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Development of Learning Objectives for an Undergraduate Computer-Aided Drafting and Design Animation Using the Delphi Technique

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DEVELOPMENT OF LEARNING OBJECTIVES FOR AN UNDERGRADUATE COMPUTER-AIDED DRAFTING AND DESIGN ANIMATION USING THE DELPHI TECHNIQUE

BY

Gavin M. Wilk

THESIS

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FOR THE DEGREE OF

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CHARLESTON, ILLINOIS

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ABSTRACT

This study reflects on learning objectives created for an advanced computer aided drafting (CAD) learning module(s) or course with the emphasis on simulation and engineering animations. These objectives were derived by using the Delphi technique by access the support of a panel of subject matter experts (SME) from academia and industry that are interested in CAD. The results of this study are intended for the use of creating instructional modules for undergraduate studies.

A panel of experts were chosen through an electronic listserv of engineering and technology supporters. Two rounds of two different Delphi survey instruments were utilized to complete a comprehensive list of necessary and extremely necessary learning objectives. Through the various instruments the necessary learning objectives were derived to help formulate the building blocks for learning module(s).

ACKNOWLEDGEMENT

I would like to first thank my parents who have always stressed the importance of education. Without their love and support I would not be where I am today. I would also like to thank Dr. Melton. He has helped guide me through my education and the writing of this study. Thank you again.

TABLE OF CONTENTS

ABSTRACT iii

ACKNOWLEDGEMENT iv

INTRODUCTION 1

- Purpose of the Study 1
- Statement of the Problem 2
- Principle Research Questions 2
- Justification 3
- Delimitations 3
- Limitations 3
- Assumptions 4
- Definition of Terms 4
- Summary 5

LITERATURE REVIEW 6

- The History and Evolution of CAD 7
- Animation and Simulation Process 8
- Technology and Curriculum 9
- Bortz 10
- Mager's Instructional Objectives 11
- Delphi 12
- Summary 13

METHODOLOGY 15

- Delphi Method 15
- Participants 16
- Design 16
- Summary 17

RESULTS 19

- The Delphi Methodology 19
- Description of Panel Members 20
- Panel Member's Opinions 20
- Delphi Round One Results 20
- Delphi Round Two Results 26
- Summary 30

CONCLUSION 32

- Significance of the Study 32
- Research Question 32
- Appropriate Learning Objectives 32
- Recommendations 32
- Summary 33

REFERENCES 37

APPENDICES 39

Appendix A 40
Appendix B 41
Appendix C 48

CHAPTER 1

INTRODUCTION

Engineering animations and simulations are used in many different industrial applications. The specific industrial application that this technology is used in will determine what type of simulation or animation is implemented. Animations are useful for allowing potential customers to comprehend how different components make up a specific model, or illustrate how certain components are assembled. Simulations are useful in determining specific properties of components, for example, tensile strength. Having the ability to simulate a test rather than facilitate a test can save companies both in time and money. A simulation allows a company to identify potential flaws and errors in parts before production takes place, saving valuable resources.

Because of cost and time savings, along with flexibility of the software engineering animations and simulations are becoming quite popular. With the advancements in computer technology and the software itself, the simulations and animations are becoming very advanced, detailed and technical.

Eastern Illinois University currently does offer courses with the basic features of CAD; however, it does not incorporate advanced features such as simulation and engineering animations. Graduates of the School of Technology are finding careers that they are utilizing these advanced CAD skills, thus providing a need for learning and understanding of these features.

Purpose of the Study

Eastern Illinois University has offered a course in 3-D modeling to students for many years. The course was taught as a lecture/lab course. Over the past few years different 3-D modeling software has been utilized. Different configurations of the course has been delivered to students based on the current software available in the Computer Integrated Manufacturing (CIM) Laboratory at Eastern Illinois University.

The purpose of this Delphi study was to gather information from a group of subject matter experts (SME) obtained from academia and industry. This information would be used to create learning objectives that will support the development of a comprehensive instructional module(s) that will assist undergraduate students in gaining knowledge and experience with computer aided drafting (CAD).

Statement of the Problem

As Computer Aided Drafting (CAD) continues to grow, the use and reliance on CAD will become more prevalent in industry. The software is already available to students; however simulation and animation software or learning modules are not always included in many of the undergraduate courses offered.

Having an animation and simulation module at Eastern Illinois University will provide undergraduate students with a more rounded educational experience that will prepare them for futures in industry. The availability of the software in Eastern Illinois University's CIM Lab incorporated with the Delphi Study technique, provides an opportunity to investigate the development of comprehensive learning objectives to gain knowledge and skills of CAD animation and simulation processes.

Principle Research Questions

The following research question has been analyzed during the course of this study to determine the practical significance of the development of learning objectives in regards to

CAD animation/simulation. What CAD animation/simulation learning objectives are most significant for undergraduate students?

Justification

This study will gather information from the opinions of various experts to determine the best learning objectives for instruction to undergraduates in the School of Technology. Because CAD software is commonly used in industry, students will greatly benefit from this study.

Results from this study will allow other universities and technology institutes access to the learning objectives created from this study. Others can also use this research as a foundation for further devolvement of coursework regarding engineering animations and simulations.

Delimitations

Only experts nominated from academia and industry are utilized in the creation of this undergraduate CAD animation/simulation-learning module development research.

Limitations

A few limitations will be considered in this study. The first limitation is the small sample size. Many experts expressed an interest after the first Delphi letter and then were unavailable to participate in the later rounds of the survey. Secondly, the experts have little knowledge outside of their realm of industry or academia. Finally, though Solid Works® software was used during the research and mentioned in this paper, learning objectives can be used for any CAD software that utilizes 3-D modeling, animation and simulation

Assumptions

An assumption is made that the panel of experts do not know each other and will not communicate during the study.

Definition of Terms

There are several terms used in the paper that have specific meaning in the context of computer-aided design and draft that also hold different meaning when used in everyday conversation. For sake of clarity and to enable the reader to be sure of the meaning intended, this definition of terms is included.

CAD: Computer Aided Design or Computer Aided Drafting

Simulation: the imitative representation of the functioning of one system or process by means of the functioning of another a computer simulation of an industrial process>

Animation: the act of animating for engineering purposes. (Webster)

Rapid Prototyping: A modeling process used in product design in which a CAD drawing of a part is processed to create a file of the part in slices, and then a part is built by depositing layer (slice) upon layer of material; includes stereo lithography, selective laser sintering, or fused deposition modeling.(answers.com)

Pixel: any of the small discrete elements that together constitute an image (as on a television or computer screen) (Webster)

Plotters: A graphics printer that draws images with ink pens. It actually draws point-to-point lines directly from vector graphics files. (answers.com)

2-Dimensional: Two dimensional state. Usually in the X, Y directions.

3-Dimensional: Three dimensional state. Usually in the X, Y, Z directions

Animation Wizard: Feature in SolidWorks to simplify the animation and simulation process for the user. (Solidworks Corporation, 2006)

Timeline: The timeline is a temporal interface used to display and control the sequence of events in an animation. (Solidworks Corporation, 2006)

Wireframe: In computer-aided design, a line-drawn model. In computer graphics, an image-rendering technique in which only edges and vertices are shown. (answers.com)

Render: to reproduce or represent by artistic or verbal means (Webster)

Exploded View: breaking down assemblies to show the different components that make up that assembly.

Collapsed View: view where components are restored to their original orientation within an assembly

Summary

Computer Aided Drafting has been around for many years. With the current advancement in computer technology more advanced features have been added to these software packages. Many graduates of Eastern Illinois University are entering careers where the knowledge of CAD is extremely important. Having the knowledge from this study will help them advance in professional careers. This learning module will allow graduates of the Eastern Illinois School of Technology to gain a competitive advantage over their less experienced counterparts.

CHAPTER 2

LITERATURE REVIEW

This review of literature is related to CAD processes, principals, learning and training modules, and learning and training objectives that will support the later development of an instructional module(s) for CAD with the focus on animation and simulations. This review of literature contains both articles and books. The literature that was selected for this study focused on the history of CAD, the advancements of CAD software, animation and simulation processes, the development of instructional modules and Mager's learning objectives. Additionally, this review includes resources that pertain to Rand Corporation's Delphi method.

Resources that were used in this study can be found at the Eastern Illinois University's Booth library. EBSCO, Lexus Nexus, and Academic Search Premier's online hosts were also used to search for resources pertaining to CAD, the Delphi Method, and Mager's learning objectives. Various websites that had articles, provided further information about the history and advancements in CAD. There were a few results when searching for information on creating a curriculum for CAD, but the articles and books gathered proved to be enough information to complete a valid study.

This review of literature contains five major areas: (a) the history and evolution of CAD, (b) animation and simulation process, (c) Bortz's Occupational curriculum development (d) Mager's instructional objectives, (e) and finally the Delphi Study technique and process.

The History and Evolution of CAD

The engineering process has evolved naturally and slowly as the demand for services of craftsman and artisans grew. (Medland,1992). CAD has many different areas of application including architecture, mechanical engineering, electrical engineering, and many others. Computer Aided Drafting is the current industry standard for creating drawings of parts, components, and other detailed drawings.

Before CAD, drawings were done by hand on drafting boards. This took a great amount of skill, patience, and time. With the design and creation of CAD software in the early 1960's drafting times were reduced. It was not until the mid-1980's that advancements in computer technology made the computer much smaller and affordable (Bozdoc, 2004). In addition, in 1982 John Walker unveiled his CAD software that was able to run on a personal computer. (Bozdoc, 2004) His software, entitled AutoCAD, was released to the public in December of 1982.

By the end of 1990, AutoCAD would sell 500,000 copies and win *Byte* Magazine's "The Best CAD Product". An honor it held the next eight years. In 1996, SolidWorks Co. shipped its first version of SolidWorks. SolidWorks was equipped with a complex surface modeling and a graphical user interface (Bozdoc, 2004) . CAD had started to transform from a 2-D flat world to a 3-D world.

The improvements in computers, computer hardware, and the availability of the internet, brought forth better CAD programs. An engineer could design or modify a part and be miles away from the office. CAD software today has become very complex and detailed.

Parts and components can be given certain characteristics based on the type of material assigned to them. Using SolidWorks COSMOS simulation software, various stress and strain simulations can be performed. Running simulations before a product is sent to the production floor can mean the difference of turning a profit or having the company go bankrupt. CAD systems also give the user options for animations. These animations can show a customer how various components come together to form a finished product. Having the ability to see the various parts put together can help people understand the product better.

Animation and Simulation Process

This study will focus on animation and simulation processes with various CAD programs. In this study Solidworks will be used as an example of one CAD program capable of running animations and simulations. At the time of this study Eastern Illinois University used this program in various undergraduate courses. SolidWorks Animator is capable of rotating models, exploding components, collapsing components, and running various physical simulations.

Students that want to learn these advanced features of CAD should already have basic experience with the SolidWorks software and the Windows operating system (Solidworks Corporation, 2006). Learning animation and simulation will be a process or task – based approach to learning (Solidworks Corporation, 2006).Students will be using practice application materials and exercises to reinforce the content that is taught.

The SolidWorks Animator software is a software solution from SolidWorks. It fully integrates the SolidWorks software to create animations from SolidWorks assemblies. Animator can be used in conjunction with PhotoWorks to produce photorealistic animations, which adds visual interest to presentation and written documents (Solidworks Corporation, 2006).

Technology and Curriculum

Over the previous decades many countries have begun to emphasis the importance of technological literacy through curriculum development (Mitcham, 1994).

> Technology is a major and, some would argue, a determining feature of the world we inhabit. In consequence, young people, as future citizens, need to understand how it shapes the world and how they can participate in it. If future citizens are to understand and participate in decision-making, technology education must prepare them adequately by dealing with the technical, social, ethical, political, and economic issues that underlie technological process and by ensuring that students recognize that technology is located within a philological, historical and theoretical context (Mitcham, 1994).

Technology is an activity that not only involves the social context but the physical context as well (Mitcham, 1994). Research in student learning should consider both the conceptual and procedural understanding. Another aspect that should be considered in student research is the way technological tools and objects influence the student thinking (Mitcham, 1994). Some of these ideas include the following:

- Cognitive processes differ according to the domain of thinking and the specifics of the task context (Rogoff, 1990).
- Learning is a process of enculturation into a domain through participation in shared activities with three forms; participation, corresponding respectively to personal,

interpersonal, and community processes: participatory appropriation, guided participation, and apprenticeship (Rogoff, 1990).

- There is an intimate connection between knowing and doing (Rogoff, 1990).

Bortz

Career awareness and career orientation must be promoted in the educational framework of an employment-orientated based curriculum. (Bortz, 1981)

> Career education is not a synonym for vocational education, but vocational education is an integral and important part of a total career education system. It is through vocational education programs that employment skills can be delivered. In career education, a student is guided toward a better understanding of him \ herself, his \ her interests, abilities and aptitudes. He or she is made aware of career opportunities consistent with their aspirations. He or she is provided a wide range of explorations, which should assist them in career direction setting decisions. These decisions ultimately culminate in some kind of specific training for employment. (Bortz, 1981)

This model demonstrates the progressions through the phases of involvement of learning. *Awareness* is the first stage. It allows learners to become "aware" of the working world and its organizational structure (Bortz, 1981) Next, the learner moves into the *exploration* phase. In this phase, the learner is orientated toward personal and career related interests. The learner then transitions to the *orientation* phase. Orientation takes place when the learner begins to be directly involved with working alongside people in an occupation that they find interesting. Finally, what this study is focusing on is the *preparation* phase. This phase is intended to prepare people for employment.

Mager's Instructional Objectives

Robert Mager states, "Instruction is effective to the degree that it succeeds in changing students in desired directions and not in undesired directions.'…"If instruction does not change anyone, it has no effect, no power." (Mager 1975). He states if an instructor teaches something a person must be certain there is a reason for learning the material and students do not already know what the instructor intend to teach.

An objective is a description of a performance that an instructor want learners to be able to exhibit before the student considered competent. An objective describes an intended result of instruction, rather than the process of instruction itself. (Mager 1975). Objectives are crucial because if they are not defined clearly there is no way to design instructional materials. Next, if a student does not know where they are going, it can be hard for them to find a way to get to the desired objective. Secondly, having objectives stated plainly will make it easier to find out if the object has been accomplished. (Mager 1975) Thirdly, students can organize their own efforts to accomplish objectives if those objectives are stated openly.

Mager informs his reader how to instruct their students to learn what is expected of them. Mager felt things should be stated simply in order for the student and the instructor to get the most from the learning experience. Mager's feeling are expressed clearly in the following quote, "Until you say what you mean by "knowing" in terms of what students ought to be able to do, you have said very little at all." (Mager 1975)

He derived a list that has words that have many interpretations, which means that when learners hear words that have many interpretations, they can be confused. Mager also developed a list of words with few interpretations, this lists demonstrates words that are easy for the learner to understand and clearly illustrates what is expected of them. Examples of these lists are as follows:

Many Interpretations	Few Interpretations
To know	to write
To understand	to recite
To really understand	to identify
To appreciate	to sort
To grasp the significance of	to construct

In Mager's 1975 book, he describes three important characteristics of learning objectives that are used as the basis for developing the learning objectives of this study. They are as follows:

1. Performance – An objective always says what a learner is expected to be able to do.
    a. "What should the learner be able to do?"
2. Conditions – An objective always describes the important conditions (if any) under which the performance is to occur.
    a. "Under what conditions do you want the learner to do it?"
3. Criterion – Wherever possible, an objective describes the criterion of acceptable performance by describing how well the learner must perform in order to be considered acceptable.
    a. "How well must it be done?"

Delphi

In the early 1950's the RAND Corporation brought forth the Delphi technique. The Delphi method is a technique that is used to elicit opinions with the objective of obtaining a group of responses from a panel of experts. (Brown, 1968). The Delphi method has four steps to it. The first step is to arrange a panel of experts. Once the panel has been selected, they will be given the first round of questioners. When all experts have answered the first round of questions, the second round can take place. In this round, respondents are asked to rank and critique the first round answers. In the third round the median and inter quartile range of the previous round would be used as numerical feedback. (Delphi brown). The majority and minority opinions would be then asked to reconsider the pros and cons presented and give a final, possibly revised, answer (Brown, 1968).

Experts have been brainstorming in round table settings for many years. The fact is brainstorming has major drawbacks. Some examples include psychological factors such as the presence of dominate persuasive personality, and the tendency to seek the approval of the group (Brown, 1968).The Delphi method tries to eliminate committee activity. Eliminating committee activity allows the participant to be free from the pressures of psychological factors (Brown, 1968). Without the added pressures of group acceptance participants are free to voice their opinions. This will help by gathering more responses from participants and help (Brown, 1968).

Summary

The idea behind reviewing other literature for this research is as follows: (a) the history and evolution of CAD, (b) the animation and simulation process within SolidWorks, (c) Bortz's occupational curriculum development, (d) Mager's instructional objectives, (e) the Delphi technique and process.

A basic understanding of CAD processes, animation, and simulation are essential to this study. Bortz's book on Developing Occupational Curriculum describes the need for technical education. He describes the different phases in life that one goes through in order to achieve their desired career. Next, Mager defines an effective approach to a successful learning objective. He points out that in order to have a successful learning experience objectives must be clear, concise, and have direction.

In addition, he states that if instruction is to be successful it must change the student, move the students in desired directions, and not move the student in undesired directions. (Mager) The final part of the review of literature describes the Delphi Method. Understanding the Delphi method is crucial to this study, since it is where all data and information was derived.

The main purpose of this study is to create learning objectives that can later be adapted to develop a CAD animation simulation learning module(s) for undergraduate students, which will give them the knowledge and experience that will give them a competitive edge in industry. This review of literature provided a solid base for the study and help to further build to the actual development of a learning module.

CHAPTER 3

METHODOLOGY

CAD is widely used throughout industry. CAD is widely used because of its versatility. Similarly, it's ease of creating, editing drawings, the ability to animate how parts and components fit together, and simulate various load tests. Undergraduates preparing for industry would greatly benefit from this learning module.

This study focused on learning objective development for four categories of CAD animation and simulation procedures and principles. A panel of experts was utilized from academia and industry nominated by a group of individuals from industry, research institutions, professional organizations, and academia.

The study gathered learning objectives derived from the panel of experts. Once the information constituents of the study were gathered, grouped and evaluated, they were analyzed in order to derive the most important learning objectives for creation of a comprehensive instructional module for undergraduate studies.

Delphi Method

The approach to this study utilized the Delphi Method. Brown states "the Delphi method is a name that has been applied to a technique used for the elicitation of opinions with the object of obtaining a group response of a panel of experts." (Brown, 1968) Delphi basically asks a panel of professionals their opinions, builds on their responses to form later questions. Their responses will help put together the framework for the learning modules that will be derived from this study.

Participants

The nominated participants are experts in the field of CAD. They were from both industry and academia. The mixture of industry and academia was utilized to give the panel a variety of opinions and thoughts from differing backgrounds. The participants selected for this study were sent a letter via an electronic listserv (Appendix A). The participants had to meet the following requirements to participate in the study:

Criteria for nominated experts (Industry):

- 15 years' experience closely working with CAD
- Has experience with design and manufacture related to CAD
- Resides within the United States of America

Criteria for nominated experts (Academia):

- Graduate degree from a technology program.
- Ten or more years working in academia (Technology related)
- Resides within the United States of America

Design

After the nominations were received, a list of experts was derived. This list consisted of eight experts that expressed their willingness to help. These experts then received the first Delphi instrument in round one (Appendix B). As soon as the first round was complete, the results were compiled and the second Delphi instrument (Appendix C) was formed. This was then sent to the experts and their responses were compiled.

The structure for each round is as follows:

Round 1: This round will ask the experts to list four learning objectives for the learning module. There will be space provided for additional comments and learning objectives to be added by the experts.

Round 2: This round will ask the experts to look at the list of learning objectives compiled from round one and rate them on a Likert Scale from 1-6. One will be extremely unnecessary and 6 will be extremely necessary. A Likert Scale is a method of putting a quantitative value to qualitative data.

Round 3: This round will send the results of round two to the experts which will have each expert's response and the response of the experts as a whole. The experts will then be asked to review this and if their answers deviate from the majority, either decide to change their answer or support their answer with appropriate reasoning.

These learning objectives will represent the most important elements of CAD animation and simulation. From what Mager states, these elements should "change students in desired directions and not undesired directions." (Mager, 1970) These objectives should provide the student with a better education to help better prepare themselves for their professional careers.

The goal was to send out an instrument each week. This was greatly slowed due to lack of responses in a timely manner. After each instrument was supposed to be turned in a follow up email was sent to elicit responses to those who did not.

Summary

The objective of this research is to create a comprehensive advanced CAD animation and simulation instructional modules. This modules will incorporate the learning objectives from this research to give undergraduate students the chance to gain knowledge and skills pertaining to CAD animation simulation process and procedures.

This study incorporated experts from academia and industry alike. The participants were selected from their expressed willingness to help and their qualifications. These experts were sent a series of instruments to help create learning objectives that they feel is important pertaining to CAD animation and simulation. They were then asked to rate the compiled results on a Likert scale based on their opinion and expertise. From this, the learning objectives that proved to be the most necessary for undergraduate study will be derived.

This study utilized the Delphi Method to elicit opinions from the experts. This method is used to help brainstorm and eliminate the various drawbacks that "round table brainstorming" introduces.

CHAPTER 4

RESULTS

The purpose of this study was to develop comprehensive learning objectives that would most benefit undergraduate's knowledge and skills pertaining to CAD animation and simulation. These learning objectives were derived using the Delphi Method. The development of these learning objectives will be able to provide solid information in the development of curriculum for teaching undergraduate students.

This study addressed: What CAD animation/simulation learning objectives are most significant for undergraduate students.

In this chapter the Delphi methodology will be revisited, a short description of each panel member, the panel's opinion, and the summary of the data. Findings regarding the research question also will be addressed based on the opinions provided from the panel responses and evaluation process.

The Delphi Methodology

The Delphi Method is a method of receiving feedback that was introduced by the RAND Corporation in the 1950's. The idea behind the Delphi is to reach a common consensus from a panel of experts about a certain topic. This method tries to alleviate the many disadvantages that face to face discussion introduces, such as "jumping on the bandwagon". This method was chosen to ultimately help better understand what the majority of industry and academia personal alike thought were the most important skills were to be incorporated into the learning module.

Description of Panel Members

Initially when the letter for nominations was sent out 15 members expressed their interest to participate with the study. As the study progressed these members did not participate leaving only three members who actively participated. These members include a professor at University of Alaska Anchorage, and two experts in manufacturing. All three experts use CAD or teach CAD software. The mix of a professor in the education field and two experts that were in the working world gives the study a balance from different prospectives.

Panel Member's Opinions

The opinions from the panel of experts were reviewed and compiled. Their responses are as follows.

Delphi Round One Results

The following learning objectives have been derived by the panel of experts:

Category I. - The History and Evolution of CAD

- Learner able to draw a time line describing the history and evolution of CAD, including advances and developments of new programs and their contributions to animation.
- Students able to analyze and describe milestones and specific niches that CAD programs have regarding animation and design.
- Learner will list companies and organizations who have contributed to the evolutions of CAD and animation.

- The learner will describe the role that digital multimedia plays today in CAD and animation and will be able to provide projections of how the industry and skills will change in the future.
- The learner will be able to explain how humans have used stories and storytelling for centuries and will compare and contrast animation to these needs of communication.
- Chronological evolution the object representation from 3D wireframe to faceted surface model to solid mass models.
- The historical correlation between hardware speed and capacity versus the software requirements and the resultant end-product 'size'.
- The transition from the efficient duplication/representation of 2D manual drafting to the 3D solid modeling of objects with their physical properties.
- The progression of output devices: pen plotters, printers, and FDM (Fused Deposition Modeling).
- The transition from single mainframe with shared access to software, to independent personal platforms with distributed software, to networked collaborative access to single projects
- The progression of input devices: keyboard, digitizer, mouse, stylus, voice, touch screen, etc
- The progression from static to dynamic to 'intelligent' objects.
- The people who envisioned and then created these 'things'
- Basic computer graphics elements and their biological basis. Pixels, resolution and its relation to contrast ratio and perception. Vector versus raster graphics. Color depth and bit depth.

- Representation of objects, wireframe, solids, surfaces, and their mathematical descriptions.
- Hardware and software systems history starting with Evans and Sutherland's computer graphics CAD stations, IBM's CADAM, Movie Arizona and Movie BYU, AutoCAD. Modern systems and applications.

Category II. – Types of CAD animations / Simulations

- Representations of physical elements, CAD
- Representation / simulation process and phenomena, CFD, FESA, CAM, CAE
- Business graphics, charts, curves, representation of data, curve fitting, interpolation, and extrapolation.
- Communications and multimedia, movies, presentations.
- Aesthetic representations, shaded surfaces, industrial engineering, photorealistic representations, photo and video overlays
- All types to include both static and dynamic representations, i.e. still images, movies.
- Morphology of the component: bending, warping, bulging, stretching, etc.
- Translation of the component: linear, rotational, scale, parent/child relationships
- Transition of appearance: opacity to transparency, change of material, aging
- Translation of environment: submersion, illumination, decompression
- Relational, locked and sequential transitions and interferences.
- The learner will be able to list different types of animations and simulations and indicate which ones are CAD based and which ones are not.
- The student will be able to explain the benefits of animating with CAD as compare to other means.

- By using a CAD software package, the student will be able to create animations for entertainment, education and marketing.
- The learner will understand and provide examples of how simulation is used today in many disciplines to develop, analyze and test products and systems.
- Through the use of a parametric CAD software package, students will design a mechanical system in which animated simulations would be beneficial in obtaining a desirable output.

Category III. – Industries or areas where CAD animations / Simulations are required

- The learner will list industries and disciplines where CAD animations and simulations are required.
- The learner will explore and present on how animations and simulations could potentially be used in disciplines that traditionally have not used these means of analysis and communication.
- The student will be able to explain how animation and simulations are impacting the disciplines of engineering and design, and will show examples of how engineering and design companies are using these tools.
- The learner will be able to provide a critical perspective of the benefits, costs and that uses CAD animations and simulations have on companies, and when the implementation is advisable and when is it not.
- It could be easily argued that animations/simulations are never 'required'. There are advantages in the visualization of change, particularly for those becoming familiar with a particular domain. It might actually be easier to list those fields where simulations and animations would not be an advantage.

- Forensics, process/production, manufacturing, robotics, architecture, accident and crime reconstruction, entertainment
- Animations and simulations provide advantages for situations where scale presents difficulty. Very large or very small objects can be accurately modeled and conveniently sized for inspection and manipulation. I once modeled a benzene molecule, among others, for inspection and manipulation by chemistry students.
- The remote control or modification of objects either in real or artificial environments.
- The placement of objects (real or virtual) in alternate environment forms.
- Where the cost of error is very high, if not unacceptable: surgery, munitions (assembly and disposal)
- The simulation and animation of hazardous objects or environments.
- Business and communication applications, pie charts, earning statements, projections
- Architectural
- Engineering and manufacturing including automotive and aerospace
- Multimedia, movies, commercials, corporate advertising

Category IV. – Presentation of CAD animations / Simulations

- Hardware and software considerations, demands on computer hardware, disc storage considerations
- Commercial standards, 1080p, 760p, MPEG, JPEG, and proprietary standards such as DXF, raw, BMP.
- Transfer and presentation techniques, flash cards, USB keys, CD, VCD, DVDs of all types, projectors, LCD, organic LC, LEDs, massive (Stadium) displays

- Human interface effects of color, resolution, frame rate, contrast, brightness, and other considerations.
- Group virtual immersion environments using caves and multi-screen projection
- Haptic stylus for individuals
- Goggles, either red/blue screened, shuttered, or parallax projection monitors for the individual immersion.
- 2D monitors and projectors
- Printing of strobic iMagery.
- The learner will develop skill to create an animation using CAD.
- The student will animate objects and the camera using CAD.
- The learner will be able explain the importance of storyboarding in animation and be able to create a storyboard.
- The student will be able to use another person's storyboard to create animation sequences using CAD.
- Students will be able to use movie editing software like Adobe Premiere to create a movie or story from the animation sequences.
- Students will be able to explain the options that exist with regards to rendering their animations and simulations.

Category V. Disadvantages or deterrents to CAD simulation and animation

- Cost; does a client see the value in it, at least enough to want to pay for it? Animation and simulation require higher (costly) levels of technologies.

- Time; short versus long term investment of time for gains in the reality of the result? Eventually the first two are interconnected and results in a balance between Investments of Time versus Duration of Relevance.
- The reality factor: how detailed must the perception of a reality be. Is every bolt, or the helical thread of the bolt, or the radius on the ridge of the thread, required to produce a satisfactory result, even if that result is the illusion of a designed reality?

Category VI. – Future of CAD animation / simulation

- The probable elimination of dimensioning and traditional 'views' of objects (Orthographic, Axonometric, and Perspective) as the animation and simulation of modeling evolves.

Category VII. – Animation, Multimedia and Interactivity

- The learner will be able to explain user controls for web and other digital mediums.
- Students will use Adobe Flash to create a digital portfolio and provide interactivity capabilities for the end user of the animations created.
- The learner will be able to incorporate multimedia features to their animations such as sound(s), text and/or other visual components.
- The learner will have an understanding of criteria for uploading animations to the web and will be able to post their personal animations to the WWW.

The student will be able to describe recent developments related to animation and simulation in immersive virtual environments and the role they play in training, analysis and entertainment.

Delphi Round Two Results

The following is what is deemed necessary by the panel of experts after round two:

Category I. History and Evolution of CAD

- Learner will list companies and organizations who have contributed to the evolutions of CAD and animation.
- The learner will describe the role that digital multimedia plays today in CAD and animation and will be able to provide projections of how the industry and skills will change in the future.
- The progression from static to dynamic to 'intelligent' objects.
- Basic computer graphics elements and their biological basis. Pixels, resolution and its relation to contrast ratio and perception. Vector versus raster graphics. Color depth and bit depth.
- Representation of objects, wireframe, solids, surfaces, and their mathematical descriptions.

Category II. Types of CAD animations / Simulations

- Representations of physical elements, CAD
- Representation / simulation process and phenomena, CFD, FESA, CAM, CAE
- Translation of the component: linear, rotational, scale, parent/child relationships
- Relational, locked and sequential transitions and interferences.
- Through the use of a parametric CAD software package, students will design a mechanical system in which animated simulations would be beneficial in obtaining a desirable output.

Category III. – Industries or areas where CAD animations / Simulations are required

- The student will be able to explain how animation and simulations are impacting the disciplines of engineering and design, and will show examples of how engineering and design companies are using these tools.
- The learner will be able to provide a critical perspective of the benefits, costs and that uses CAD animations and simulations have on companies, and when the implementation is advisable and when is it not.
- Forensics, process/production, manufacturing, robotics, architecture, accident and crime reconstruction, entertainment
- Animations and simulations provide advantages for situations where scale presents difficulty. Very large or very small objects can be accurately modeled and conveniently sized for inspection and manipulation. I once modeled a benzene molecule, among others, for inspection and manipulation by chemistry students.
- The remote control or modification of objects either in real or artificial environments.
- The placement of objects (real or virtual) in alternate environment forms.
- Where the cost of error is very high, if not unacceptable: surgery, munitions (assembly and disposal)
- The simulation and animation of hazardous objects or environments.
- Business and communication applications, pie charts, earning statements, projections
- Engineering and manufacturing including automotive and aerospace

Category IV. – Presentation of CAD animations / Simulations

- Hardware and software considerations, demands on computer hardware, disc storage considerations

- Commercial standards, 1080p, 760p, MPEG, JPEG, and proprietary standards such as DXF, raw, BMP.
- Transfer and presentation techniques, flash cards, USB keys, CD, VCD, DVDs of all types, projectors, LCD, organic LC, LEDs, massive (Stadium) displays
- The learner will develop skill to create an animation using CAD.
- The student will animate objects and the camera using CAD.
- The learner will be able explain the importance of storyboarding in animation and be able to create a storyboard.

Category V. Disadvantages or deterrents to CAD simulation and animation

- Cost; does a client see the value in it, at least enough to want to pay for it? Animation and simulation require higher (costly) levels of technologies.
- Time; short versus long term investment of time for gains in the reality of the result? Eventually the first two are interconnected and results in a balance between Investments of Time versus Duration of Relevance.
- The reality factor: how detailed must the perception of a reality be. Is every bolt, or the helical thread of the bolt, or the radius on the ridge of the thread, required to produce a satisfactory result, even if that result is the illusion of a designed reality?

Category VI. – Future of CAD animation / simulation

- The probable elimination of dimensioning and traditional 'views' of objects (Orthographic, Axonometric, and Perspective) as the animation and simulation of modeling evolves.

Category VII. – Animation, Multimedia and Interactivity

- The learner will be able to explain user controls for web and other digital mediums.

- The learner will be able to incorporate multimedia features to their animations such as sound(s), text and/or other visual components.
- The learner will have an understanding of criteria for uploading animations to the web and will be able to post their personal animations to the WWW.
- The student will be able to describe recent developments related to animation and simulation in immersive virtual environments and the role they play in training, analysis and entertainment.

Summary

In summary the first round of the Delphi study brought in many learning objectives in the seven areas of the study. Because all of the panel members were not in direct contact with each other or know each other there the members were able to freely express their thoughts. The panel helped derive seven areas that would aid in the creation of the learning objectives. These areas include the following:

1. History & Evolution of CAD
2. Types of CAD animations / Simulations
3. Industries or Areas where CAD animations / Simulations are required
4. Presentation of CAD animations / Simulations
5. Disadvantages or deterrents to CAD simulation and animations
6. Future of CAD animations /simulations
7. Animation, multimedia and interactivity

The first rounds helped brainstorm and bring ideas to support the seven areas. After reviewing and compiling those responses from round one, the ideas were sent out again to the panel to rank their importance from Extremely Unnecessary to Extremely Necessary. The second round helped narrow the learning objectives to ones that are the most important to the learner in the panel's opinion. This helped to eliminate the least important learning objectives and narrow in the most important topics. This helped shed light on where the learning objectives should take a learner. This goes back to Mager's thought that if "instruction does not change anyone it doesn't have any effect, no power." If you don't have a direction to take the learner there is no reason to put forth the effort in instructing the topic.

Because the lack of responses from round two, there was not a round three sent out.

CHAPTER 5

CONCLUSION

In the conclusion we determined why this research is significant, further research questions, the appropriate learning objectives and the recommendations based upon the results of the study.

Significance of the Study

This study is significant because there is a need for simulation and animations utilizing computer aided drafting software. Because there is a need for this software, individuals will need training and the knowledge to utilize this software. When these individuals become engaged in this topic, they become learners. Now one must convey the learning objectives to the learner so they are competent in using the software.

Research Question

Upon concluding the research there were many topics of the learning objectives. These where narrowed down by the research panel to find which learning objectives of CAD Animation / Simulations were the most significant to undergraduate students.

Appropriate Learning Objectives

The research was able to derive a list of significant learning objectives that the learner will be able to comprehend upon finishing the learning modules. Again going back to Mertz thought, this gives a path for the learner to follow with an end measurable result.

Recommendations

At the conclusion of this research there are some recommendations specific to this study. One could further research the seven learning objectives to further drill down these learning objectives to develop courses. CAD is constantly changing and evolving, thus this research can also be expanded to with the advancements in technology. Category III had the most responses with importance. This area stressed the importance of areas that CAD animations / Simulations would be utilized. Having this result helped prove that there is a need for education to help prepare the learner for industry. One can take this research as a building block for further research. This research can include:

1. Build learning modules based upon these learning objectives in this research
2. Research the best way to deliver the learning objectives to the learner.
3. Research further what is industry using currently & where they want to go.

Summary

In summary the various opinions gathered from the SME, Magers Instructional objectives and Bortz idealisms were combined to help form the appropriate leaving modules for this study. Reflecting back on Magers instructional objectives, it is important that these learning objectives "must have a direction that the learner understands." If they understand where they are starting and where they will end the likelihood of them learning will increase. As a starting point the learner must have already possess the basic understanding of CAD software. From there the learner will follow the path through the seven categories of the learning module. These include:

- The history and evolution of CAD

Referencing Magers list of words that have few interpretations the learner will identify the important corporations that have played key roles in the history & evolution CAD. They will also be able to understand the progression from a 2-D wireframe objects to intelligent solid objects. This is an important starting point to understand how things were done to how they are done currently. It will also help pave the way for future learning topics.

- Types of CAD animations / Simulations

The next topic of the learning objective will focus on the types of CAD animations / simulations. In this category the learner will be able to understand representations of physical: elements, the simulation process, and phenomena. Such elements would be material types of the widget they are modeling. They will be able to understand the process of what is being shown within the model. Such as a widget used in a tensile strength simulation. During the simulation there will be an event, classified as a phenomena. This phenomena will be something such as the widget failing under stress. It will be this phenomena that the learner will be able to identify. For more advanced animations & simulations the learner will be able to identify the translation of the components: linear, rotational, scales, and parent / child relationships. Finally the learners will use a parametric CAD software package to design a mechanical system in which animated simulation would be beneficial in obtaining a desirable output. Upon designing an animated simulation the learner will progress to the next learning topic.

- Industries or Areas where CAD animations / Simulations are required

Once they are able to design an animated simulation of a mechanical system they will be able to identify how this would be beneficial to engineering and design companies. They will be able to incorporate a critical perspective of the benefits, costs, and uses CAD software have on companies. This would be beneficial to see if the implementation of such software would be beneficial or not to a company.

- Presentation of CAD animations / Simulation

The next area will focus on the presentation of the CAD animations / simulations. The learner will be able to understand the hardware and software considerations, demands on the computer, and disc storage requirements. They will also be familiar with commercial standards such as 1080p, MPEG, JPEG and proprietary standards such as DXF, raw, and BMP. Being able to understand what these formats are will be important to being able to present the animation or simulation. The learner will also need to know how to transfer the files that will be used to present. Such techniques that would be used to transfer the files would be flash drives, CD's DVD's. The learner will also be able to explain the importance of storyboarding in animation and be able to create a storyboard. This is also very essential as if there isn't a flow to the animation or simulation it may not convey the message that the presenter is trying to tell.

- Disadvantages or deterrents to CAD simulation and animations

With everything there is also a negative side to them. In this area we will discuss some of the downfalls of CAD simulations and animations. One of the major flaws is the cost of the software and the hardware that is involved with CAD animations and simulations. The next flaw would be time. The learner will be able to see the short term & long term investments. Time and costs are eventually interconnected in a balance between Time vs. Money. And finally the learner will be able to determine the reality factory. How detailed do you need to get with the animation or simulation? Sometimes it is better to run a physical test on a physical part.

- Future of CAD animations /simulations

The next topic focused on the future of CAD animations and simulations. Technology is every changing at an accelerated rate. One of the areas is the probable elimination of dimensioning in traditional views as the animation and simulation software evolves. The learner will be able to see current drawbacks in the present software and ideas on how to improve them in future releases.

- Animation, multimedia and interactivity

The final topic will talk about how animations, multimedia, and interactivity. Here the learner will be able to explain user controls for web and other digital mediums. The learner can also incorporate other features into the simulation or animation such as sound, text or other visual components. The learner will have an understanding of criteria for uploading the animations to the web and be able to post their animation or simulation to the web. Finally they will be able to describe the recent developments related to animations and simulations in immersive virtual environments and the role they play in training, analysis and entertainment.

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APPENDICES

Appendix A
Letter for Nominations

Dear Academia and Industry Personnel,

With today's fast paced competitive manufacturing industrial challenges it benefits to hire both well-educated and rounded individuals. These individuals gain this advantage from the education received during their academic careers. In many cases the more manufacturing experiences they are exposed to during their education, the greater benefit they can be in industry. Every industrial professional wants employees to be a valuable asset with the skills expected to perform the assigned duties and responsibilities.

At Eastern Illinois University's School of Technology the aim is to prepare students for careers in different technological fields. The program strives to stay current with industrial advances and offers a comprehensive curriculum to their students. Currently the program lacks a curriculum for an Advanced CAD Solidworks course, with a focus on animation. Animation is a feature in the Solidworks software program that allows users to animate components and simulations. The question that must be asked then, do we teach animation as part of the curriculum and if so what should be the learning objectives?

As a result here at EIU we are doing research on creating learning objectives for an animation learning module. These learning objectives would be the bases for creating an individual instructional module for undergraduate studies. We have chosen to do the study via the Delphi technique. A panel of experts in the field of Solidworks is essential to complete the study. This is where your help is needed in nominating Solidworks experts within industry or academia areas. If you know someone whom meets either of the following criteria we would like to ask you today to respond with their contact information. Your help is greatly appreciated for the furthering of this study and the enhancement of the quality of undergraduate studies in the future.

Criteria

1. Industry
    1. 15 years' experience closely working with a CAD program similar to Solidworks
    2. Has experience with design and manufacture related to a CAD program similar to Solidworks
    3. Resides within the United States of America
2. Academia
    1. Graduate degree from a technology program
    2. 10 years or more working in academia (technology related)
    3. Resides within the United States of America

Thank you for your time,

Gavin Wilk
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David W. Melton
Assistant Professor
Eastern Illinois University
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(217) 581-5762

Appendix B

Delphi Instrument – Round One

March 19th, 2008

Dear Academia and Industry Personnel,

Thank you for your participation in Eastern Illinois University's CAD Delphi study. Enclosed is Round 1 of a 3 round study on setting objectives for particular topics of CAD animation / simulation.

In the form below you will see 4 main topics (History and Evolution of CAD, Types of CAD animations / simulations, Industries or areas where CAD animations / simulations are required, Presentation of CAD animations / simulations) in which you will input the most important learning objectives to be covered for each. There is also two blank sheets in which you may input a main topic you feel important for undergraduate students to learn. Please include at least four learning objectives under each while not using more than eight. Include what the learner is currently able to understand, important conditions under which the performance is expected to occur, and quality or level of performance considered acceptable.

Type your responses directly in the form and email results to Gavin Wilk or Dr. David W. Melton at the address listed below **no later than Friday March 28th, 2008.**

Thanks again for your time and effort in this study,

Gavin M. Wilk
CAD Research Assistant
Eastern Illinois University
University
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(708)362-1402

Dr. David W. Melton
Assistant Professor
Eastern Illinois

dwmelton@eiu.edu
(217)581-5762

Computer Based Estimating Delphi Round 1
Eastern Illinois University

1.) History and Evolution of CAD

1.)
2.)
3.)
4.)
5.)
6.)
7.)
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2.) Types of CAD animations / simulations

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3.) , Industries or areas where CAD animations / simulations are required

1.)
2.)
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4.) Presentation of CAD animations / simulations

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5.) Topic:________________________________

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Topic:______________________________

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Appendix C

Delphi Instrument – Round Two

Thank you for your valued response in round one. This round should be much quicker. All learning objectives from round one have been compiled to make a final list under each respective category. Like objectives were combined. Please rate each objective according to your opinion about its necessity within an undergraduate CAD animation / simulation curriculum. When you are finished please electronically mail your response back within one week (April 28, 2008). Thanks again.

	Extremely Unnecessary	Very Unnecessary	Unnecessary	Necessary	Very Necessary	Extremely Necessary

Example:

- CAD is Fun ___ ___ ___ ___ ___ _X_

Category I. - The History and Evolution Of CAD	
o Learner able to draw a time line describing the history and evolution of CAD, including advances and developments of new programs and their contributions to animation.	___ ___ ___ ___ ___ ___
o Students able to analyze and describe milestones and specific niches that CAD programs have regarding animation and design.	___ ___ ___ ___ ___ ___
o Learner will list companies and organizations who have contributed to the evolutions of CAD and animation.	___ ___ ___ ___ ___ ___
o The learner will describe the role that digital multimedia plays today in CAD and animation and will be able to provide projections of how the industry and skills will change in the future.	___ ___ ___ ___ ___ ___

o The learner will be able to explain how humans have used stories and storytelling for centuries and will compare and contrast animation to these needs of communication.	___ ___ ___ ___ ___ ___
o Chronological evolution the object representation from 3D wireframe to faceted surface model to solid mass models.	___ ___ ___ ___ ___ ___
o The historical correlation between hardware speed and capacity versus the software requirements and the resultant end-product 'size'.	___ ___ ___ ___ ___ ___
o The transition from the efficient duplication/representation of 2D manual drafting to the 3D solid modeling of objects with their physical properties.	___ ___ ___ ___ ___ ___
o The progression of output devices: pen plotters, printers, rapid proto-types	___ ___ ___ ___ ___ ___
o The transition from single mainframe with shared access to software, to independent personal platforms with distributed software, to networked collaborative access to single projects	___ ___ ___ ___ ___ ___
o The progression of input devices: keyboard, digitizer, mouse, stylus, voice, touch screen, etc	___ ___ ___ ___ ___ ___
o The progression from static to dynamic to 'intelligent' objects.	___ ___ ___ ___ ___ ___
o The people who envisioned and then created these 'things'	___ ___ ___ ___ ___ ___
o Basic computer graphics elements and their biological basis. Pixels, resolution and its relation to contrast ratio and perception. Vector versus raster graphics. Color depth and bit depth.	___ ___ ___ ___ ___ ___
o Representation of objects, wireframe, solids, surfaces, and their mathematical descriptions.	___ ___ ___ ___ ___ ___
o Hardware and software systems history starting	

with Evans and Sutherland's computer graphics CAD stations, IBM's CADAM, Movie Arizona and Movie BYU, AutoCAD. Modern systems and applications.	___ ___ ___ ___ ___ ___
Category II - CAD Animations / Simulations	
o Representations of physical elements, CAD	___ ___ ___ ___ ___ ___
o Representation / simulation process and phenomena, CFD, FESA, CAM, CAE	___ ___ ___ ___ ___ ___
o Business graphics, charts, curves, representation of data, curve fitting, interpolation, and extrapolation.	___ ___ ___ ___ ___ ___
o Communications and multimedia, movies, presentations.	___ ___ ___ ___ ___ ___
o Aesthetic representations, shaded surfaces, industrial engineering, photorealistic representations, photo and video overlays	___ ___ ___ ___ ___ ___
o All types to include both static and dynamic representations, i.e. still images, movies.	___ ___ ___ ___ ___ ___
o Morphology of the component: bending, warping, bulging, stretching, etc.	___ ___ ___ ___ ___ ___
o Translation of the component: linear, rotational, scale, parent/child relationships	___ ___ ___ ___ ___ ___
o Transition of appearance: opacity to transparency, change of material, aging	___ ___ ___ ___ ___ ___
o Translation of environment: submersion, illumination, decompression	___ ___ ___ ___ ___ ___
o Relational, locked and sequential transitions and interferences.	___ ___ ___ ___ ___ ___
o The learner will be able to list different types of animations and simulations and indicate which ones are CAD based and which ones are not.	
o The student will be able to explain the benefits of animating with CAD as compare to other means.	___ ___ ___ ___ ___ ___

o By using a CAD software package, the student will be able to create animations for entertainment, education and marketing.	__ __ __ __ __ __
o The learner will understand and provide examples of how simulation is used today in many disciplines to develop, analyze and test products and systems.	__ __ __ __ __ __ __ __ __ __ __ __
o Through the use of a parametric CAD software package, students will design a mechanical system in which animated simulations would be beneficial in obtaining a desirable output.	__ __ __ __ __ __
Category III. – Industries or areas where CAD animations / Simulations are required	
o The learner will list industries and disciplines where CAD animations and simulations are required.	__ __ __ __ __ __
o The learner will explore and present on how animations and simulations could potentially be used in disciplines that traditionally have not used these means of analysis and communication.	__ __ __ __ __ __
o The student will be able to explain how animation and simulations are impacting the disciplines of engineering and design, and will show examples of how engineering and design companies are using these tools.	__ __ __ __ __ __
o The learner will be able to provide a critical perspective of the benefits, costs and that uses CAD animations and simulations have on companies, and when the implementation is advisable and when is it not.	__ __ __ __ __ __
o It could be easily argued that animations/simulations are never 'required'. o There are advantages in the visualization of change, particularly for those becoming familiar with a particular domain. It might actually be	__ __ __ __ __ __

easier to list those fields where simulations and animations would not be an advantage.	
o Forensics, process/production, manufacturing, robotics, architecture, accident and crime reconstruction, entertainment	___ ___ ___ ___ ___ ___
o Animations and simulations provide advantages for situations where scale presents difficulty. Very large or very small objects can be accurately modeled and conveniently sized for inspection and manipulation. I once modeled a benzene molecule, among others, for inspection and manipulation by chemistry students.	___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___
o The remote control or modification of objects either in real or artificial environments.	
o The placement of objects (real or virtual) in alternate environment forms.	___ ___ ___ ___ ___ ___
o Where the cost of error is very high, if not unacceptable: surgery, munitions (assembly and disposal)	___ ___ ___ ___ ___ ___
o The simulation and animation of hazardous objects or environments.	___ ___ ___ ___ ___ ___
o Business and communication applications, pie charts, earning statements, projections	___ ___ ___ ___ ___ ___
o Architectural	___ ___ ___ ___ ___ ___
o Engineering and manufacturing including automotive and aerospace	___ ___ ___ ___ ___ ___
o Multimedia, movies, commercials, corporate advertising	___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___
Category IV. – Presentation of CAD animations / Simulations	
o Hardware and software considerations, demands	

on computer hardware, disc storage considerations	
o Commercial standards, 1080p, 760p, MPEG, JPEG, and proprietary standards such as DXF, raw, BMP.	___ ___ ___ ___ ___ ___
o Transfer and presentation techniques, flash cards, usb keys, CD, VCD, DVDs of all types, projectors, LCD, organic LC, LEDs, massive (Stadium) displays	___ ___ ___ ___ ___ ___
o Human interface effects of color, resolution, frame rate, contrast, brightness, and other considerations.	___ ___ ___ ___ ___ ___
o Group virtual immersion environments using caves and multi-screen projection	___ ___ ___ ___ ___ ___
o Haptic stylus for individuals	___ ___ ___ ___ ___ ___
o Goggles, either red/blue screened, shuttered, or parallax projection monitors for the individual immersion.	___ ___ ___ ___ ___ ___
o 2D monitors and projectors o Printing of strobic iMagery.	___ ___ ___ ___ ___ ___
o The learner will develop skill to create an animation using CAD.	___ ___ ___ ___ ___ ___
o The student will animate objects and the camera using CAD.	___ ___ ___ ___ ___ ___
o The learner will be able explain the importance of storyboarding in animation and be able to create a storyboard.	___ ___ ___ ___ ___ ___
o The student will be able to use another person's storyboard to create animation sequences using CAD.	___ ___ ___ ___ ___ ___
o Students will be able to use movie editing software like Adobe Premiere to create a movie or story from the animation sequences.	___ ___ ___ ___ ___ ___

o Students will be able to explain the options that exist with regards to rendering their animations and simulations.	___ ___ ___ ___ ___ ___
Category V. Disadvantages or deterrents to CAD simulation and animation	
o Cost; does a client see the value in it, at least enough to want to pay for it? Animation and simulation require higher (costly) levels of technologies.	___ ___ ___ ___ ___ ___
o Time; short versus long term investment of time for gains in the reality of the result? Eventually the first two are interconnected and results in a balance between Investments of Time versus Duration of Relevance.	___ ___ ___ ___ ___ ___
o The reality factor: how detailed must the perception of a reality be. Is every bolt, or the helical thread of the bolt, or the radius on the ridge of the thread, required to produce a satisfactory result, even if that result is the illusion of a designed reality?	___ ___ ___ ___ ___ ___
	___ ___ ___ ___ ___ ___
Category VI. – Future of CAD animation / simulation	
o The probable elimination of dimensioning and traditional 'views' of objects (Orthographic, Axonometric, and Perspective) as the animation and simulation of modeling evolves.	
Category VII. – Animation, Multimedia and Interactivity	___ ___ ___ ___ ___ ___
o The learner will be able to explain user controls for web and other digital mediums.	
o Students will use Adobe Flash to create a digital portfolio and provide interactivity capabilities for the end user of the animations created.	___ ___ ___ ___ ___ ___
o The learner will be able to incorporate multimedia features to their animations such as	

sound(s), text and/or other visual components.	
o The learner will have an understanding of criteria for uploading animations to the web and will be able to post their personal animations to the WWW.	___ ___ ___ ___ ___ ___
o The student will be able to describe recent developments related to animation and simulation in immersive virtual environments and the role they play in training, analysis and entertainment.	___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___