Chapter 1

The Principles of Design

In this chapter, you will learn the following to World Class standards:

1. **A Discussion Concerning Designers**
2. **The Structure of our Discussion**
3. **Innovation on Demand**

A Discussion Concerning Designers

Given the ability to design any product or system is a great honor and if we are presented with an early accolade by being awarded the assignment, we will quickly be humbled by the immensity of the task and the quantity of the work. Every design present in nature or created by humans represents the past and points towards the future and all great architects of products study previous developments in order to construct their novel version using the known technology and materials of the era. During the process towards developing the idea, the creative spirit and the physical stamina of the individual or group diminishes along with the time allotted and then the current moment becomes occupied physically with our best attempt to solve the design problem. As soon as the invention is installed, the affects from the environment corrode the material, customers offer their positive or negative opinion and other product engineers start to develop alternatives in newer designs. The end of the imaginative progression now becomes the beginning of a new design cycle and if the process whether formal or informal is successful, the singular idealist, the multifaceted group and finally the culture itself matures.

Designers do not develop in a vacuum, but rather push whatever system of mankind presently in affect towards their limitations by utilizing technology, cultural norms and teamwork. In this textbook, we will examine two premises; the first is that design performed by humans is the pinnacle property of man's existence and we will discuss the methods that we have found over the years that will cultivate this creative expression in any person or group. The second principle, however tedious, we will discuss is the actual techniques to promote discovery which propels us towards development and solutions. In mankind's continual search, we do recognize luck or in other words the probability to stumble onto a promising find while looking for something totally different. However, the majority of accomplishments on our planet are a result of visionary processes and purpose such as the pyramids, the aqueducts, fortresses, iron and steel works, airframes for flying, electric motors and lights, computers and the Internet, medicine and medical science, and more. As in any design book, we will convey similar processes, but in our adaptation of the science, we will refrain from restricting anyone from the continual invention and restructuring of their method.

A question we can ask one another in our studies is "what causes the design process to begin?" We may have already answered our query previously by stating that the design process commences at the end of a previous innovation cycle. For example, once an engineer concludes with the production release of the new flat screen computer monitor, assembly technicians can and will find better ways to build the product. Customers will appreciate the widescreen feature, but will soon discover that not all of the websites adjust to the newer format. Whatever the cause for starting a new design, whether from a formal declaration from a corporation's marketing department or from collecting the randomly dropped notes from a suggestion box, the engineer will receives a request to create a new design statement to begin the modifications to his or her product or commence the construction of an entirely new one.

How soon the engineer implements a new design feature into his or her man-made good really depends on the capability of the organization tasked with constructing the apparatus. Since there are two common types of manufacturing methods in use today; the first being mass production, which is the capacity to create a few thousand components in each day, every day of the year for the life of the product. And the second technique is precision assembly of fine tools and devices where the industry does not have the capability of high speed replication. The best example of mass production is the automotive industry that can manufacture 10,000 automobile tires per day for a specific line of cars. An illustration of a meticulous assembly is the Hubble space telescope where the resources of the entire planet is spent to develop the capability of producing high definition images of stars, solar systems, and galaxies at extreme distances. Some companies will task their engineering departments with developmental goals based upon the annual design cycle, while other organizations develop their innovative products without the calendar. Since most institutions utilize annual budgeting, they lock their developmental budget into the same 12 month system. Then if the design engineer wants to pursue a new product in midstream that year, they will find that they do not have the resources to do their research, build and test prototypes and to construct tools for production. We train professionals to avoid these man made financial obstacles that hinder the course of innovation.

We know that building a diverse engineering team is paramount to the design effort, since many assemblies need components requiring multiple disciplines such as mechanical design, electrical design, software development, quality control, manufacturing support, marketing assistance, technical writers, graphic consulting and shipping expertise. We can start to develop the partnerships required to bring a new product to market immediately when we are working on our earliest projects whether in college or on the job. Partnering with other engineering firms and suppliers will reduce the primary cost of invention and development by utilizing the other organizations talents and expertise. Both the individual and the company that supports innovation almost always benefits form the relationship and everyone involved generally becomes more knowledgeable and increases the size of their business. For our own department, eventually, we find that we will need regular assistance in a certain area, so we will bring that particular specialist on board in our own office. Prior to the oncoming of mass production done by larger companies, support specialists worked closely with the individuals on the shop floor and were part of the production team. As companies built their engineering departments away from the manufacturing plant, a division developed between technicians and the innovators and they were no longer a cohesive element focused on fixing old problems and developing new solutions. We could here the comments from production workers saying “we are paying for your departments’ salaries”, and they were right.

In some instances in mass production during the 20th century, the individuals assigned to machine and paint the parts and assemble the components did the work and the people in the office would handle paper work and coordinate with the customer. In reality, both groups and their capability to maintain their employment status were reliant on one another, but uncreative financial managers allowed both sides to build walls to defend their positions. At many organizations, we can see the remnants of the outdated engineering system, where team division and not team unity and diversity is maintained. At these businesses, the current employees and managers may see the problem, but do not have the ability to tear the system apart and rebuild. In the 21st century, we observe these companies, which have large dysfunctional groups, falling apart, having customers that are not happy with their products and the organization lacking the leadership in developing new innovative designs. The sooner the businesses redesign themselves and lose their specialist mentality and begin to work together from technician to senior engineer, the quicker those organizations will be able to create original solutions to this century's problems.

If team diverse approach to innovation creates better products, then listening to the customer is all of the input we need to make outstanding designs. In the western culture, listening is a challenge and surrendering overall control to a person or group who does not have the technical expertise is difficult for designers. In our experience, architects designers and engineers want the littlest amount of input from the consumer and then they begin to demonstrate to and persuade to the customer what they really want. There is a middle ground to the conundrum that will bring success to nearly all of our projects. First, the design individual or group should begin to prepare for the assignment long before they meet the customer at the design crossroads. Secondly, the society at whole will eventually become the owner of every product, both in positive and negative terms, so architects of goods need to maintain a macro view of development throughout the design process, and we will want to contribute to the overall good in the community and we do not want to create structures and systems that damage the surroundings. Design engineers that add to a positive influence to their community will gain an alliance with the majority of the populace and the product will continue to adapt over an era versus spending the totality of the component's history in a landfill. A perfect contrast to this type of engineering is the Ohio Stadium in Columbus Ohio in the United States to other sports arena built in the 1970s. Engineers, owners and city managers did not think through the development of super coliseums and they have been torn down since their design, the materials used and most importantly the community did not accept their imprint within their cities. In opposition to poor development, the Ohio Stadium has been brought through years of remodeling and updating to sustain a positive impact to the consumer, the owners and the environment. Designers need to prepare themselves for larger projects by completing successful smaller ones, each time gaining experience and most importantly learning to listen and integrate their ideas.

In today's world, organization means computer implementation and our overall ability to development new designs depend on our efficiency to utilize computers and digital devices to solve problems as quickly as we identify them. Designers need to use Computer Aided Design (CAD) software, word processing applications, spreadsheet programs, graphic art computer tools, database applications and many more. If our supervisor was watching a successful meeting with the consumer, he or she would observe the give and take between us and the customer while they are watching their design appear in front of their eyes on a large flat screen monitor. Patrons that have to wait days, weeks and even months for a visual representation of the facts discussed in the meeting will lose the creative energy after they have had their moment of insight. Today's digital tools have the capability to deliver solutions to our clients in seconds, but few companies have the personnel to conduct the speedy session. Over the centuries, major inroads have been made in prototyping designs discussed with the client and the at the moment businesses that are making the greatest strides in design engineering are using the best software applications and are enforcing their standards onto employees that they must achieve proficiency in multiple software applications simultaneously. So in the present as well as in the future, designers should expect more requirements to become specialist in a multitude of computer applications.

Prototyping since the 1990's is exceptional and will make its impact on mass production this century. All organizations must prepare for individual consumer industrialization in this century, where by having the personal computer operator at their home download a new toy design during the holidays, and send the stereolithography file to a rapid prototyping apparatus next to their paper printer and minutes later the totally colorized plastic toy is manufactured in a matter of minutes. Some companies and all communities have this potential right now, and companies that make three dimensional goods will sell their designs to a community that has enclosed ballistic particle manufacturing tools right in the home. This new technology will replace many existing mass production facilities with an Internet like, spread out network of precision component making. There will be a great demand on solid modelers and the type of individual who plays video games in this computer era will evolve to constructing precision machines and the public will see more customization of products.

As companies continue to move towards more efficient and quicker methods of manufacturing and assembly, designers still need to transform their lower volume prototype concepts into medium and high volume developments. For example, the prototype and initial production units that are constructed with basic steel angles and plates using welding techniques need to transform to a sand casting or another mid level manufacturing process when the numbers reach from the hundreds to a few thousand units a year. When the quantities continue to expand from five to ten thousand units and upward, die cast and other high speed forming techniques become essential. The basic form, fit and function of the product will remain the same, however the shape will become smoother and less rigid, since high production tools require curves and draft angles to enhance the removal of the components from their molds. Not only the contour of the part has better eye appeal to everyone from the workers, the sales team, the customer and the public in general, but color can be added to the material even during the high speed formation in the casting tool. Some companies that produce thousands of parts everyday are manufacturing their goods in facilities that have less than twenty employees. These organizations use partner businesses such as shipping companies, law and accounting firms and computer network firms to handle distribution, settle contracts, bill customers and issue the payroll, maintain the servers and handle online orders. This pocket-sized and well-organized institution with optimized capability is better capable of surviving economic peaks and valleys.

As the designer moves through the stages of the product life, they need to issue Computer Aided Design (CAD) drawings to their purchaser to control the quality of the incoming parts. We need to communicate similar information to the Receiving department for inspection, and develop quick methods for checking the parts using computer tools so that we do not have to build an entire team just to inspect components. The designer is responsible for understanding the existing capability of the people and their equipment in our own shop and in increasing their competence throughout their time in production. In short, we should be able to make continue improvement over the years in manufacturing our products and we do that by having a proactive designer working with all involved to advance the efficiency and quality of making the merchandise. Designers also create the manuals for the technicians to use on the factory floor and for the consumer to utilize at their homes while employing the invention. Only a small fragment of the overall production release package was in play during the design process and at the initial conception, because we were so focused on the ability to solve the design problem. However, the designer now must spend more time moving the wheels of progress to exploit every facet of the new concept. There is a saying “that from a new technological notion come thousands of new products.” The customer had us add motion sensors to a faucet to solve their problem and now we have the potential to create hundreds of spin-off designs to increase the profitability of our organization.

The importance of designers in our century is greater than ever before since there are so many technologies to embrace in our modern world, so each conceptualist becomes critical to advancing their chosen industry in many key areas such as transportation, environmental health, medical advances, and computer infrastructure. The spread of rapid communications via the computer networks throughout the world has given all individuals an expectation to share in the ability to communicate universally, have an adequate diet and standard of living, obtain a quality education and experience a satisfactory lifestyle and most of all, except responsibility for the continuation of the human path in a positive direction. Ideas to solving problems and knocking down the obstacles to meeting the global demand, takes ingenuity, access to technology and a lot of hard work. Once in an electronics lab, we observed a young electrical engineer fresh out of college approach a senior design engineer with a question. “Why are you so more efficient in designing printed circuit boards and writing the software for them than any other engineer in the division?” The senior engineer did out perform the rest of the department, making six to ten more products each year than the rest of the team and his cleverness to solve problems placed the company in the position that they still benefit from today, twenty years later. He had abilities that crossed over into more than one discipline and was able to push his electromechanical products through to production and installation. On that day, our elder mentor spelled out one word for the apprentice, “W – O – R – K”. The younger engineer left for the day and the wise guru told us that although the department had the most current troubles in the industry on our design list, the facility had multiple design labs and the most current software and hardware available, a successful inventor still needs to make the effort to conceptualize tomorrows’ solutions.

W • O • R • K

The Structure of Our Discussion

Our textbook is a discussion that guides designers and we strive not to create obstacles or suggest that one method of creativity is any better than another scheme. We suggest that a new or even an experienced designer can spend some time reflecting on the topics in this textbook, so that they can continue to redevelop their processes when concerning this most important subject.

Unit one begins the study of design with three papers focusing on idea conception. The first thesis, Birthing an Idea will examine how designers bring about innovations in their particular industry. The second essay, Growing the Concept discusses how we can develop simple products and processes and move towards solving challenges that are more complex as the design team gains experience. The last dissertation, Putting Technology to Work starts to build a network of tools, which will assist our organization in quickly visualizing answers.

In Unit 2, we transition to building the design team by examining what would constitute the perfect engineering group. Next, we study what specialized motivation tools the supervisor needs to manage a group of highly trained individuals. Lastly, we research the best methods to educate the design professional.

In Unit 3, we explore the design process, and the study of ergonomics in conjunction with product development. In the next thesis, we find that sometimes a designer will come up with an inspired thought and can only proceed by collaborating with another organization to generate a new invention on a zero budget.

The fourth unit investigates mechanisms that assist us in testing our concepts, rapid prototyping for making samples, and when and how to employ software tools to assist in design.

As we wind up the textbook, we have three papers to consider. First, there is the move towards construction, and then we reflect on how to train the individuals who will build the new merchandise. Moreover, the last thesis will discuss how we can maintain the duplicity of the parts and the overall levels of quality. The book could contain thousands of pages that bring the present day innovator through the millions of creative processes that resulted in the multitude of products we see on the planet today, but we have chosen a diverse array of subjects to spark the professional's curiosity. Now before we begin the study of design, we will call on our ability to respond to a great challenge.

Innovation on Demand

Can we ask for innovation on call? Individuals, states and nations ask that question regularly. We do know that we have to look over the horizon to seek the answer, so in this textbook, we will ask each individual to participate in the search.

To keep the entire training scenario in this textbook both alive and demanding, we will propose that all students of these principles pursue an actual solution to a real world problem. Some of the challenges to professionals in this century are energy efficient products, exploring medical advances, synchronizing precise computerized tools with our lives, and expanding techniques to educate and train the population. We do not want to overlook that one more paper clip design or fastener can change an industry, but in this training process, we want the lead designer to incorporate as many technologies into their product, so they can work with software developers, electrical engineers, mechanical designers, technicians and artists. The multiple facets of the problem should create a diverse approach to solving the dilemma selected and send the designer on an exciting path of discovery. This project should not be easy and will generate enthusiasm in the entire department and with other students. Over the years, we have attended many presentations done at the college level that have impressed the customers, the faculty and all the professionals in attendance. When picking our design challenge, use a checklist to ask whether the design is multifaceted.

We will want to ask ourselves whether the product solution we have chosen contains a mechanical component. That is an easy one. The next question is "does the assembly have an electrical component?" Then are we using software to program all are a fraction of how the device works? Did we consider the aesthetics of the product? Does the product use energy efficiently? How will we build the unit and will the device be safe to utilize?

Design Checklist

The Project has a:

- ☐ Mechanical Component
- ☐ Electrical Feature
- ☐ Software Program
- ☐ Artistic Element
- ☐ Efficient Power Consumption
- ☐ Production Control Aspect
- ☐ Safety Controls

When we watch certain disciplined professionals work, they often ignore the other technical partners that they need to join in creating the building, transportation module or mechanism. We believe that they learned this as part of there very specific and focused education where the school and training staff were one dimensional in design capability. Enforcing an amount of collaboration in to an early project helps overcome the ignorance from only understanding one method in solving a problem.

Now, we wish to mull over the amount of time in our design considerations. If we do not have a half a year or a full sixteen-week semester to create a more complex assembly, we can choose to innovate a portion of a larger design such as an hand held tool, a smart door or window assembly for a building or another subassembly of the larger design. Many times the lead designer can work with a company that has just released a new type of plastic that now can perform in an environment where only glass or metals have survived before. By studying other innovations, we can learn to apply these new materials to solve older problems.

The team at World Class CAD, LLC wants to congratulate anyone who has completed the basic texts on the website and is ready to tackle their first complex design problem.

*** World Class CAD Challenge 25-00 * - Complete this textbook in 10 weeks or 40 hours of**

classroom training. Pass your Principles of Design Levels 1, 2 and 3 certification to be ranked among the best in the world.