The Design Process

Rochester Institute of Technology
College of Imaging Arts and Sciences
School of Design
Graduate Graphic Design Program

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The Design Process

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Date 5/8/2000

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Thesis Project Definition

This thesis investigates the relationship between graphic design and engineering, and their use of similar problem-solving processes. It reveals the underlying principles that are inherent in graphic design and engineering and illustrates how these disciplines use a common creative process.

By comparing vastly different disciplines and identifying how they use a similar creative thought process, this thesis is constructing an understanding of the methodology of thought. This thesis demonstrates that although these two disciplines may use different terms and tools, the process in creating is the same.

Precedents

What is Science:
Introduction to the Structure and Methodology of Science

James V. Mannoia writes about the existence of two different communities in the world. The first he labels the scientific community which includes scientists, engineers, and technicians. The second is labeled the humanities which includes philosophers, writers, and fine artists. He draws attention to the apparent dichotomy between these two entities, and he explains that this separation exists because of a lack of communication and understanding. He proposes that each of the respective fields needs to learn to appreciate the qualities that the other possesses. Communication is the key to understanding and learning. This book is a precedent to this thesis investigation by supplying a case study on the relationship between the art and science worlds.

Mannoia, James V. *What is Science: Introduction to the Structure and Methodology of Science,* University Press of America, London, 1980

Systems Engineering:
Art and Science in an International Context

This critical essay discusses the talents necessary for a systems engineering career. John MacDonald writes that creativity is often hidden within the functional aspects of engineering. He states that creativity primarily functions within the problem-solving process that is concerned with the ability to overcome time, budget, and material constraints, to produce a product. *Systems in an International Context* is similar to the proposed thesis topic in that it documents how the creative thought process is used in a function-based career.

John, McDonald *System Engineering: Art and Science in an International Context,* On-Line MacDonald Dettwiler, Available: http://www.mda.ca/incose/jsm_incose_speech.htm, Nov. 1999

Research

Three main topics were researched during this thesis: graphic design, engineering, and philosophy. The correlation between these disciplines was developed through the consultation of a variety of books and periodicals. Numerous discussions were also held in order to collect a wide range of materials.

Graphic design and engineering design processes were collected that ranged from basic idea generation to those which define structural integrity. The collection of these processes provided an extensive reservoir of terms that would act as a foundation for the development of a new hybrid design process between graphic design and engineering.

All collected processes for graphic design are located in Appendix 1, pages 36-41
All collected processes for engineering are located in Appendix 1b, pages 42-46

Research

Philosophy

The works consulted focused on the process of learning (Albert Whitehead) and the concept of quality (Robert Pirsig). Both are integral to the design process and are illustrated in these works as universal processes, not separately defined for art and science. This is a significant in establishing a relationship between graphic design and engineering processes.

Albert Whitehead
The Aim of Education

"What education has to impart is an intimate sense for the power of ideas, for the beauty of ideas, and for the structure of ideas, together with a particular body of knowledge which has peculiar reference to the life of the being possessing it."

According to Whitehead, learning makes no distinction between art or science. He states that learning can be defined through the mental growth stages of romance, precision, and generalization. This was significant to this thesis because the stages of learning run a parallel course to the stages of design. The stages of both learning and design start with a novelty and excitement for something new, and progress to a stage where knowledge is acquired and analysis occurs. The final stage is where an understanding is formed and a specific goal is achieved.

Robert Pirsig
Zen and the Art of Motorcycle Maintenance

Robert Pirsig's writings were studied because of his ideas on quality. He states that the quality of an object is determined before the cognitive understanding of the object takes place. Therefore, the standards of quality are the same whether a person is discussing quality about a painting or vehicle.

Design determines needs, and then creates a solution to fulfill them. Considering an object, "designed" means that the object has been thought about systematically. A well-designed object is constructed with order, understanding, and intention. Quality is determined by how well a design meets the determined needs. When an object has been designed successfully the expectations dealing with quality are heightened. Good design is a signifier of high quality, but quality is not necessarily a signifier of good design.

Paul Rand
Writings on Quality,
Memo to author, October 1998

"The concept of quality is difficult to define, for it is not merely seen, but somehow intuited on the presence of the work it is embedded. Quality has little to do with popular notions of beauty, taste or style, and nothing to do with status, respectability or luxury. It is revealed, rather, in an atmosphere of receptivity, propriety and restraint... Quality is concerned with truth."

Synthesis

In this part of the process a structured relationship was formed between the two disciplines. This involved the development of a hybrid process that utilized terms and ideas from graphic design and engineering.

The creative process is cyclical. In its purest form it is a mass of undulating information where all of its parts merge together. Because an infinite amount of terms exist between disciplines, it is often hard to make exact distinctions between the parts of the creative process. By using familiar process terminology as a tool, the designer began to organize the collected processes into understandable relationships. Below are the terms, with definitions, that helped structure a relationship between the processes from both graphic design and engineering.

The collection of terms are located in Appendix 2, page 47

Known Terms	Definitions
Problem	What is the problem? What needs to be solved?
Research	Collect information that will help in understanding the problem.
Ideation	Generation of a wide range of possible solutions for the problem.
Analysis	Organize the research into logical groups.
Synthesis	Construct relationships based on collected research. These relationships help create direction for the process of ideation.
Implementation	Construct the most promising idea into final form.
Evaluation	How successful was the process? Did the solution solve the needs of the problem?

Synthesis

Graphic Design Process Matrix

Before a hybrid process could be created, an understanding of the terminology used by each process had to be established. Following are matrices defining collected processes based on known terms.

References for collected processes are located in the Bibliography, page 35

Known Terms	Collected Processes					
	Universal Traveler	*Asimow and Watts*	*Bauhaus*	*Frank Armstrong*	*William Pena*	*Bruce Archer*
Problem	Acceptance	Divergence	Observation	Define Problem	State Problem	Programming
Research		Transformation			Collect	Collect Data
Ideation	Ideation		Representation	Schematic Diagram		Development
Analysis	Analysis			Organize Information		Analysis
Synthesis	Definition				Establish Goals	Synthesis
Selection	Idea Selection	Convergence		Prototype	Needs	
Implementation	Implement		Composition		Test Concepts	Communicate
Evaluation			Evaluation		Uncover	

Synthesis

Engineering Process Matrix

Known Terms	Collected Processes					
	Triz	*Black Box*	*Technical Process*	*Problem Process*	*Georgia Tech*	*Structural Failure*
Problem	Identify Problem	Problem	Determine	Identify Problem	Task	Failure
Research	Specification	Inputs			Specification	Key Qualities
Ideation	Identify Tools	Outputs	Energy Conversions	Generating Alternatives	Preliminary Layouts	Mathematical Model
Analysis	Model Refinement	Model Reduction	Transform Materials	Parameter Analysis	Concept	Characteristics
Synthesis		Analogies				Design Inequality
Selection	Using Tools	Solution		Choice	Definitive Layout	
Implementation	Implement		Connection	Implement	Solution	Geometry Found
Evaluation	Evaluate			Control		

Synthesis

After an understanding of the terminology was attained, the next step was to find the terms which existed between both disciplines. Below are the definitions of the overlapping terms explaining the thought process during each step of the design process. The new design process utilized terms familiar to both graphic design and engineering and are effective in describing the creative process.

Preliminary constructed processes are located in Appendix 2b, page 48

New Design Process	**Definitions**
Acceptance	During this portion of the process the client presents the problem. The designer accepts the task and agrees to solve the problem to the best of his/her ability within the project constraints. The problem is often not yet defined or could be defined more specifically. This illustrates why the problem definition is not determined until the second step in the process.
Problem Definition	During this portion of the process one should collect research to define the initial problem statement. This stage can accurately define the problem and develop achievable goals by gathering information and formulating comparisons.
Concept Development	During this portion of the process one should generate as many ideas as possible. By utilizing the connections constructed with the research a number of solutions are created to solve the defined problem. A preliminary evaluation can also be performed to remove the least effective solutions and reveal a solution that will most accurately solve the problem.
Implementation	During this portion of the process one should take the selected idea generated in the prior stage and assemble it into its final form.
Post Evaluation	During this portion of the process one should review the successes and failures of the process by assessing the effectiveness of the solution.

Ideation

The ideation phase explored several possibilities for the application's final form. With the collection of the processes and a desire to form a new process, it became necessary to generate a diagram which would visually document the flow of the creative process. An application was also necessary that would display the diagram and give details which would describe the design process. Below are questions that were asked to help in defining the applications form.

Preliminary sketches of application are located in Appendix 3b, page 51-53

Available Applications

Book, Informational Posters, Installation, Study Guide, Multimedia Website

What is it going to say?

The application is going to be an informational tool which documents the creative thought process and the newly developed design process which exists between graphic design and engineering.

Who is the target audience?

The new process would be targeted to junior and senior designers or people new in the design profession.

Where will it be displayed?

The application would be made available in an educational or work environment where the viewer has direct access to the information.

From the questions above, the initial decision was to construct a series of posters and a study guide. The posters would contain more visual explanation of the process, while the study guide would construct a verbal relationship between graphic design and engineering.

Ideation

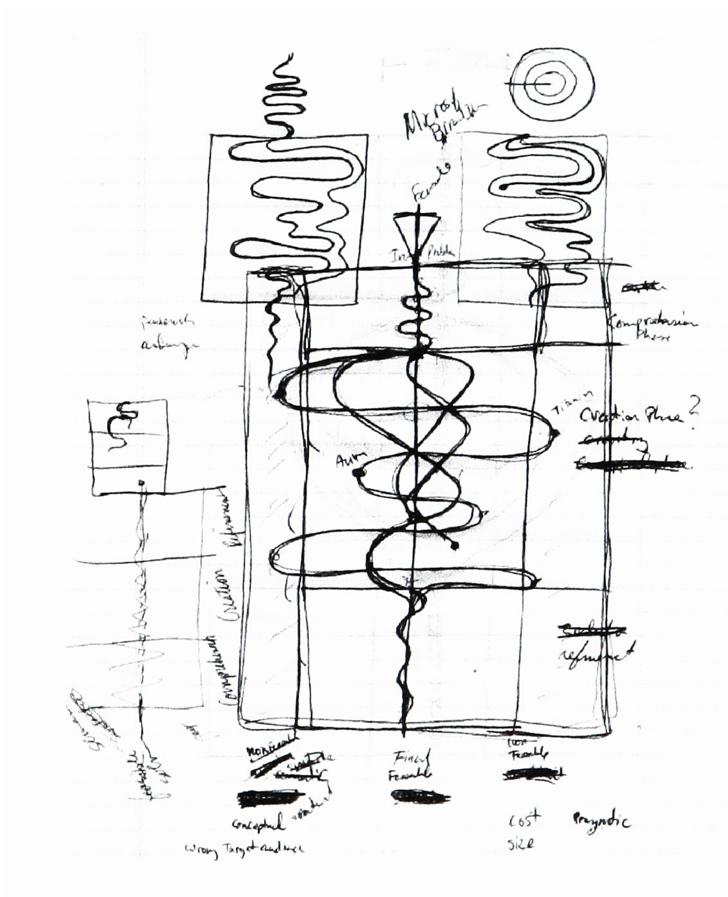
Flow Chart

Completion of the hybrid process allowed for the development of a diagram which represents the flow of the thought process. Below is an initial sketch of the flow chart diagram.

Additional sketches for diagram are located in Appendix 3, pages 49-50
The final diagram is located on page 17

Developed Process

Acceptance
Problem Definition
Concept Development
Implementation
Post Evaluation



Ideation

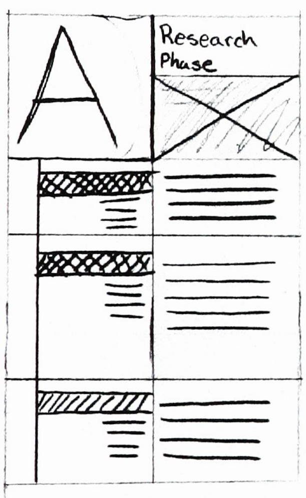
Application

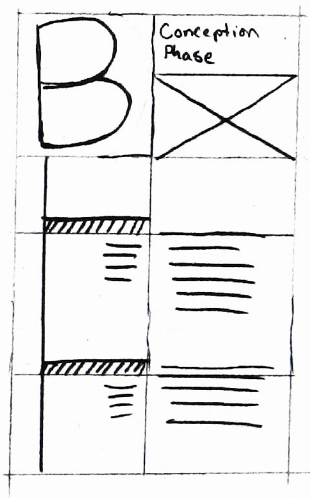
During this stage, the layout for the posters was developed. It was necessary for the posters to document the diagram and display the visual documentation from the graphic design and engineering processes. Below is an initial sketch of the application.

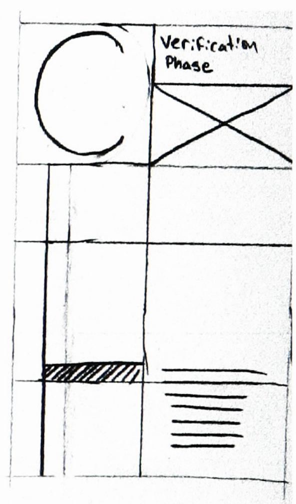
Additional sketches for application are located in Appendix 3b, pages 51-53
The final layout of the posters is located on pages 18-24

Developed Process

Acceptance
Problem Definition
Concept Development
Implementation
Post Evaluation







Intermediate Evaluation

At this point it was concluded that the application would be a set of posters which would document sequential information about the design process. The ideas generated for the posters were evaluated against the semiotic model in order to determine their success or failure.

Pragmatic Issues

Ergonomics, Production, Specifications, and Distribution
Pragmatic issues included the size and number of posters required. The posters were designed in Adobe Illustrator as vector images. This allowed the posters to be scaled to any size without the threat of pixelation and could adapt to printer specifications.

Semantic

Meaning, Perception, and Communication
At this stage, specific visual examples pertaining to graphic design and engineering were established. The visuals for graphic design were derived from a previous project in which the designer developed a brand identity for Microsoft Windows. It consisted of visual documentation that was already broken down and only needed to be transferred to the posters.

Initially, the visuals that were going to be used for the engineering documentation were from the development of a bridge. Concerns about using a bridge were expressed by committee members because of the aesthetics used in the design. A decision was made that it would be more appropriate to document a piece of work that was created totally on its functionality. This would help to strengthen the differences between both disciplines, while still showing how they use similar creative processes. The Ball Corporation: Techstars Small, Smart Space Systems satellite was chosen to document the engineering process. Satellite construction fit the criteria, because they are functional and use highly intricate systems and architecture in their development.

Syntactic

Form , Structure, and Variables
At this point the posters were critiqued as a system.

Color
How meaningful is the color used?
How well do the colors help organize information?

Typography
Is the type clean and accessible?
Is there a distinct hierarchy?

Language
Is the language clear, sophisticated, yet easy to read and understandable?

Spatial
Is the space divided logically?

Intermediate Evaluation – continued

Peer Presentation

In February of 2000, the designer gave a presentation to the first year graduate graphic design students at Rochester Institute of Technology. This was the first time the designer needed to explain the thesis topic in front of an audience. A reassessment of the final application came out of this presentation. Until this point there where plans to construct a study guide that would assist the series of posters. Comments during the presentation influenced the designer to remove the study guide and concentrate on creating a sequence of posters.

Committee Members

Committee members discussed the creative thought process and it functions. The discussions were based on the similarities and differences between the way engineers and graphic designers synthesize information. The meetings created a clear understanding of the design process and the dichotomy between the two disciplines' design process. More importantly, the meetings helped in rethinking how the relationship between the two might be constructed.

Informal Discussions

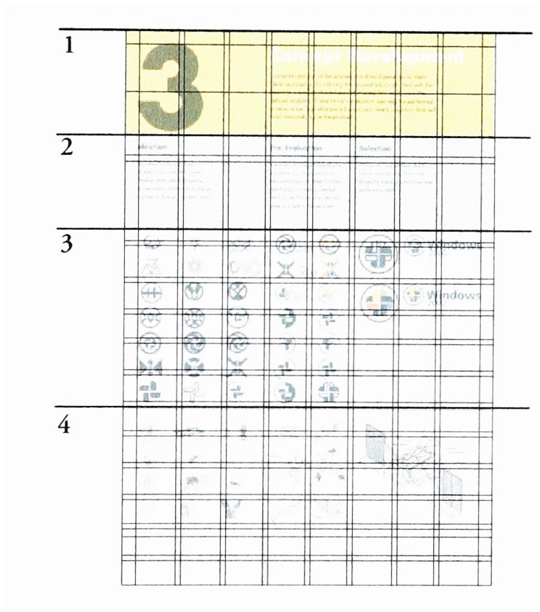
This method of evaluating was based on conversations with friends, family members, and colleagues. Most of these discussions were based on personal interpretations of what design is, how design should be conducted, and what the purpose of design is. These conversations reinforced the objective of this thesis. Every conversation would end in saying that design is not an art or science but a combination of both. These conversations reinforced the question this thesis was proposing: not *what is design?*, *how do you design?*

Implementation

Application

The form of the final application was determined by evaluating the ideas generated in the ideation stage. The creation of a strong grid system was necessary in order to construct the posters. The grid helped to allocate the information into five distinct segments. It would allow the viewer to intuitively locate information by setting up expectations on where to find information.

Organization of Space



1 Shows the name of the stage in the process and provides a definition for it. Provides information numerically on the step of the process being discussed. The numbers correspond with the numbers on the diagram.

2 Goes into detail on the steps of the process. Discusses where the process might go after this stage.

3 This portion of the poster organizes the graphic design examples.

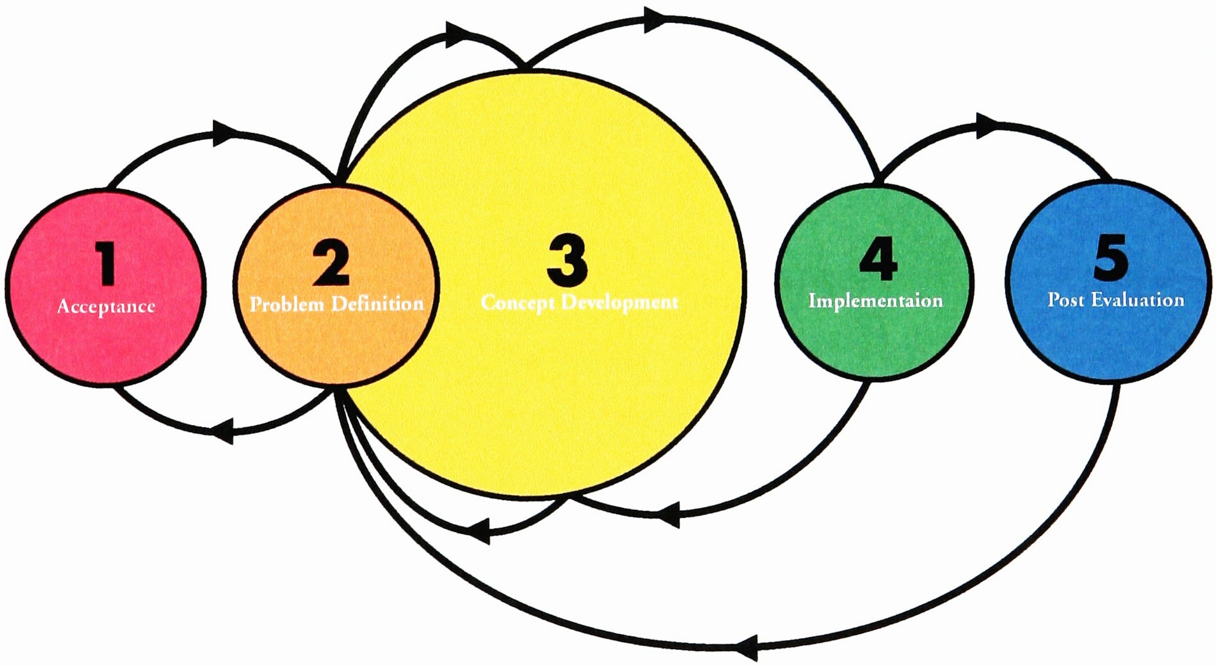
4 This portion of the poster organizes the engineering examples.

Implementation

Diagram

Final Process

The diagram illustrates how the stages of the process are connected. It documents how concepts are developed and evaluated, moving back and forth between the stages of the creative process.



Implementation

Application:

Introduction Poster

The Design Process

Thomas Pasquini

Thesis Topic

These posters document similar creative problem-solving processes between graphic design and engineering. They illustrate a hybrid design process that incorporates ideas and terms from both professions. It expresses how both disciplines use a design process to create functional work. The posters show that design is not an art or science, but a synthesis and a way of thinking about relationships.

Design

What does it mean when an object is said to have been designed? Considering an object, "designed" means that the object has been thought about systematically. It has been constructed with order, understanding, and intention. When an object has been designed the expectations dealing with quality are heightened. Quality is the signifier of good design. Design and quality are of equal value.

"The concept of quality is difficult to define, for it is not merely seen, but somehow intuited on the presence of the work it is embedded. Quality has little to do with popular notions of beauty, taste or style, and nothing to do with status, respectability or luxury. It is revealed, rather, in an atmosphere of receptivity, propriety and restraint... Quality is concerned with truth."

Paul Rand

Graphic Design

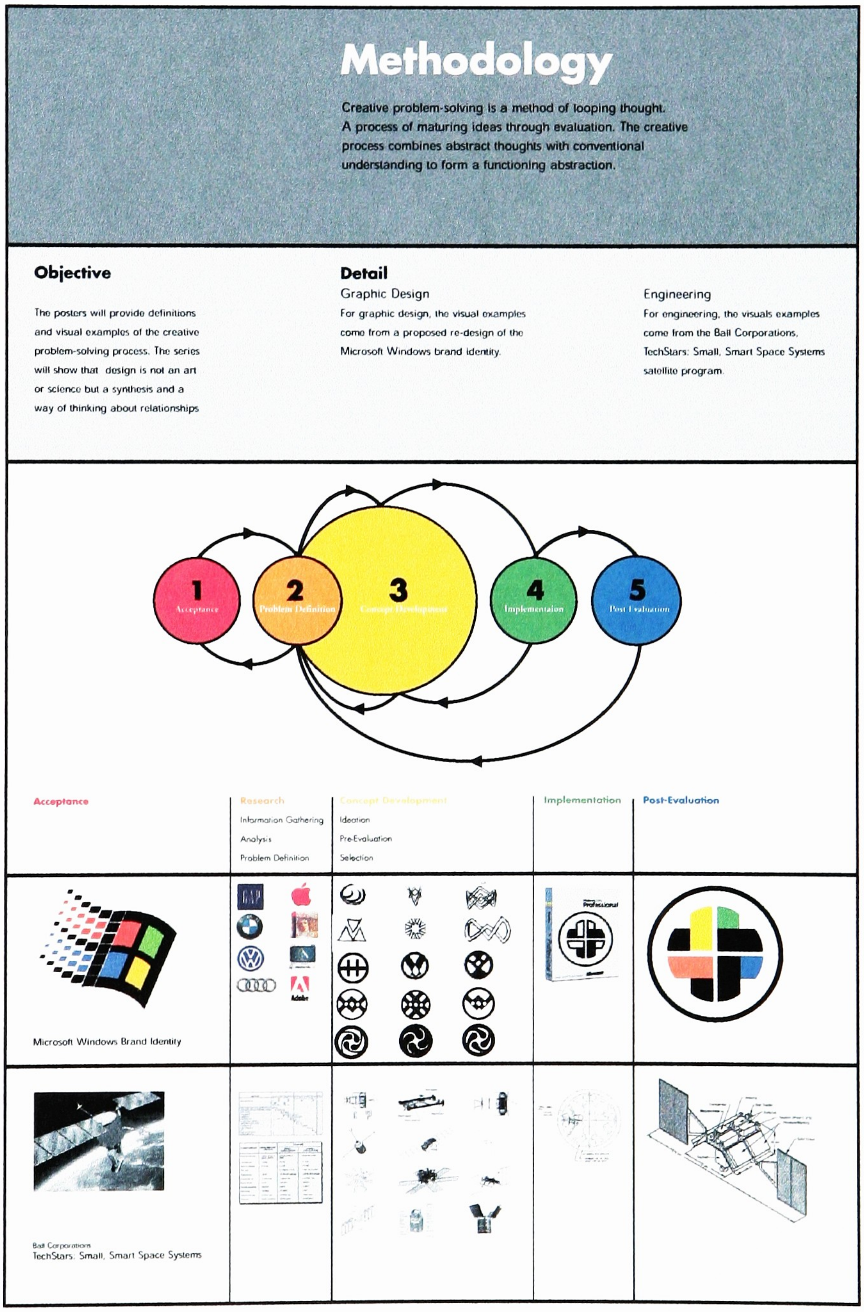
A profession in which a cognitive understanding of information is developed through its visual organization. Graphic designers develop visual representation for ideas that do not exist in a visual format. They strive to present information to the viewer with the fewest questions and the highest degree of honesty.

Engineering

A profession that constructs an application through the study of the sciences, improving the quality of society by solving problems of practical interest. Engineers meet the needs of a society by reducing the complexity of daily tasks.

Implementation

Application:



Implementation

Application:

1 Acceptance

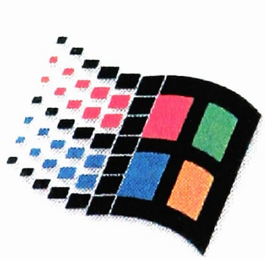
During this portion of the process the client presents the problem. The designer accepts the task and agrees to solve the problem to the best of his/her ability within the project constraints. The problems often not yet defined or could be defined more specifically. This illustrates why the problem definition is not determined until the second step in the process.

Objective

Think about pragmatic issues such as cost, deadlines and scheduling.

Detail

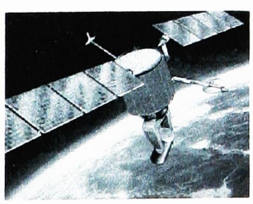
The designer needs to ask the client questions to assess their needs. Find what aspects of the problem are the most problematic and begin to address possible tactics.



Microsoft Windows:
Brand Identity

The flag is the main identity for Windows, and represents the rich heritage of the operating system. The colors selected designate the different product types: blue is for the servers, red is for the clients, green is for Windows CE, and yellow represents the user. Dynamic gradients and dimensions have been developed to emphasize the new generation of Windows. People are included because, above all, Windows was designated to empower the people who use it.

Design process courtesy of:
Thomas Pasquini and Rochester Institute of Technology



Ball Corporations
TechStars: Small, Smart Space Systems

Ball Corporations TechStars initiative is aimed at the development of technologically advanced, small space systems that can perform significant missions at greatly reduced cost. New technologies and launch vehicles advances have spurred the development of smaller, lighter, cheaper, yet highly capable satellites. These small satellite systems are now designed and deploy within months instead of years.

Design process courtesy of:
Ball Corporation's TechStars: Small, Smart Space Systems
Horais, Brian, *Small Satellite Technology and Applications*,
The International Society for Optical Engineering, Vol. 1495, 1991, pg 100

Implementation

2 Problem Definition

During this portion of the process one should collect research to define the initial problem statement. This stage can accurately define the problem and develop achievable goals by gathering information and formulating comparisons.

Information Gathering

Collect a wide range of general to specific materials that are pertinent in defining the problem.

Analysis

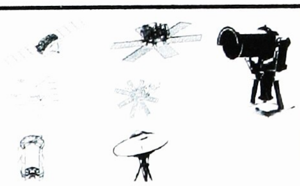
Study collected information and start to formulate connections with known knowledge and technology

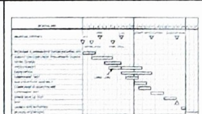
Objectives

Pinpoint positives and negatives from the analysis and create a list of objectives that will solve the problem.

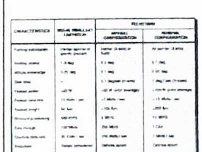
Successful Corporate and brand identity marks

Key Words:
Integration
Growth
Innovation
Sophistication





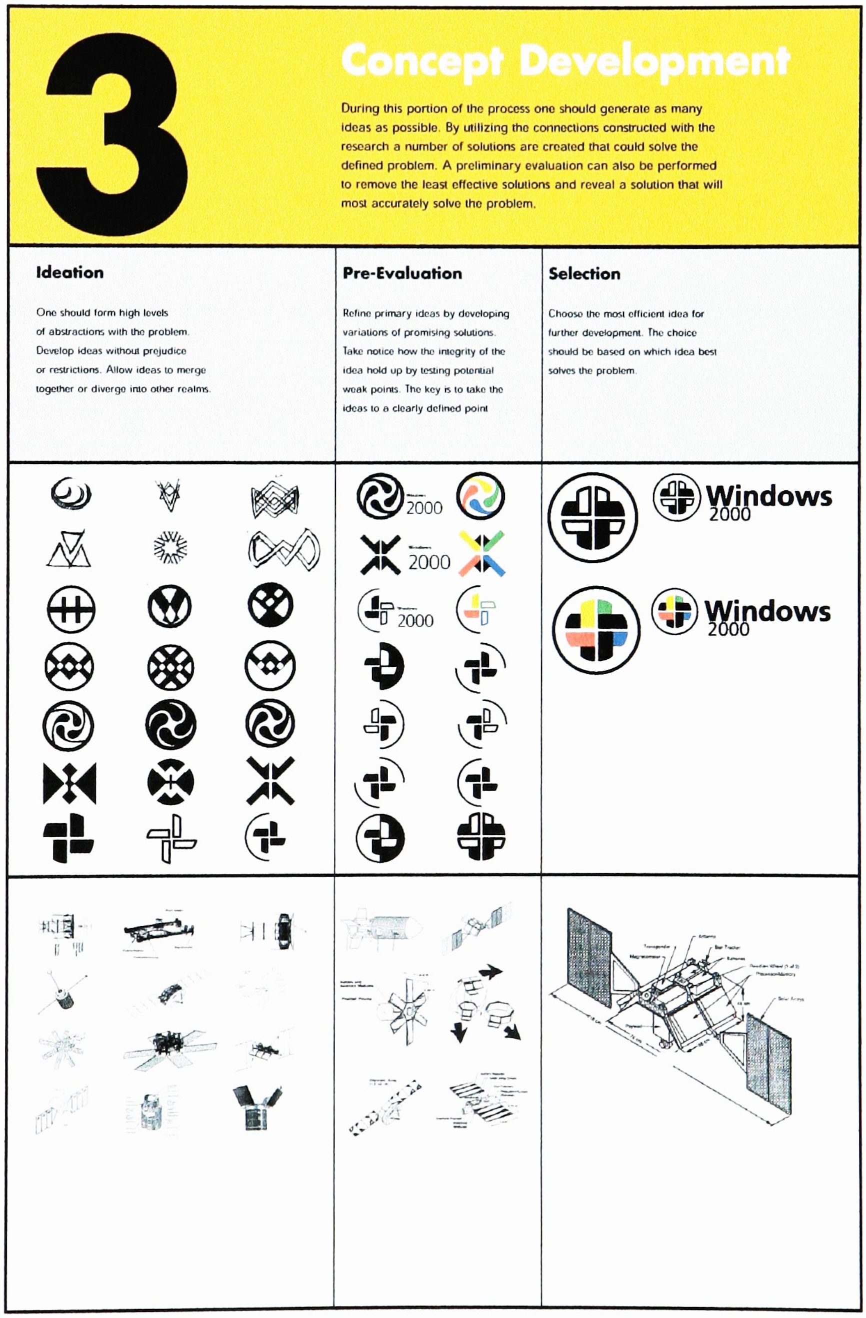
Development Schedule



TechStar satellite compared to other typical small Satellites

Key Words:
Capable
Flexible
Survivable
Reconstitutable
Short Lead-Time
Affordable

Implementation



Implementation

4 Implementation

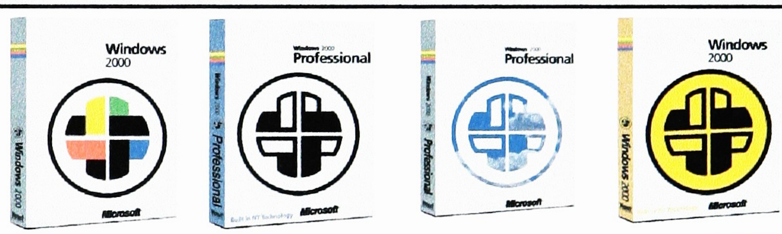
During this portion of the process one should take the selected idea generated in the prior stage and assemble it into its final form.

Objective

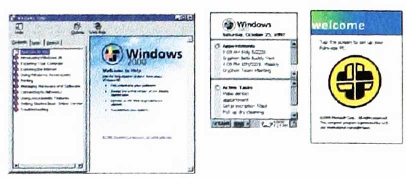
A clear picture of the final product is within reach. Ideas and information should be organized and accessible.

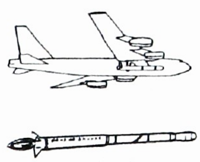
Define

In the process of implementation, it is inevitable that problems will arise. Further refinement will need to happen and venturing back to previous stages will be necessary.

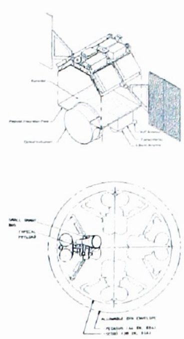


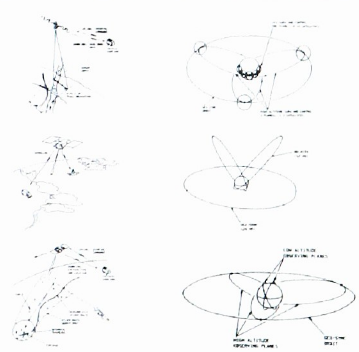
Microsoft Windows final mark can be appear in a variety of styles, allowing it to adapt into a wide range of applications.





Above: Images are of possible launch vehicle configurations
Right: Simple integration of a payload
Far Right: Possible missions areas for small satellites





Implementation

5

Post-Evaluation

During this portion of the process one should review the successes and failures of the process by assessing effectiveness of the solution.

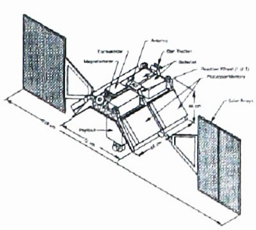
Objective

Notice how the key words work with the final solution. Do they relate? Does the final solution define the problem definition? Where are the successes and failures?

Detail

What can be learned from the experience? Develop a tactical scheme for the future. Look at the final solution. Does the solution fall short, meet, or exceed the clients desired outcome?

Key Words:
Integration
Growth
Innovation
Sophistication



Key Words:
Capable
Flexible
Survivable
Reconstitutable
Short Lead-Time
Affordable

Dissemination

Gallery Presentation

The posters were displayed in the RIT Bevier Gallery from March 10 through March 30, 2000. The display consisted of an introductory panel that stated the thesis objectives and displayed the posters in the designed sequence.

Other Presentations

Engineering

After the Gallery presentation was completed, the posters were brought to the engineering department at RIT. They were displayed and evaluated by Professor Allen Nye's Senior Engineering Design class and Professor Kevin Kochersberger's Multi-Disciplinary class.

Industrial Design

The posters were then displayed at RIT's industrial design classroom where Professor Kim Sherman's Senior Career Planning class had an opportunity to evaluate them.

Future Presentations

Modifications could be made to tailor the process to a specific audience such as a fine artist, salesman, or computer programmer. In the future the development of a multi-media presentation could be generated that would be able to animate the creative thought process.

Retrospective Evaluation

Gallery Presentation

The gallery opening gave the designer a chance to see how people reacted to the formed relationship. The relationship between the disciplines helped create a platform for the understanding of the design process for both professions. Comments from the three week presentation revealed that the viewers could understand the design process and see that it is about critical thinking. It also revealed aspects of the disciplines which most people do not get to see. This gave the viewer a chance to view the profession beyond the pre-conceived ideas.

Unexpectedly, a person at the opening had worked for the Ball Corporation for 25 years. He commented that the Ball Corporation never worked with a documented process. By the way the visuals where laid out in comparison to the documented process, he could see how the Ball Corporation might have documented their process.

This comment made the designer think about the developed process, and question its ability to represent the graphic design and engineering disciplines. This also posed a question about the visual relationship formed. Did the abstract relationship between the two disciplines become too generalized?

Graphic Design Students

From comments on the evaluations, the graphic design students could understand what the visual represented on the posters and context they were being used in. They commented that they would like to see a more involved explanation of the development of the piece of work, knowing how and why the final solution was chosen.

Written on the evaluation sheets were comments about the readability of the diagram. Suggestions were made to increase the effectiveness of the diagram by making the process a more integral part. By improving the placement of the process terminology, the rest of the posters would have a better cohesion with the diagram.

The success in the posters came from the organization of the information and the color system used. These aspects of the posters enticed the viewer to come and read the content.

Retrospective Evaluation – continued

Engineering Students

The engineering students expressed that they were not accustomed to parts of the developed process, but the explanation of the process was correct in its generalization. The evaluators commented that the Ball Corporation's satellite development was a good choice to document for engineering, but the use of color in the images and more explanation of their process would be helpful. They felt that the Windows mark overwhelmed the page demanding more attention, making, the engineering visuals appear secondary.

Although improvements need to be made on the posters, the success lies in their ability to increase the awareness of the graphic design profession. Before viewing the posters the engineering students thought graphic design was about making beautiful pieces of work. By viewing the posters and seeing graphic design in context with engineering effectively heightened their understanding of the graphic design profession. They could see that graphic design creates a visual representation of an idea with purpose and meaning, not just empty visual appeal.

Industrial Design

This evaluation did not turn out as expected. Many of the evaluators failed to see any connection between the graphic design and engineering disciplines. Many of the comments recommended continuing research on the engineering process because it did not accurately document the engineering thought process. The other comments were similar to the graphic design and engineering evaluation in that the diagram needed to be re-evaluated and modified, and improvements needed to be made in representing the circular aspect of the creative thought process in the series of posters.

Retrospective Evaluation – continued

Self Evaluation

Overall, the concept that was developed between graphic design and engineering is pushing the limits of design. Illustrating that design is a separate entity that exists in all aspects of thought. As for the application itself, it was not successful. There needs to be improvement on the organization, flow, and amount of information on display. The creative process is circular, yet the posters work in a linear fashion. The posters could be designed or arranged to help reinforce the circular flow of the design process.

Stepping back from the application and looking critically at what was made, the designer began to question the reason why posters were created. Posters are good for displaying information on a wall, but posters do not effectively document an extensive amount of information. If the project were to be re-created, the designer feels that the amount of visuals should be decreased and the amount of explanatory text should be increased. This thesis investigation is about the methodology of thought. The choice to use a heavy visual documentation to explain a theoretical idea is tremendously difficult and was a poor choice with a limited amount of time.

Conclusion

This thesis project focused on a way of thinking. It examined how any discipline, in this case graphic design and engineering, can benefit from knowing and understanding how the design process functions. At first this thesis was trying to answer, *what is design*? As this thesis progressed it became evident that the question was not, *what is design*? but, *how do you design*? The advantage of asking 'how' instead of 'what' is opening the door to see the process behind design. This allows one to see that design is a cross-disciplinary activity that can't be defined by art or science, but rather as a way of thinking about problems by forming relationships and creating quality work.

What was learned from this investigation was that professions may use different tools and terms that are unique, but the underlying creative process and the desire to create quality is a common thread. If people can learn to utilize effective thought processes from a wide range of disciplines, what will be created is a body of knowledge where ideas will develop with an inclusive instead of exclusive attitude. Work will be created that will be in tune with many different parts of society from the visual to the methodical.

Glossary

Graphic Design	A profession in which a cognitive understanding of information is developed through its visual organization. Graphic designers develop visual representation for ideas that do not exist in a visual format. They strive to present information to the viewer with the fewest questions and the highest degree of honesty.
Engineering	A profession that constructs an application through the study of the sciences, improving the quality of society by solving problems of practical interest. Engineers meet the needs of a society by reducing the complexity of daily tasks.
Design	A mental activity, an activity of thinking. The psychology of thought that investigates human thinking activities, particularly during problem-solving.
Association	Forming connections between different concepts; the occurrence of one concept can cause another concept to raise into consciousness.
Logic	Conscious thought, methodical, systematic.
Intuition	Experimental thought in which the various stages of creating are no longer fully conscious.
Functionality	How an entire item works as a whole.
System	A series of steps that logically moves you from one point to another.
Useability	How an item is used, dealing with the human interface and comprehension
Aesthetics	How an item visually appears.
Dichotomy	Division into two, usually contradictory, parts or opinions.
Methodology	Properly refers to the theoretical analysis of the methods appropriate to a field of study or to the body of methods and principles particular to a branch of knowledge.
Creativity	Looking at a problem critically and solving it to meet the needs of the problem.
Hybrid	Something of mixed origin or composition.

Glossary

Matrices	The arrangement of specific or general information into a vertical and horizontal comparison, allowing for the cross-reference of terms or ideas for creation of new relationships.
Diagram	A plan, sketch, drawing, or outline designed to demonstrate or explain how something works or to clarify the relationship between the parts of a whole.
Flow Chart	A schematic representation of a sequence of operations.
Thesis Project Definition	Introducing, identifying and understanding the nature of the problem – including history, situation and goals.
Precedents	Describing other existing projects, case studies, models that have meaningful relationships to your study.
Research	Describing facts, principles, theories or relationships that have been discovered to help to solve the problem.
Synthesis	Describing interrelationships and patterns – sorting, sequencing, ordering information or parts of the problem.
Ideation	Describing the generation of conceptual solutions and preparation of a range of preliminary design approaches.
Evaluation	Describing testing strategies that were used to judge ideation and the resulting selection of possible design solutions.
Implementation	Describing how the project was refined, developed and produced to its final form or application.
Dissemination	Describing plans for future audience interaction – how could this product or information be distributed/used in the future?
Retrospective Evaluation	Assessing the final product to determine strengths and weaknesses – how could future versions be improved?
Conclusion	Summarizing overall experience and outcome – what was gained?

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Appendix 1

Collected Processes
Graphic Design

Graphic Design Problem-Solving Methodologies: **Individual Methods**

Beardslee	Poincare	Getzel	Edwards	LowenFeld	Frank Armstrong
Problem Identification	Saturation	First Insight Saturation	Saturation	Preparation	Define Problem
Research and Analysis	Incubation	Incubation	Incubation	Incubation	Parameters
Synthesis	Illumination	The Ah-Ha	Illumination	Illumination	Organize Information
Ideation	Verification	Verification	Verification	Verification	Schematic Diagram
Evaluation					Relative Hierarchy
Implementation					Schematic Plan
Retrospective Evaluation					Precise Structural Grid
					Typographic Values
					Prototype
					Evaluate Effectiveness
					Evaluate Composition

Asimow and Watts	W. Pena (Considerations)	Allen Hurlburt	Hirsch	Berry	Bruce Archer Ulm School
Divergence Transformation Convergence	Function People Activities Relationships Form Site Environment Quality Economy Operating Budget Operating Cost Life Cycle Cost Time Past Present Future	Background Constraints Concept Verification Working Methods Scale Technique Chance Summary	Idea Form Surface Final Presentation	Identify Preliminaries Refine Analysis Decide Implement	Programming Data Collection Analysis Synthesis Development Communication

Appendix 1

Collected Processes
Graphic Design

Graphic Design Problem-Solving Methodologies: **Individual Methods**

Fallon	What is Design
Ulm School	Problem
Preparation Phase(stating)	Thinking
Information Phase(facts)	Sketching
Evaluation(define function)	Showing
Creative Phase (less costly solution)	Evaluating
Selection Phase(alternatives)	Making
Implementation	Solution

Appendix 1

Collected Processes
Graphic Design

Graphic Design Problem-Solving Methodologies: **Psychology Methods**

Kepling	Whitehead	Gestalt Theory	Visual Rhetoric	Rhetorical Operation	Freud
What	Romantic Stage	Spontaneous	Content	Identity	Id
Why	Precision	Know	Structure	Similarity	Ego
When	Generalization	Perception	Cadence	Difference	Super Ego
Where		Appear	Style	Opposition	
How			Action	False Homologies	
Who					

Semantic	Pragmatic
Meaning	Specifications
Perception	Production
Communication	Distribution
	Human Factors

Appendix 1

Collected Processes
Graphic Design

Graphic Design Problem-Solving Methodologies: **Groups / Businesses Methods**

Design Process *Universal Traveler*	DeLor Design Group	Cooper Hewitt	Bauhaus	Design by Committee	External Process
Acceptance	Research	Start	Observation Study Analysis	Sponsors	Information Transfer
Analysis	Criteria Development	Thinking	Representation Descriptive Geometry Techniques of Construction Models	Design Team	Side Effects
Definition	Client Review and Refinement	Sketching	Composition Color Theory Space Theory Deign Theory	Suppliers	Standards to Ensure Compatibility
Ideation	Prototype Design	Showing		Producers	Sensitivity to Humans
Idea Selection	Implementation	Evaluating		Distributors	Transformation
Implementation	Success	Making		Purchasers	
Evaluation		Solution		Users	
				Systems Operators	
				Society	

Internal Process	Creative Process *The Design Concept*
Investment	Analysis
Apply Information from Outside Forces	Incubation
Rational Decision Process	Inspiration
	Verification
	Literal Thought
	Play Instinct
	Word Games
	Humor
	Summary

Appendix 1

Collected Processes
Graphic Design

Graphic Design Problem-Solving Methodologies: **Specific Tactical Methods**

System Analysis	Problem Solving	Design	Morphological	Communication	Incremental Strategy
Manage	Acceptance	Define Goals	Define functions	Who	Brief
Asses Needs	Analysis	Collect Data	List alternative means of performing each function	Why	Re-assess Existing Solution
Design	Define	Analysis	Select sub-solutions, one for each function	Say What	Minion Modifications
Develop Standards	Ideate	Design		To Whom	Accommodate Modification
Development and Operation	Select	Evaluate		Through What (Media)	Outcome
Disseminate	Implement	Optimize		To What Effect	
Evaluate	Evaluate				
Apply Data					

Circularity	Linearity	Adaptive Strategy	Branching Strategy	Boundary Searching
Identify Variables	Research	Brief	Problem	Performance Specifications
Identify Relationships	Design Action 1	Decide First Solution	Parallel Strategies(prelim.)	Range of Dimensions which Uncertainty Exists
Maximize Output	Design Solution 1	Carry-out First Solution	Pre-selection	Make Simulator
	Design Action 2	Decide Second Solution	Selection Stage	Performance Tests
	Design Solution 2	Carry-out Second Solution	Alternative Stage	
	Solution	Decide Third Solution	Final	
		Carry-out third Solution		
		Solution		

Appendix 1

Collected Processes
Graphic Design

Graphic Design Problem-Solving Methodologies: **Related Methods**

Simplest Form	Visual Inconsistencies	Minimize Conflicts	Human Factors	Strategy Switching	Literature Searching
Analysis	Examine Samples of an Existing Design	Existing Conflicts	Specify Human Performance	Embark Upon a Strategy That Fits the Problem	Identify Purpose
Synthesis	Identify Inconsistencies	Transform Problem Structure	Design Man-Machine Interface's	Record Spontaneous Thoughts	Identify Kinds of Publications that Contain Information
Evaluation	Infer reasons for Inconsistencies	New Design Solution Explored	Design Jobs Aids	Work With spontaneous Thought for a new Direction	Select most Relevant
	Envisage ways of removing Inconsistencies	Long-Term Problem Structure	design training Procedures	Review Initial and Spontaneous thoughts to find a pattern	Minimize selections through possible delays
		Long Term Solution		Contradiction form, Choose new strategies or initial strategies	Keep accurate and complete reference that can be used
				Continue until satisfied	Keep local collections that that have rapid retrieval

Unknown
Brief
Design Situation
Problem Structure
Final Design

Appendix 1b

Collected Processes
Engineering

Engineering Problem-Solving Methodologies: **Specific Methods**

Quirk Reliability	Black Box (intuitive)	Glass Box (rational)	Acceptable Design	Forced Amplification	Against Structural Failure
Identify Unreliability	Problem	Information	Objective	Function	Modes of Failure
Estimate the Degree of Unreliability	Input	Analysis	Identify Fail-safe Direction	Special Effect	Failure Predictor
Calculate Average Values	Analogies	Synthesis	Examine Available Evidence	Equation	Key Qualities
Describe Components for New Design	Output	Evaluation	Specify Criterion	Example of Arrangement	Mathematical Model
Calculate Average Unreliability Index Number	Solution	Optimum	Repeat 1-4 or each Objective	Amplification	Design Inequality
Alter Design to Have High Scores				Stroke	Limited Value
				Friction on Amplification	Geometry Found
				Constructional Length	
				Guides	
				Properties	

Originality of Problem	Design for Concept	Procedural Model	Procedural Model
Few Meaningful Solutions	Ideation	Problem Statement	Abstract
Concretisation	Conception	Design Specifications	Object Neutral
Existing Solutions	Selection	Function Structure	Defined Factors
Co-operation	Comprise	Concept	Relationships
Systematic Procedure	Prototyping	Preliminary Layout	Substantiation
		Dimensional Layout	Results
		Detail and Assembly Drawings	From
			Application

Appendix 1b

Collected Processes
Engineering

Engineering Problem-Solving Methodologies: **Technical / Procedural Methods**

Technical Process	Technical System	Procedural Model	Procedural Model	Problem Description	Design for Manufacturing
Determining	Materials	Problem Statement	Abstract	Good Ideas	Computer Aided Design
Prepare Transformation	Energy	Design Specifications	Object Neutral	Gathering Data	Solid Modeling
Transform Materials	Information	Function Structure	Defined Factors	Negotiating with Client	Tolerances
Energy Conversion		Concept	Relationships	Negotiating with Research and Development	Manufacturing Process
Connection		Preliminary Layout	Substantiation	Negotiating with Manufacturing	Costing
		Dimensional Layout	Results	Employing Heuristic	
		Detail and Assembly Drawings	From	Innovative Research and Development	
			Application	Field test	
				Presentation	

Traditional Design	Decision Process
Product Management	Function Needs
Configuration	Orientation
Layout	Maximum Ratio
Production Design	Maximum Forces
Design Data Control	Maximum velocity
Product Analysis	Average Efficiency
	Average Life Cycle
	Relative Cost

Appendix 1b

Collected Processes
Engineering

Engineering Problem-Solving Methodologies: **Related Methods**

Economic Decisions	Social Decisions	Unknown	P.E.T.	Two Categories	Unknown
Overall Cost	Workspace	Design factors	Phase	Planning Action	Components
Initial Cost	Power	Management	Event	Trouble Shooting	Sequencing
Annual cost	Transducer	Working	Task		Modifications
Running Cost	Processor of Information	Auxiliary	Decision		Tactics
	Tracker and Controller				Interdependence
	Person With Motives, Emotions, Habits				

Unknown
Elaboration of Problem
Conceptual Design
Laying Out
Elaboration

Appendix 1b

Collected Processes
Engineering

Engineering Problem-Solving Methodologies: **Groups / Businesses Methods**

Feiler and Humphrey	Virginia Tech.	Welker	Georgia Tech.	McDonnell-Douglas	Triz
		Virginia Tech. Student			**Russian Engineer**
Process Architecture	Problem Statement	Goal	Task	Identification	Identify Problem
Process Definition	Input/Output Descriptions	Task Allocation	Specification	Design Objectives	Formulate Problem
Process Plan	Hand Example Mathematical Analysis Hand Calculation (Excel)	Synthesis	Concept	Solution Alternatives	Categorize Problem
Process Design	Algorithm Development Define Data Structures Decompose Problem Write Code	Mathematical Modeling	Preliminary Layout	Primary Design	Identify Problem
Enactable Process	Testing	Solid Modeling	Definitive Layout	Final Solution	Identify Tools
Model		DFM / DFA	Documentation		Process of Using Tools
		System Assembly	Solution		Evaluate Results
		Time Allocation			Implementation
		Observations, Conclusion			

Kim Sherman	Sidell
Think Design	**Ulm School**
Initial problem	Problem
Research	Deign Variables
Divergent Thinking	Create Basic Concept
Convergent Thinking	Analysis
Communication	Survey of Suppliers
Final Product	Optimization
	Detailing
	Calculations
	Procurement
	Prototyping
	Testing
	Final Changes/ Production

Appendix 1b

Collected Processes
Engineering

Engineering Problem-Solving Methodologies: **Working Methods**

Wheelchair Development	Welding Process	Vertical Thinking	Lateral Thinking	Problem Solving
Ease Of Operation	Function	To develop a solution to a problem through a step-by-step process where you work to refine one solution to a final point	To develop and discover many different solutions to a problem in hopes to get inspiration or confirmation on a direction to take the problem	Problem Recognition
Reliability	Determined Properties			Problem Identification
Durable	Operational Properties			Making Assumptions
Weight	Ergonomics			Generating Alternatives
Size	Appearance			Choice
Safety	Distribution			Implementation
Proper Use of Resources	Delivery Laws Standards			
Aesthetics	Manufacturing			
Requirements and Constraints	Economic Properties			
	Design Properties			

Appendix 2

Reservoir of Terms

Know Terms	Related Terms and Words
Problem	Acceptance, Problem Recognition, Identify Unreliability, Problem Statement, Identification, Identify Problem, Problem, Initial Problem, Elaboration of Problem, Define Problem, Identify, Identity, Identify Purpose, Preparation Phase
Research	Research, Data Collection, Information Phase, Inputs, Observation
Analysis	Analysis, Failure Predictor, Design Variables, Divergent Thinking, Energy, Why, Thinking, Saturation
Synthesis	Synthesis, Problem Structure, Sequencing, Tolerances, Defining Factors, Structure, Transform Materials, Orientation, Configuration, Specifications, Objectives, Categorize Problem, Survey, Process Plan, Operational Properties, Criteria Development, Definition, Problem Definition, Incubation, Analogies, Conception, Equation
Ideation	Ideation, Illumination, Schematic Plan, Transformation, Form, Concept, Surface, Preliminaries, Development, Operation, Ideate, Design, Generate Alternatives, Accommodate, Parallel Strategies, Simulator Creative Phase, Showing, Substantiation, Prototype, Composition, Sensitivity to Humans, Inspiration, Generating Alternatives, Process design, Algorithm Development, Mathematical Modeling, Basic Concept, Negotiating, Tolerances, Transducer, Elaboration, Spontaneous Thoughts
Selection	Idea Selection, Choice, Outputs, Specify, Geometry Found, Dimensional Layout, Results, Making, Selection Phase, Decide, System Assembly, Enactable Process, Documentation, Identify, Communication
Implementation	Requirements, Solution, Implementation, Communication, Connection, Detail, Assembly Drawing, Presentation, Costing, Decision, Action, Appearance, Long Term Solution, Final Design, Final Composition, Summary, Convergence, Final, Maximized Output, Apply Data, Optimize, Outcome, Making, Optimum, Geometry Found, Success, The Ah-ha
Evaluation	Evaluate, Outcome, Maximize, Performance Tests, Retrospective Evaluation, Evaluate Process, Identify Inconsistencies

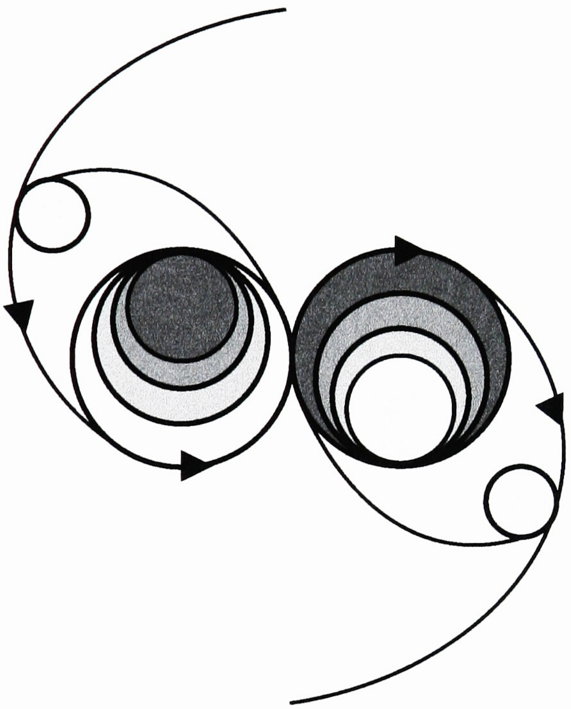
Appendix 2b

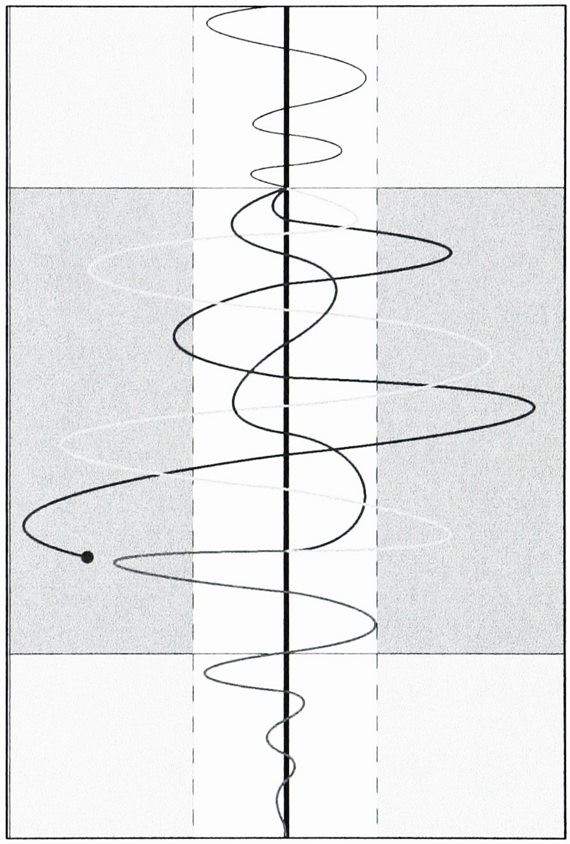
Preliminary Processes

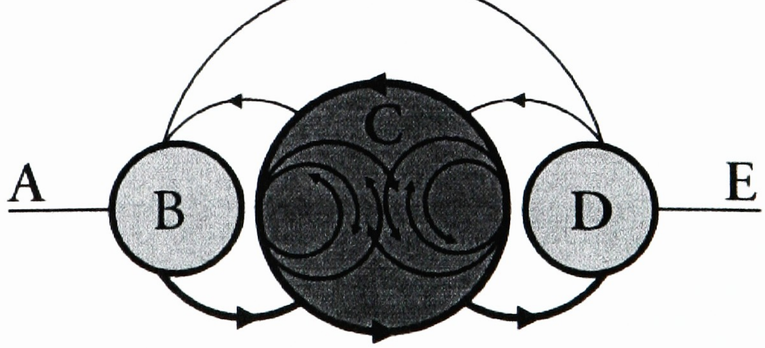
Acceptance Research Analysis Prototype Alternatives Geometry Tests	Problem Recognition Data Collection Failure Predictor Composition Idea Selection Requirements Evaluate Process	Problem Statement Information Phase Design Variables Sensitivity to Humans Choice Solution Inconsistencies	Identification Observation Energy Inspiration Specify Communication Evaluate Process
Problem Research Divergence Definition Illumination Final Composition Evaluate	Initial Problem Information Phase Energy Incubation Schematic Plan Summary Outcome	Define Problem Inputs Thinking Conception Form Final Performance Tests	Identify Observation Saturation Equation Concept Output Retrospective
Acceptance Data Collection Analysis Conception Preliminaries Evaluation Implementation	Problem Statement Research Sequencing Verification Final Solution	Initial Acceptance Gathering Information Programming Structure Evaluation Solution	Beginning Information Saturation Inspiration Illumination Implement
Identify Inputs Divergent Outputs Implementation Retrospective	Elaboration of Problem Data Collection Why Analogies Transformation Convergence Maximize	Identity Research Analysis Definition Prototyping Decision Testing Application	Acceptance Research Concept Development Implementation Post Evaluation

Appendix 3

Diagrammatic Flow Chart

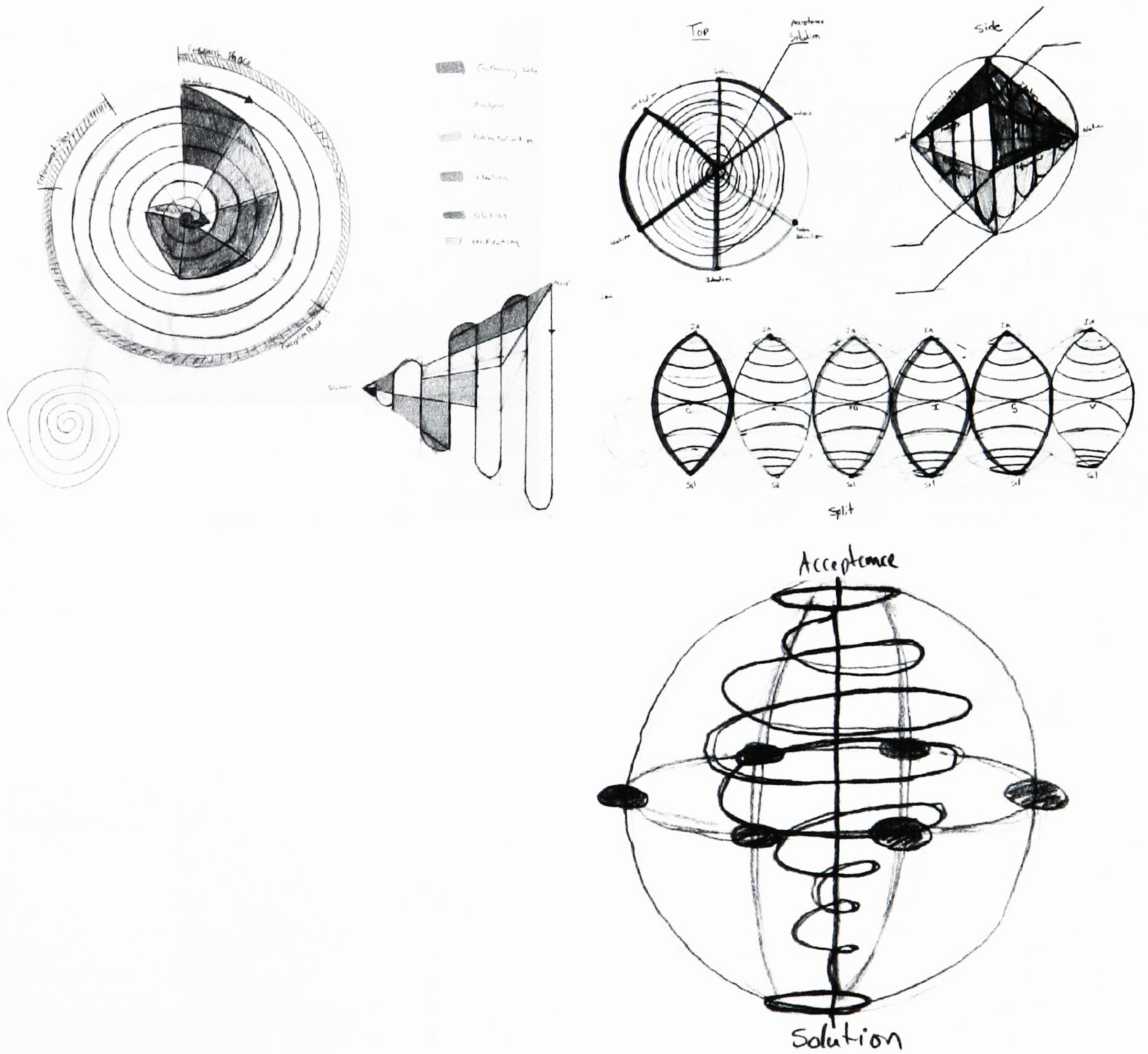






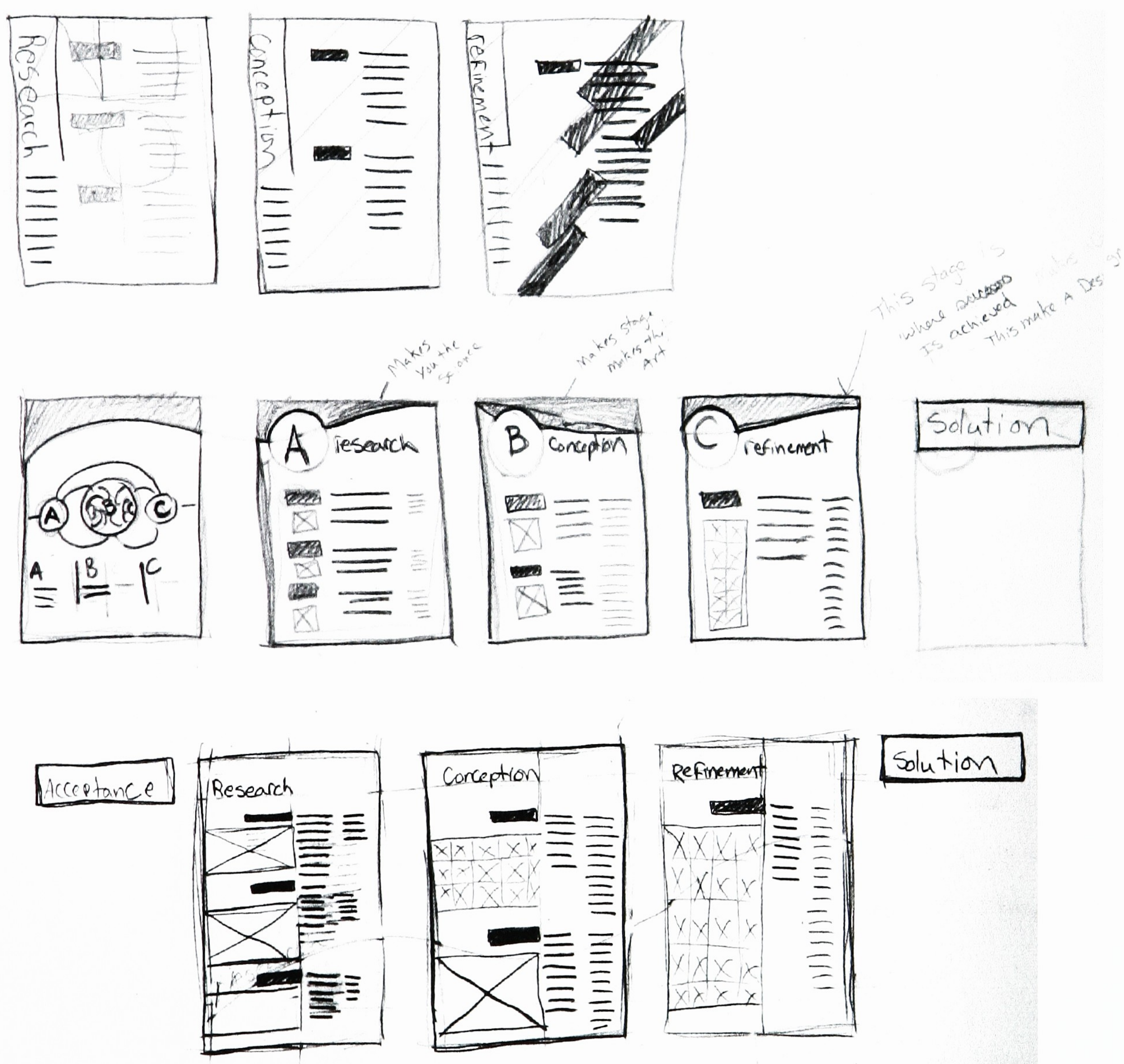
Appendix 3

Diagrammatic Flow Chart



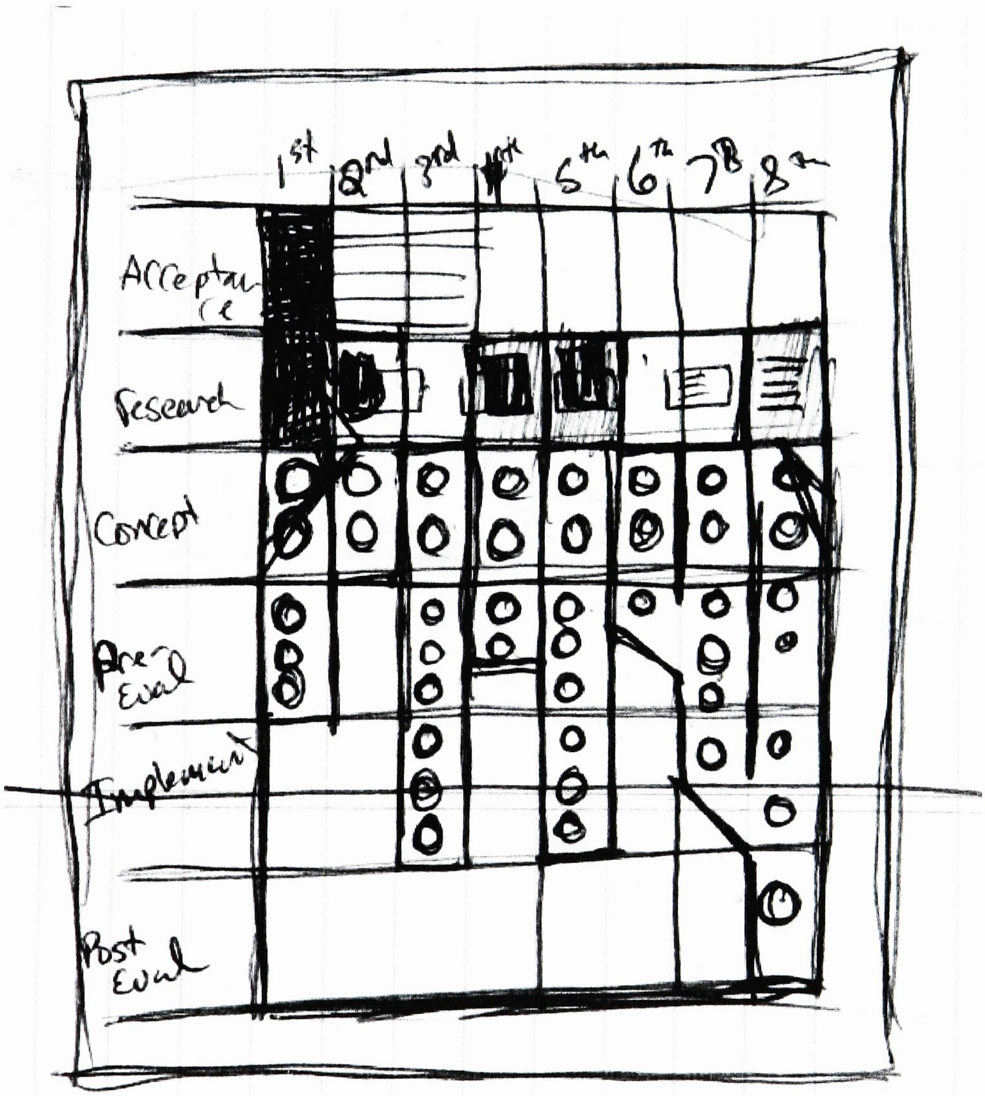
Appendix 3b

Application



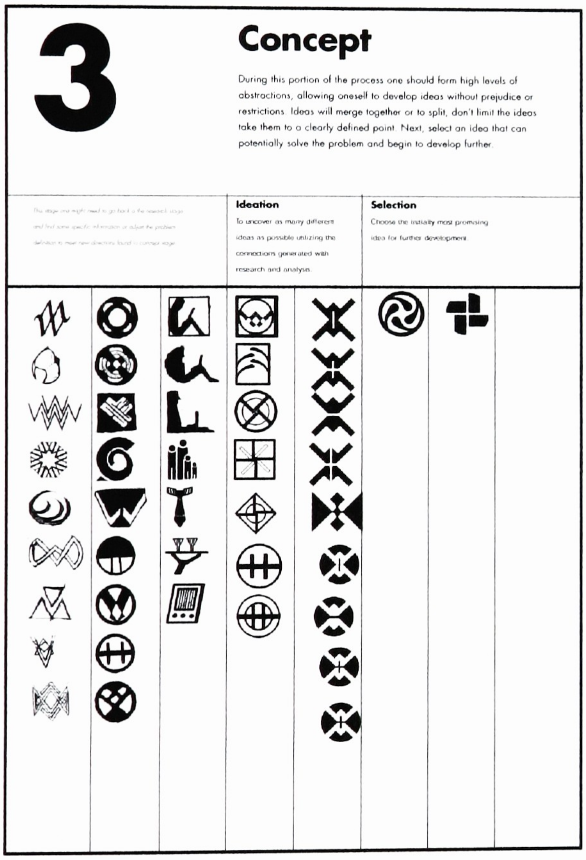
Appendix 3b

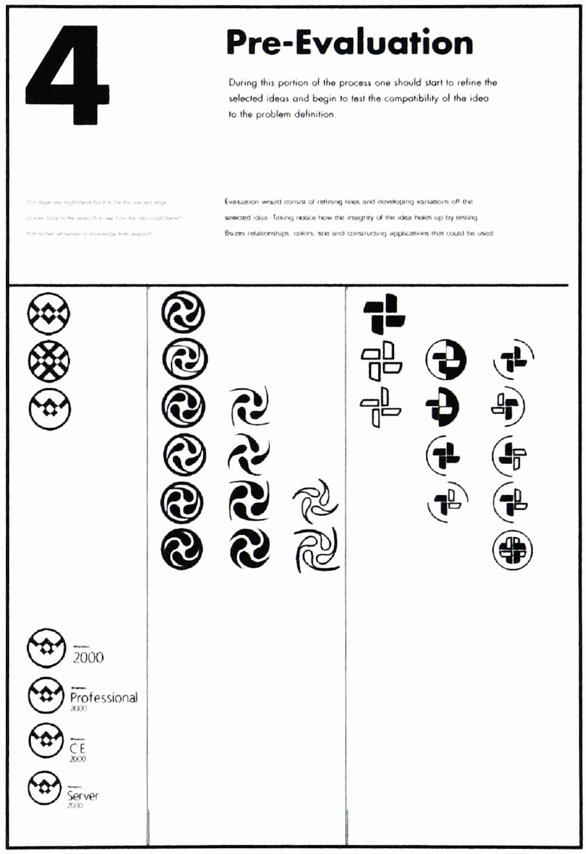
Application



Appendix 3b

Application



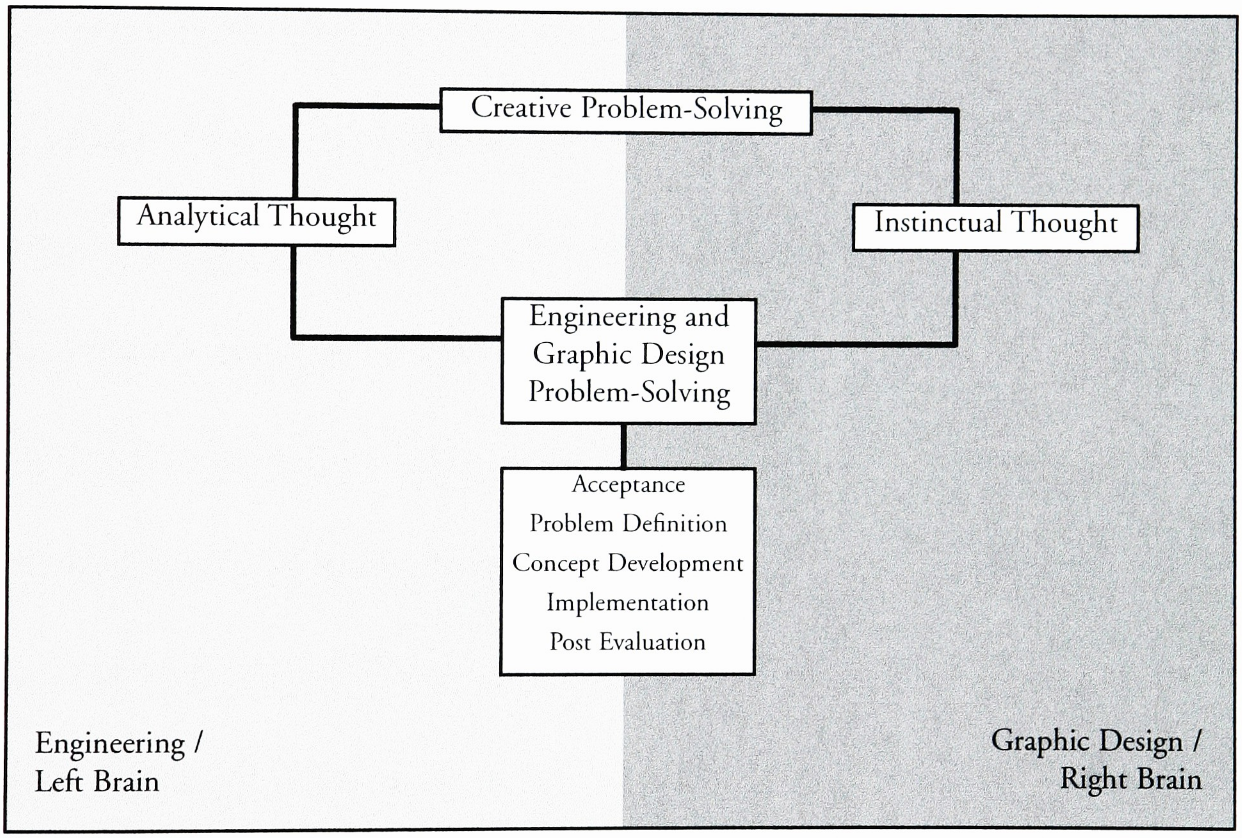


Appendix 4

November Research on philosophy, g.d. and eng. processes	1 *Research*	8	15	18 Break Begins		
December Revisions on proposal, diagram and collect creative processes.	**6**	**13**	**18** **Committee**			
January Finish research, construct comparison, matrices, preliminary design	**3**	**10** *Research*	**17** *Analysis*	**24** *Synthesis*	**31** **Committee** *Ideation*	
February Finish ideation, start application	7 **Committee**	14 Finalize *Application*	21 Spring Break	26		
March Create display format for thesis show, start writing	6 *Revision of Application*	**9** Setup Show	**13** Show Opens	17 **Committee** *Writing*	20 Show Closes	29
April Finish application, continue writing	3 *Editors Last Writing*	10	17 **Committee**	24		
May Refine writing, finish writing	8 **Committee Sign Off**			20 Commencement		

Appendix 5

Explanatory Diagram



Appendix 6

Evaluation Sheet

1 Is the intended message of the posters easy to understand?

yes *no*

Please Explain:

2 Is it claer how the design process works on the poster?

yes *no*

Please Explain:

3 Do the posters successfully illustrate the design process relationship between graphic design and engineering?

yes *no*

Please Explain:

4 Is the information on the posters arranged in a logical and easily accessible way?

yes *no*

Please Explain: