Department, in filming of "Solar Energy Research at UF" by ABC T.V. at UF, May 17-18, 1973 (to be shown later on nationwide ABC T.V.).

Maintain active contacts with NASA Goddard, and other technical personnel in solar energy area.

Host numerous visitors to UF inquiring about UF's Solar energy research work and answer large numbers of inquiries about solar-electrics.

UF Graduate Seminar presentation: "Product Redesign-- A Case History of the Shopsmith Woodworking Machine", January 1973.

1973-79    Made numerous technical presentations throughout Florida on Direct Energy Conversion, Solar-Electrics, and P.E. Exam Refresher courses (Jacksonville, IEEE)

PATENTS

Electromagnetic Wave Energy Converter, U.S. Patent No. 3,760,257, Sept. 18, 1973. Filed by NASA Goddard Space Flight Center. (Assigned to NASA under Fletcher's name)

UNDERGRADUATE STUDENT PROJECTS

Have initiated and supervised several hundred on a wide range of technical topics.

THESES AND DISSERTATIONS SUPERVISEDHigh Honors Committees

Numerous and on-going.

Master's Theses

- Potdar, "Construction and Evaluation of a Novel Solar Electric Motor," 1971.  
 Rush, "Electromagnetic Wave Interaction With A Corrugated Surface," 1977.  
 Heaney, "A Theoretical Analysis of Electromagnetic Radiation From The Sun As Applied To Electromagnetic Wave Energy Converter," 1977.  
 Aimone, "The Hybrid Solar-Electric Service Concept," 1974.  
 Watson, "Potential Impact of Solar Energy Utilization on Florida Utilities," 1974.

Engineer's Theses

None

Doctoral Dissertations

None (Principally interested in Undergraduate students)

RESEARCH GRANTS AND CONTRACTS

- |           |  |
|-----------|--|
| 1969-1972 | NSF "Instruction Scientific Equipment Program" Grant for improving UF EEE Laboratories (\$62,500. total).  |
| 1966-1977 | "Power Institute Grant" (Four Florida Utility Companies), about \$50,000/year total, about 25% of time spent on this grant.  |
| 1973      | NSF-RANN, "Electromagnetic Wave Energy Conversion Research--Phase I", (\$278,000. for a two year program, 5 EE faculty, 1 Entomology faculty, 3 undergraduate students, and 3 graduate students). Proposal not funded. |
| 1973-1975 | NSF, Energy Related Graduate Traineeships (in cooperation with UF Mech. Eng. Dept.) (~\$90,000. total)   |
| 1975      | NASA, GSFC, "Electromagnetic Wave Energy Conversion Research" (\$20,000.).   |
| 1977-1978 | US Department of Energy, "Solar-Electrics And Their Integration" (\$30,000.).  |

RESEARCH AND DEVELOPMENT ACCOMPLISHMENTSGeneral Electric Company:

- Air Circuit Breakers-Helped create first AC/DC automatic trip aircraft circuit breakers. (Philadelphia, PA plant, 1949)  
Gunfire Control Systems-Assisted testing early manufactured MK57 and MK37 shipboard gunfire control systems. (Pittsfield, MA plant, 1949)

RESEARCH AND DEVELOPMENT ACCOMPLISHMENTS (Cont.)

Heating Devices-Assisted with development engineering tests on electric blankets, plasma bottle warmers, foot warmers, radiant home heating, and early version of manned space suit. (Bridgeport, CT plant, 1950)

Washing Machines-With a senior engineer successfully developed new suspension system for GE washing machine and successfully transferred to production. Thousands were sold. (Trenton, NJ plant, 1950)

for ~ 45 yrs.

Television Receivers-Developed new low cost video amplifier for large production receiver. Developed circuitry for CBS color TV receivers. (Syracuse, NY plant, 1950)

Television Studio Equipment-Developed suitable camera tube cooling later used in all GE TV cameras. Developed first successful mechanical mirror-change-over-unit for TV stations, eliminating need for two-thirds of then required electronics. (Syracuse, NY plant, 1951)

Automatic Pilots-Developed first successful thyatron voltage doubler power supply for early Navy delta wing carrier fighter. Successfully solved rudder jitter control problem by application of thyatrons. (Schenectady, NY 1951)

Receiving Tubes-Circuit development engineer on team which successfully developed 6AJ4, 6AM4, 6AF4 UHF receiving tubes and circuits. Also 6BY4 and 7077 ceramic triode, a major advance in the state-of-the-tube art. Created many new novel circuits and UHF instrumentation schemes for development, design, and manufacture of receiving tubes. Wrote book, The Years 1951-1956 in General Electric's Receiving Tube Development Engineering-Springboard to a New UHF Television Era. (GE Internal Document) (Owensboro, KY plant, 1951-1956)

Neutron Sources-Successfully transferred an electronic neutron source from a developmental state-of-the-art idea to a production reality. Involved technical and management responsibility for the electronic system; personal responsibility for acquisition of over two million dollars of electro-mechanical equipment; planning, building, and debugging a large factory; and technical liason with AEC and Sandia. Involved nearly 20 million dollar/year business in a highly sophisticated technology. (St. Petersburg, FL plant, 1956-1960)

University of Florida:

Travelling Wave Tubes-Performed experimental research on bifilar helix travelling wave tube (1960)

Thermionic Converters-Conceived, built, and successfully tested first thermionic energy converter at UF (1962)

Direct Energy Conversion-Established first Direct Energy Conversion Engineering Laboratory at UF (1966). Conducted solar DEC research, Goddard Space Flight Center (1968), resulting in major changes in direction of NASA's solar energy work toward terrestrial use. Invented Electromagnetic Wave Energy Converter (EWEC). Patented by NASA. Engaged in follow-up research confirming validity of EWEC. Wrote first U.S. integrated state-of-the-art treatment of new solar-electric engineering field (Beginnings of a new textbook (1977-78)).

RESEARCH AND DEVELOPMENT ACCOMPLISHMENTS (Cont.)

Communications-In proximity fuse research, developed successful solid-state voltage density function instrument, 1965, (used by DOFL and GSFC), developed early solid-state logarithmic voltage attenuator (1966), and developed successful unique thermal-electrical environmental chamber (1967)

Creativity-Based on 30 years of studying creative people and the creative process, spent nine years writing new engineering textbook, Disciplined Creativity, integrating this complex field.

REPORTS AND PUBLICATIONSGeneral Electric Company:

1. Bailey, R. L., "An Evaluation of Several Different Plate Structures for the 6AJ4 UHF RF Amplifier," (Informal Internal GE Report)
2. Bailey, R. L., "Some of the Factors Affecting the Performance of Receiving Type UHF RF Amplifier Tubes," GE Report No. 53E777, 1953
3. Bailey, R. L., "A Comparison of Push-Pull and Single-Ended RF Amplifiers at 900 MC," (Informal Internal GE Report), 1953
4. Bailey, R. L., "Expressing the 900 MC RF Amplifier Performance of the 6AM4 by Means of Contours," Report No. 53E783, 1953
5. Bailey, R. L., "Fundamental Relations for Tracking and Band-spreading Harmonically Related Resonant Circuits," (Informal Internal GE Report), 1953
6. Bailey, R. L., "A 900 MC Power Gain Test set for RF Amplifier Tubes," (Informal Internal GE Report), 1953
7. Bailey, R. L., "A Coaxial Type Wattmeter for the 400-900MC Region," Report No. 53E785, 1953
8. Bailey, R. L., and James W. Rush, "Measuring Tube Performance at UHF," Presented at Emporium, PA, IRE Section, June 24, 1953 and at Evansville-Owensboro IRE Section, Dec. 9, 1953
9. Bailey, R. L. "Tube Evaluation at UHF," Presented at AIEE Winter Meeting, New York City, Jan. 21, 1954 and at Dayton, OH Hamvention, April 3, 1954
10. Bailey, R. L., "UHF Grounded-Grid Amplifier Performance at 890 MC," Report No. 54E779, 1954
11. Bailey, R. L., "Analytical Solution of a Lumped Constant Plate Circuit Considered for use with UHF Grounded-Grid Amplifiers," (Informal Internal GE Report), 1954
12. Bailey, R. L., "Electrical Loss Problems Encountered in UHF Ceramic Tube Development," Report No. 54E787. Presented at National Conference on Tube Techniques, New York City, Oct. 26, 1954; AIEE Winter General Meeting, New York City, Jan. 31, 1956; and Huntsville, AL, IRE Section, March 13, 1956
13. Bailey, R. L., and J. B. Quirk, "A Coaxial Wattmeter for the 400-900MC Region," Electronics, Nov., 1954
14. Bailey, R. L., "Notes on Installation on 6BY4 RF Amplifier Stage in a Commercial UHF Tuner," Report 56ETR-2, 1956
15. Bailey, R. L., "A Novel UHF Coaxial Amplifier Circuit Featuring Tube Accessibility," Report 56ETR-4, 1956



University of Florida:

16. Bailey, R. L., "Design and Development of a Test Device for Optimizing Thermionic Energy Converter Efficiency," Masters Thesis, University of Florida, Dec., 1962
17. Mathews, B. E., and R. L. Bailey, "A Course in Creative Problem Solving," IEEE Transactions on Education, Vol. E-8, No. 4, Dec. 1965
18. Mathews, B. E., and R. L. Bailey, "A Study of the Undergraduate Laboratories in the Department of Electrical Engineering," Nov. 2, 1966 (Informal UF document)
19. Bailey, R. L., "The Need, Objectives, and Specifications for a Direct Energy Conversion Engineering Laboratory at UF," Feb. 15, 1967 (Informal UF document)
20. Bailey, R. L., "An Environmental Chamber for Snakeye Fuze Evaluations," (U), Report No. SR 67-1, April, 1967
21. Bailey, R. L., Couch, and Henry--Secret Report Title, Report SR 67-5, June, 1967
22. Bailey, R. L., "Energy Gap--DEC Teaching," Intersociety Energy Conversion Engineering Conference RECORD, 1968, pp. 105-111
23. Bailey, R. L., and Ervin S. Priem, "An Integrated Proposal for Junior-Level Electric Energy Conversion Courses and Laboratory, May 15, 1968 (Informal UF Document)
24. Bailey, R. L., "A Proposed New Concept for a Solar Energy Converter," first presented at International Solar Energy Society Conference, GSFC, Greenbelt, MD, May 12, 1971. Presented at ASME Winter Annual Meeting, Washington, D.C., Nov. 28, 1971, as paper No. 71-WA/Sol-1. Published in ASME Journal of Engineering for Power, April, 1972, pp. 73-77
25. Bailey, R. L., Disciplined Creativity for Engineers, Ann Arbor Science Publishers, Inc., Ann Arbor, MI, 1978
26. Bailey, R. L., Solar Energy as a National Energy Resource: NSF/NASA Solar Energy Panel, published December, 1972 by University of Maryland (Served as Chairman of Unique Systems, one of 5 subpanels. About 43 people contributed to writing this major document, the first coherent U.S. Solar Energy R and D program)
27. Bailey, R. L., "Electromagnetic Wave Energy Conversion," Presented at NASA Laser Energy Conversion Symposium, Jan. 18-19, 1973, Moffet Field, CA. (Published in a NASA Symposium Proceedings by NASA Moffet Field, CA)
28. Bailey, R. L., "Disciplined Creativity--One Key to the Future," Proceedings of Southeastern 74, Region 3 Conference, IEEE, pp. 2-5
29. Bailey, R. L., et.al., "Final Report: Electromagnetic Wave Energy Conversion Research," Grant NSG-5061, Sept. 30, 1975. Submitted to NASA GSFC, Greenbelt, MD
30. "A Floridian's Guide to Solar Energy," Dec. 8, 1975. Coordinated by Florida's State Energy Office, Tallahassee, FL. I wrote Solar-Electric sections of it.
31. Bailey, R. L., "Foreward," in Phillip S. Callahan's, Tuning Into Nature, Holiday House, 1976

University of Florida:

32. Bailey, R. L., "Solar-Electrics and Their Integration: A Mid 1970's State-of-Art Survey", Final Report for the U.S. Dept. of Energy, Division of Electric Energy Systems, Oct. 1, 1977-Nov.15, 1978, Contract EC-78-S-05-5624.
33. Bailey, R. L., Solar-Electrics: Research and Development, [Ann Arbor, Michigan: Ann Arbor Science Publishers, Inc., 1980].

*Robert L. Bailey*

Associate Professor  
October 6, 1980

**Appendix H: Robert L. Bailey's Retirement Speech**

## REFLECTIONS AT RETIREMENT

by

Robert L. Bailey  
Associate Professor  
Department of Electrical Engineering  
University of Florida

A speech before the Eta Kappa Nu  
Electrical Engineering Honor Society,  
students, faculty, and friends.

Holiday Inn - University Center  
Gainesville, FL  
April 16, 1982

I'm overwhelmed by the generosity of your kind remarks! You honor me more than I deserve.

### Ups and Downs

One of my favorite stories, claimed to be true, is a letter from a Barbados British West Indies bricklayer to his boss:

"Respected Sir:

When I got to the building, I found the hurricane had knocked some bricks off the top. I rigged up a pulley at the top of the building and hoisted a couple of barrels of bricks.

When I fixed the building, there was a lot of bricks left over. I hoisted the barrel back up again and secured the rope at the bottom, then went up and filled the barrel with extra bricks. Then I went to the bottom and cast off the line.

Unfortunately, the barrel of bricks was heavier than I was, and before I knew what was happening, the barrel started down, jerking me off the ground.

I decided to hang on, and halfway up I met the barrel coming down and received a severe blow to the shoulder. I then continued to the top, banging my head against the beam and getting my fingers jammed in the pulley.

When the barrel hit the ground, it burst its bottom, allowing the bricks to spill out. I was now heavier than the barrel and so started down again at high speed.

Halfway, I met the barrel coming up and received severe injuries to my shins. When I hit the bottom, I landed on the bricks, getting several cuts and bruises from sharp edges.

At this point, I must have lost my presence of mind, because I let go of the line. The barrel came down giving me a blow on the head.

Therefore, I respectfully request sick leave---

## Preview

Tonight I want to briefly speak on "Reflections at Retirement" after 22 years of service here at the University of Florida.

I want to make a few 'Thank You's', sketch Betty and my future plans, share a few feelings and reflections, and finally share 'My Pledge As A Teacher' with you.

## Thank You's

My sincere "Thank you's" to:

- Those Who Planned and Executed this Banquet: Dr. Cherrington, for the original idea of honoring me on this occasion, the President and Vice President of Eta Kappa Nu EE Honor Society, and all the committees who worked to put this large affair together--my most sincere thanks!  
Truly, this is one of life's 'peak experiences' which I shall not forget!
- All My Former Students for the high privilege of having taught you a few things about engineering, for stimulating discussions in and out of class, for brief opportunity to help shape your lives during a most difficult period in them, for the things I've learned from you via your always penetrating and relevant questions, and for your warm friendships too numerous to mention here.
- Miss Edwina Huggins, our recent bride - now Mrs. Harvey McKay, my secretary for 12 years through thick and thin. She knows my every 'hieroglyph'! She was our devoted 'right arm' in the Power area.  
  
Edwina, I shall truly miss frequently seeing your always smiling face!
- I also owe a debt of appreciation to Mrs. Gen Baxter, our EE Payroll clerk of many years, Mrs. Barbara Dorsey, EE Undergraduate Secretary for many years, and Miss Patsy Childers, our present Power secretary. These young ladies have been or are some of the unsung heros of the EE Department in keeping it smoothly running and deserve far more credit than they generally receive.
- Mr. Bob Roark, EE Technician par excellance, friend, helper on many detailed practical electrical problems, and keen observer of life. Bob, I shall truly miss the closeness shared over many a cup of tea!
- Prof. Ervin S. Priem, closest friend and confidante--one who has stuck with me through thick and thin. Respected power colleague, lover of students, devoted Christian scholar, fine teacher. He took me into his office as a mate in old Weil Hall during a down time in my life.
- Dr. Robert Sullivan, respected power colleague, for ably leading our EE Department during a difficult period, friend, sharer of interests in the Alternate Energy field.

- Prof. Ed Allen, respected power colleague, friend. We've shared many GE experiences, as we were both employed by General Electric.

Ed, I shall miss our conversations together!

- Prof. Ed Smith, respected power colleague of many years and friend. Though he recently died, he lives in my memory as a monument to persistence and longevity.

- Dr. Alex Meystel, respected power colleague, friend, sharer of a mutual interest in the wondrous God-given process of creativity, future teacher of my Creative Problem Solving course, and for giving me fresh perspectives from his sufferings on the privileges of being an American citizen.

- Dr. Olle Elgerd On the advice of my good friend, Prof. Sashoff, one of the better things Dr. Elgerd did was, as head of the Power Program, to hire me in 1966! Jovial, friendly, always spontaneous, we've gone through many academic battles together. We've been colleagues for 16 years. Respected theoretiker, one year he too will actually retire!

- Lucille George, wife of my close former mentor and friend, Dr. Ted George, a professor I greatly admired for his mathematical acumen.

Lucille, I want to thank you for being a friend these many years and for greatly helping enlarge my latent appreciation for beauty via Antiques magazine.

- Prof. Marinus Latour Long term friend and confidante through ups and downs. We worked together on the proximity fuze research project when it was at the Seagle building downtown. Philosopher, historian, able teacher, beautiful human being.

Marinus, our many conversations have always been enlightening, and I shall miss them.

- Dr. John O'Malley, former teacher, respected colleague, close friend, fellow writer. I served on numerous EE Department committees with him and always had the highest respect for him and his work.

John, I shall also greatly miss our cups of tea and our dinner theaters together!

- Dr. Ken Watson, respected colleague, honest friend. I shall miss our many philosophic discussions and exchanges of writing techniques,

- Dr. Sheng Li, friend, confidante, respected colleague. We've shared a common interest in developing solar cells to the practical state.

Sheng, I've also appreciated the introduction to Chinese culture and beauty you've conveyed. I shall miss our thought exchanges over a cup of tea!

- Dr. Leon Couch, former students together, friend. We worked closely together on the proximity fuze research project at the Seagle building.

Leon, I shall miss our discussions over a cup of tea!

- Dr. Charles Shaffer One of my most respected graduate professors, respected colleague, friend in life's down periods.
- Dr. Merwin Larsen, the EE Department head who hired me in 1960. A kind gentle man, full of quiet leadership strength, technical knowledge, and wisdom.

I always admired him, Janet, and still miss him every day as I walk into Larsen Hall. He was a wonderful manager, philosopher, and friend.

- Mr. Roger Westphal, the No. 1 scholar in the EE class of December 1981. Roger has an impressive background and has had the good fortune of being the right man in the right place at the right time. He plans an academic career and will be teaching future Alternate Energy and Solar-Electric courses, as Dr. Cherrington indicated.

Roger, I shall always be grateful to you for 'carrying the future torch' on these courses. I wish you well in their conduct and your academic career. I also trust, you graduate professors, that you will treat him kindly.

- Dr. Erich Farber, ME Department, closest friend, confidante, understander of what engineering is all about, mentor in solar energy, string supporter in our work on government's 1972 Solar Energy Panel where we wrote the Solar Research and Development blueprint for the U.S. Solar program, knowledgeable guide through Europe for Betty and me in 1973, etc.

Erich, I've always regarded you as one of the two wisest men it has been my privilege to have known and work with at the University.

- Dr. Phillip Callahan, entomologist, closest friend, fellow researcher, wonderful philosopher, man of sound perspectives on life and living, creative scientist of highest order, lover of poetry, painting, beauty, history, biography and wisdom. I shall long remember our work together on electromagnetic wave energy converters.

Phil, I've always regarded you as the other wisest man I've been privileged to know and work with here!

- Dean Wayne Chen Appreciation for his initiative in helping me get tenure and promotion to Associate Professor in 1972.

- Betty Bailey, my dear wife of 33 years, for unfaltering devotion, encouragement, and strength during my ups and downs in academia. Without her and our precious two girls, who are here tonight, I could have done little.

- And Finally to the rest of you who are here tonight, faculty and staff members too numerous to mention, I want to say "thank you" for having contributed to a part of my life here in some way.

Would you care to give all of these, a big hand?

### My Future Plans

Turning now to my plans for retirement, let me first say that I look upon this event not as a retirement from life, but a change in direction. I'm looking forward to now being able to do some things I've long wanted to do--the delightful things of life--as I move toward a slower-paced more private lifestyle.

Betty and I shall continue living in Gainesville, our home. I want to finish building our house including finishing my workshop into a first class facility. I enjoy fine woodworking and making things of utility and beauty. I've formed a small company, Creative Plans Co., to sell high quality woodworking plans via mail order, thereby sharing my creations with others. I expect to fan this small enterprise and see it grow substantially.

I hope to be able to write some articles for Fine Woodworking magazine, further sharing my gifts with fellow woodworkers.

I expect to do some genealogical research on my family and write a family record where none now exists.

There is also the matter of managing our fiscal matters in a more optimal way than heretofore, and hopefully time will be available to do so.

Finally, Betty and I may travel some, first domestically and later foreign.

I have a hunch we won't be suffering from a lack of creative projects during my retirement! There is much to be done in this personal sphere, and we are anxiously looking forward to this new phase of our lives!

### Feelings and Reflections

Transitions and Trapeze Artists I now want to share a few personal feelings and reflections.

There is an old story among my theologian friends. When Adam and Eve were evicted from the Garden of Eden, he turned to her just as they found themselves freshly deposited outside the garden gate and said, "My dear, we live in a time of transition!"

My friend, Dr. Paul Tournier of Geneva, Switzerland--noted theologian, medical doctor, psychologist, and author of many excellent books--expresses it a different way. He makes the analogy of the trapeze artist who is secure on his bar one moment only to find himself letting go of that security and, for a brief period, is 'in transition' in the air travelling on faith that his next security will, in fact, be there at the correct time. Retiring, I find, is much that way. There is the transition from the security of students, books, honest inquiry and study and research over toward a new adventure--the adventure of a new and unfamiliar lifestyle pregnant with potentialities.

All of this suggests, in a larger sense, that perhaps we're all pilgrims 'in transition' passing through this life.



### Professional Competency

For a long time, I've had the feeling that there is probably a curve of professional competency vs. age for a professor. This curve peaks in a narrow age range, that is to say a professor's competency increases as he learns more of his subject, peaks when he thoroughly masters it, and decays when he becomes bored or interested in other things.

I also have the feeling that it is probably better for the students, if the professor retires at the peak of his curve or perhaps just beyond. If he waits too long everyone knows he is 'over the hill'!

I have the burnt-out feeling that I'm only slightly 'over the hill' and am therefore retiring before all the new things in EE, as computer technology about which I know and care little about, engulf me.

There is, you see, a rather delicate problem for one to decide when to retire!

### Perspectives On Being An American

Having decided to retire, one naturally reflects on the conditions that made his life and retirement possible.

First, there is the feeling that only in America could a hard working poor carpenter's son have risen to a manager in the greatest electrical firm in the world, General Electric; and only in America could that same one have risen to the exalted state of being a Professor in a great southern university. I'm truly thankful for the privilege of having been a Professor, though it has cost me dearly financially.

Upon reflection, I doubt I could have had a better preparation to teach. I was born and raised here in the South, a region I've loved. My youth was spent in Demopolis, Alabama far removed from many advantages we take for granted today, e.g. my high school had no physics course. I learned it by self study.

I was always playing with electrical and mechanical things. My father had a wonderful shop, and I lived in an atmosphere where making things and exploring new things was encouraged and was fun. I soon found myself desperately wanting to learn! Have you ever wanted so badly to know how a generator worked that you nearly made yourself sick trying to learn without a teacher?

There in Demopolis during the early part of World War II while in high school, I serviced radios and appliances and kept my town of 7,000 going. I learned much then.

My heroes then, as now, were the Wright brothers, Edison, Nikola Tesla, Charles Kettering, Charles Lindbergh and other creative people who achieved great things--men who were not afraid to break out of the mold of conformity and launch new ideas and products.

I sometimes think how much you students miss today by not having had the privilege of living in a world where every boy had significant heroes and where one had to be resourceful and creative and where we learned of discipline, hard work, suffering, patience, joy, details of how things worked and why, etc. We had no television then to use up our time, but we read a great deal.

## On Blindness and Seeing

About 1936, refrigerators were just beginning to appear in people's houses. Few people had them in Demopolis. Dad and I decided we'd make one for our house. We found an old evaporator as a starter, and I proceeded to help open it up 'to see how it worked'. I was soon to learn what a costly thing creativity is! Unknown to us, it was filled with high pressure sulfur dioxide. It exploded directly into my face. Dad saved me, and we both narrowly escaped asphyxiation, but the freezing refrigerant had gotten directly into my eyes. I was blinded.

I later heard the doctor in Selma tell my mother, "Mrs. Bailey, in all likelihood your son will never see again." Thus, at age 9 I was poor and blind. For three weeks I was blind, then my mother knelt by my bedside and prayed. She told God she knew He had a mission in life for her son, but she didn't know what it was and to please heal my blindness so 'Bobby' could perform that mission.

The next morning, I waked up and could see again! How joyful and thankful to the Lord I was! You've never known joy, my friends, unless you've been "blind but now I see". Accordingly, I've since had a soft spot for blind people, and in our Creative Problem Solving course we've invented many specific aids for blind people.

In recent years it became evident to me that that vision my mother had, that mission, has been to teach. It is in fulfilling that mission here at UF I've found happiness.

God later called me in 1960 "to teach", and thereby, I found my life's mission. That call, too, was an interesting story which I don't have time to relate tonight; but I would point out that the gifts I've had as a professor came from God, and I am certain of that. God has been very active in Bob Bailey's life!

Boyhood Goals are of great importance. Mine were to be an engineer, an airplane pilot, or an architect. It was only as a man that I received my call to teach.

Looking back, I now see that these apparently conflicting goals have all been met. As a college professor, naturally I've taught, and that has been the chief mission of my life. I also built an airplane and flew it all over the eastern United States. I designed our present house, thereby releasing the architect within me; and I was an engineer for 11 years with General Electric.

As I reflect, it is a privilege to have lived in a very dynamic and exciting time of our nation's history and to have contributed to it in specific ways through the products I've worked on as an engineer. These include electric blankets, washing machines, television (black and white and color), and numerous weapon systems, to name a few. In my wildest imagination as a boy, I never knew my engineering education would carry me on such an exciting adventure!

Role of Teachers In My Life. Some years ago, I did a study to identify the most influential people in my life. Most of them were teachers of some kind. It is well known that teachers frequently become models for the conduct of their pupils' lives. Fortunately, I had a wonderful undergraduate

professor back in Auburn, Richard Steere, who cared for, counselled, and encouraged me in life's critical times. He was then, and still is, one of the truly great engineering teachers I've known. Many of my teaching techniques are modelled after his. And, yes, we do still interact occasionally through sharing the fine woodworking interest.

The other great teacher in my life has been Jesus from whom I've learned much about teaching as well as about the abundant Christian life.

Some of you here have been my teachers in yesteryear, as Dr. Shaffer, Dr. O'Malley and others, and I'm deeply grateful for your efforts to lift me.

My Teaching Thrusts amongst you have been in four principal areas:

- Engineering as a distinct form of professional activity. The engineer has been extolled as the Ingeneur--the ingeneous one--the artful contriver--the applier--the synthetiker.  
He is not a mathematicer alone or a physiker alone as some who have never practiced engineering so wrongly assume. Rather a systems view sees these knowledges as but tools the engineer has to occasionally use along the way of problem solving.
- Creativity has been a major human attribute in which I've always been interested. Its enhancement has been a major thrust of my life both in General Electric and here in academia. Its vehicle for expression has been the senior level course, Creative Problem Solving. By creating an environment of positive thinking and reinforcing it, along with some of you colleagues, we have been privileged to have guided many hundreds of students in their creating of many new products, including some inventions. In the process they found that engineers truly must be 'ingeneous ones' to create the products of tomorrow.  
I have formally 'made the case' for this subject so vital to the engineer in Disciplined Creativity which I feel is the scholarly work that has given me the most pleasure--along with considerable pain during its 9 year birthing period.
- A Practical Emphasis has also characterized my life and teachings. I am all too aware of the disdain many acamedicians, enshrouded in delicate webs of elegant woven theory, have for the practiker, but I would like to assert that a skilled practiker actually has to know more than the theoretiker! He certainly must know his theory well in order to apply it, but he must know a whole lot more, as any engineer will attest who has created any new practical product.  
While we're on this subject, I've enjoyed serving as an unpaid consultant and helper to many of you colleagues who have come for specific practical advice or help for home and work problems. These have ranged from furnaces flooding water on a Saturday night, to air conditioners that got hit by lightning, to problems with your automobile air conditioners, to name a few samples.
- Perspectives On Life and Living has been another hallmark of my teaching here. How easily we get lost in detailed "Do Loops" in EE! An example is the student who got flooded with all the detailed equations of an induction motor, but failed to capture the much more important physical concept of what makes the rotor turn in the first place! The student came puzzled to me, and I explained Tesla's original concept of a rotating magnetic field as characterizing all such motors. He went away with perspective and, incidentally, a new interest in motors as

some of Tesla's world was revealed to him.

I would like to assert, however, the difficulty of always maintaining a sense of perspective as we bob about on the sea of life. I myself don't always succeed in this area, but I do keep trying. There are far more subtleties here than we can deal with tonight. Shakespeare's wisdom of "God give us the gift to see ourselves as others see us" is still valid, though.

### The Weapons Issue

I now want to say a few words about the weapons topic. This is a vitally important issue today to the future of civilization. It has, in history, always been important to a body of people who would remain free. It more and more turns up in our daily newscasts.

I'm a peace-loving person, not aggressive by nature. Yet, as I reflect on a lifetime of engineering work, a substantial portion of it has been spent on weaponry of some form or other for this nation. A few examples:

Radar technician, latter part of WW II.

With GE as an engineer/manager on:

- Circuit breakers for Air Force planes (Philadelphia)
- MK 37 and MK 57 gunfire control systems for ships. (Pittsfield, MA)
- Flying suit for Air Force's X-15 aircraft along with plasma bottle warmers (Bridgeport, CN)
- Automatic pilot for Navy's first delta wing carrier fighter (Schenectady, NY)
- And the most significant of all, construction of a large plant here in Florida to produce pulse neutron source triggers for atomic and hydrogen bombs.

Finally, here in academia:

- Proximity fuzes for artillery and bombs

I spent more time on the very sophisticated engineering of weaponry than I'd have liked, in retrospect. I much more enjoy working on unclassified non-weaponry projects. Yet, there was a need my country had and I helped fill that need.

The conflict here is between the need of a free people to have adequate weapons to insure their future freedom and the need of our souls to be at peace with our worldly brothers.

There is general recognition that killing and war are wrong modes of living and contrary to the desires of the Master Engineer who created all of us.

These issues have caused me much personal pain. I wish they were better understood here in the University. In my judgment, a Pandora's box was opened when the physicists' thrust off on us the first atomic bomb. I frequently wish that box had never been opened! I have a hunch that Admiral Rickover now also feels this way, as he said in his recent parting testimony before Congress, "All atomic weapons should be disassembled.---Atomic reactors should be outlawed."

About the only humor I find in these grave issues is in a little German definition I recently came across:

"Atomic Weapon: das Loudenboomer.

Hydrogen Weapon: das Loudenboomer und alles kaput."

Unfortunately, there is more truth than humor in these. We're talking about terrible weapons in terms of their potential for human damage.

Thus, as a former nuclear weapons engineer and fully knowing the ultimate consequences of our following the nuclear path, perhaps some of you can now understand why I've never embraced the now sinking ship of nuclear power.

The only sensible answer to our present situation lies in prevention of nuclear war.

In contrast to these weighty issues, one of the many reasons I've been so enthusiastic about solar energy and its utilization is because of its inherently peaceful thrust. It is very, very, difficult--but not impossible --to turn solar energy technology into a weapon, its potential being primarily for the betterment of mankind.

Of Scholarship and Wisdom I now want to say a few things about scholarship and wisdom.

On scholarship--that elusive striving toward learning and perfection (teleios)--I am absolutely certain there is something to it. I recall a vivid incident in GE's Advanced Development group in Owensboro, Ky. In the early 1950's we were wrapped up in creating the tubes and circuitry for UHF television. The technical problems were mindblowing. I was working on unravelling the complexities of the grounded grid radio frequency amplifier. In the midst of the confusion which always surrounds the best development I still remember the terrific sense of illumination I had one day to the effect there really is something to this scholarship business about which a few of my Auburn professors had talked. There was the recognition that though much had been learned, much more was unknown ahead, and I wished I'd learned even more while in school, for here I was on the forefront and learning! I had to be a scholar to do my development engineering job. What an exciting prospect!

Incidentally, at age 55, I'm still learning! The privilege of learning and ordering is what scholarship is all about! I hope to continue learning until I die.

We should here also observe that the academic institution, as we know it today, is the only institution where scholars have true freedom to thoroughly explore new ideas without the spectre of 'vested interests'!

These thoughts suggest that there is a freedom and a quality of life peculiar to the scholar. I've truly enjoyed being bathed in that quality of life here at UF.

But in our scholarly search for knowledge and new things we in engineering particularly need to realize our deeper need for wisdom.

I find it helpful to return to ancient thinkers who had far more wisdom than we generally credit them. The advice in this quotation is particularly appropriate to you students.

### Apprenticeship to wisdom

My son, from your earliest youth choose instruction  
 and till your hair is white you will keep finding wisdom.  
 Cultivate her like the ploughman and the sower,  
 and wait for her fine harvest,  
 for in tilling her you will toil a little while,  
 but very soon you will be eating her crops.  
 How very harsh she is to the undisciplined!  
 The senseless man does not stay with her for long:  
 she will weigh on him like a heavy stone,  
 and he will lose no time in throwing her off;  
 for discipline is true to her name,  
 she is not accessible to many.  
 Listen, son, and take my warning,  
 do not reject my advice:  
 put your feet into her fetters,  
 and your neck into her harness;  
 give your shoulder to her yoke,  
 do not be restive in her reins;  
 court her with all your soul,  
 and with all your might keep in her ways;  
 go after her and seek her; she will reveal herself to you;  
 once you hold her, do not let her go.  
 For in the end you will find rest in her  
 and she will take the form of joy for you:  
 her fetters you will find are a strong defence,  
 her harness, a robe of honour.  
 Her yoke will be a golden ornament,  
 her reins, purple ribbons;  
 you will wear her like a robe of honour,  
 you will put her on like a crown of honour.  
 If you wish, my son, you can acquire instruction  
 if you give your mind to it, subtlety will be yours.  
 If you love listening you will learn,  
 if you lend an ear, wisdom will be yours.  
 Attend the gathering of elders;  
 if there is a wise man there, attach yourself to him.  
 Listen willingly to any discourse coming from God,  
 do not let shrewd proverbs escape you.  
 If you see a man of understanding, visit him early,  
 let your feet wear out his doorstep.  
 Reflect on the injunctions of the Lord,  
 busy yourself at all times with his commandments.  
 He will strengthen your mind,  
 and the wisdom you desire will be granted you.

That beautiful reading was from the Bible, the master 'textbook', Ecclesiasticus chapter 6, attributed to Solomon, the wisest man the world has seen.

## My Pledge As A Teacher

Finally, I want to share a document that has hung on my office wall throughout my years here. It has elicited little attention from anyone, but has been an important set of personal guidelines.

I wrote this August 30, 1960 at Clearwater, Florida just before coming to UF to teach.

Here is "My Pledge As A Teacher".

I will to the best of my ability:

- Practice a high standard of Christian living in and out of the classroom.
- Remember who I am, where I came from, and to whom I belong ultimately and be humbled by His continuous protection and guidance.
- Uphold the dignity of teaching as an honourable profession benefitting the general society and rendering a service by helping others.
- Not forget that my profession is one of leadership in and out of the classroom.
- Seek Wisdom in the subjects I teach.
- Be a diligent searcher after truth.
- Promote the love of creative learning in those who come under my influence.
- Challenge my students to develop their mental faculties to their ultimate capability.
- Never forget the dignity and sanctity of the individual, I will therefore retain the human touch.
- Seek to develop the whole man and caution him that "is not the life more than meat, and the body than raiment".
- Remember that creative learning is a slow process and will not get impatient with those entrusted to me.
- Always make adequate preparation beforehand for classroom activities.
- Be mindful that the body of knowledge which I possess came from others. I will therefore recognize and execute my professional responsibility to publish new knowledge on a timely basis.
- Be loyal to the institution engaging my services.
- Remember that my body is the temple of God. I will therefore keep physically fit in order to perform my mission as a teacher.
- Execute my duties as a responsible citizen fo a free nation under God.

This day these goals have been met--to the best of my ability.

My 'mission' here as a teacher is now completed!

### Finale

Thank you for the honors you've bestowed on me this evening. Thank you for the high privilege of teaching and contributing to the University of Florida. Thank you for your presence here and attention this evening and for the opportunity of sharing these few thoughts.

Finally, remember: Old professors never die. Their ideas live on through their students.

May God bless each one of you!

Robert L. Bailey <sup>7/16/82</sup>



**Appendix I: Nomination to the Solar Hall of Fame**

RCV  
8/27/93  
HJB

LAW OFFICES  
FOLEY & FOLEY  
624 BOWEN BUILDING  
815 FIFTEENTH STREET, N. W.  
WASHINGTON, D.C. 20005

FOLEY (1890-1953)  
FOLEY, JR.

(202) 737-8055

PATRICK J. FOLEY  
MINNEAPOLIS, MINN.

August 24, 1993

Dr. Robert L. Bailey,  
3124 16th Avenue,  
Gainesville, Fla. 32605

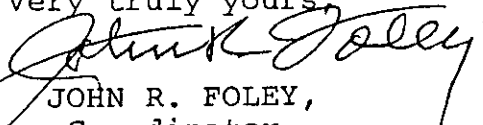
Re: Nomination To SOLAR HALL OF FAME

Dear Dr. Bailey:

It is a great personal privilege for me to inform you that you have been nominated for induction into the Solar Hall Of Fame effective as of December 31, 1993.

This unique honor is best demonstrated by reference to prior recipients who have been elected to this international group of renowned solar scientists. Some of the earlier recipients are listed in the enclosed document that describes a brief history of the Solar Hall Of Fame.

Very truly yours,

  
JOHN R. FOLEY,  
Coordinator

Encl.