

INTEGRATIVE PROJECT THESIS

CAFÉ CHAIR

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Introduction

Determining a design for the Integrative Project (IP) included an initial decision of medium, which was quickly determined to be the design and build of a piece of furniture; however, further consideration had to be given to obtaining a resolution for a problem that was plaguing this industry. When researching an entire compliment of chairs, one that had not received much attention was the outdoor café chair. With there being a new aspect of business, one that includes a mobile component, there is new generation of office setting that is evolving -- that of the outdoor café.

A common theme that seemed to reoccur during the research of outdoor chairs was the complaint associated with a lack of comfort and support, along with the instability of the chair. Therefore it was the ergonomic aspects of the chair that would be in the forefront during the design phase. Understanding the evolution of the chair was a must during the design process. The ergonomics and overall sizing of the chair needed to be researched in order to gain an appreciation for each aspect of the chair; with this knowledge being gained through book research and discussions with various Professors in the School of Art & Design.

Research

With respect to the evolution of the office chair, an invaluable source of information was the book, *Taxonomy of Office Chairs*, by Jonathan Olivares. This book is the first ‘taxonomy’ of an industrialized object. As explained by the author, “A Taxonomy of Office Chairs is an exhaustive visual history of the office chair. The book dissects the design of the chair into its separate elements and categorizes and orders these into the ultimate visual evolution of the

design of the modern chair” (Olivares, p. IV). Though it would be difficult to define a particular page that was referenced when designing the Café Chair; a review of a multitude of sketches and diagrams was used to obtain some of the initial design ideas. To review page upon page of the development of so many chairs gave the perspective needed to conceptualize the new design.

The use of a chair is the basis for its design, and this was so elegantly defined by Sigfried Giedion:

“The roots of the chair can be found in the comforts of rural American life. The American farmer, at the end of the day, will instinctively move to the rocker on his porch. The European peasant sits immovable through the twilight as if nailed to the bench before his cottage. These simple differences must be understood, for more profoundly than one might think, they change the course of inventive fantasy. As soon as mechanization became a decisive power in furniture, these differences began to show” (Olivares p. 15).

An interrelated and dynamic set of factors motivates chair design. “Work habits, production technologies, ergonomic ideals, and broad social goals change frequently and considerably and affect the features and functions of a chair” (Olivares p. 15). While researching the progression of some of the changes in the evolution of the chair, it was difficult to discern the thought that could have been behind some of the designs. The continued issues of health and how the placement of the body in a chair can affect the muscular structure of the body, was a particular concern when considering the ergonomics; therefore a high priority in the design of the IP. “As specialized a subject as the chair may be, its evolution and story are indicative of the broad and rapid changes that our society has undergone and will continue to undergo” (Olivares p. 25).

An issue of focus in the design of the chair was the impact the chair would have on the comfort of those using it. The overall ergonomics of the chair needed to provide a sense of relaxation for the user. As defined by Jonathan Puleio, a Board Certified Professional Ergonomist, “Ergonomics is the applied science of fitting the physical environment to the individual; when ergonomic design is applied, comfort improves, and efficiency is enhanced” (Puleio, p. 1). Furniture form, design and aesthetics have become intriguing subject matter. While stressing ergonomics, other issues considered in the design were the stability of the chair, along with its weight and stackability. Though the comfort of the chair was the primary design consideration, there is the factor associated with the mobility and storage of the chair. Therefore, the chair needed to be able to stack in order to accommodate the space available for storage and it had to be light weight in order to provide for easy movement.

Process - Sketching

The process of sketching individual parts of the chair provided a cut and paste type designing, thus allowing the different aspects of the chair to be pieced together, and creating designs that had subtle variations. The sketches for each component were numerous and varied. By changing the combination of parts, the Café Chair, as it will be referred, took on different shapes and form prior to making its’ way to the final form. The sketches then provided the basis for a small scale chair model that was constructed using chipboard, and lead to the detailed design in the Rhino CAD system.

Process – Rhino CAD Design

Designing the chair in the Rhino CAD system provided the specific dimensions of each piece of the chair giving the capability of adjusting the size, dimensions and curves associated with each part. By designing the chair in Rhino it provided the files that were necessary to create the forms needed that would become the basis of each part. Examples of some of the CAD files are depicted in Illustration 1.

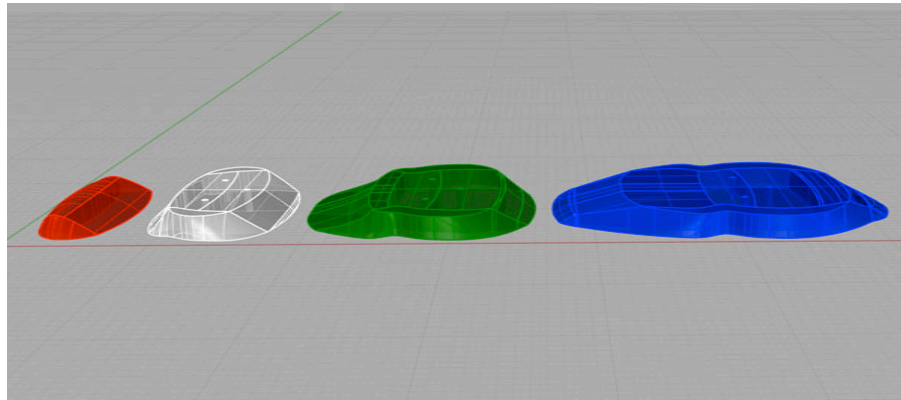
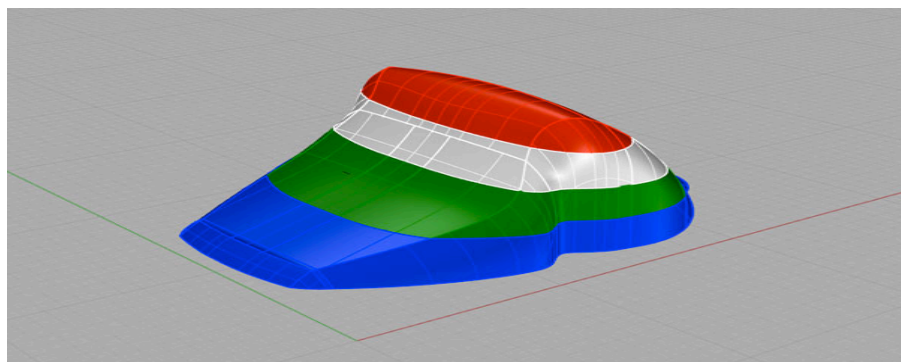


Illustration 1: The design shown provides a pictorial of how the individual pieces were constructed (above) and then combined together (below) to create the seat and back form.



Process – Creating the Mold

Once the Café Chair took on a preliminary form in the Rhino CAD System, the next step was to create a large scale model of the seat and back of the chair using a combination of foam and cardboard. The model was created using files from Rhino and transferred to the CNC router. The test mold was made with alternating slices of foam and cardboard, which were then pieced together into the back and seating area of the chair. This full scale model was then used as a prototype to allow numerous people to experience it. The process used was a survey as such, where people were invited to sit in the prototype chair seat and then critique the ergonomics and overall design.

After taking the survey results into consideration, the design was altered and the prototype remade for further critique. The use of the Rhino CAD System allowed for the slight alterations in design with a followup of a new prototype. This process was repeated numerous times before arriving at the ergonomic curvature used in the final mold of the chair. As shown in Illustration 2, the file from the Rhino CAD was transferred to the CNC router and a mold was created, that would be used to form the seat and back of the Café Chair.



Illustration 2: The mold was designed in the Rhino Cad, and the file transferred to the CNC Router where the mold was constructed.

Process – Creating the Base

The base of the chair is another complete component of the chair that was designed to accommodate comfort; and is of course another aspect of the ergonomics of the chair. The use of three legs as opposed to the more typical four legs is another defining aspect of the chair's design. The decision to use three legs was based upon the geometrical theory of 'degrees of freedom'. Statisticians use the term "degrees of freedom" to describe the number of values in the final calculation of a statistical calculation that are free to vary (Dallal, p. 1). Therefore, in the case of a chair, there are typically four legs. When a chair is presented with an uneven surface it then has four legs to rely upon when trying to solve the problem of which leg to use for balance. The wobbling occurs when the chair cannot decide which solution to use, or that it continues to change its' mind. As a result, using three legs instead of four reduces the variable of which leg to depend upon for balance by 25%; resulting in a greater probability that the chair will settle upon a particular leg for balance and therefore stabilize.

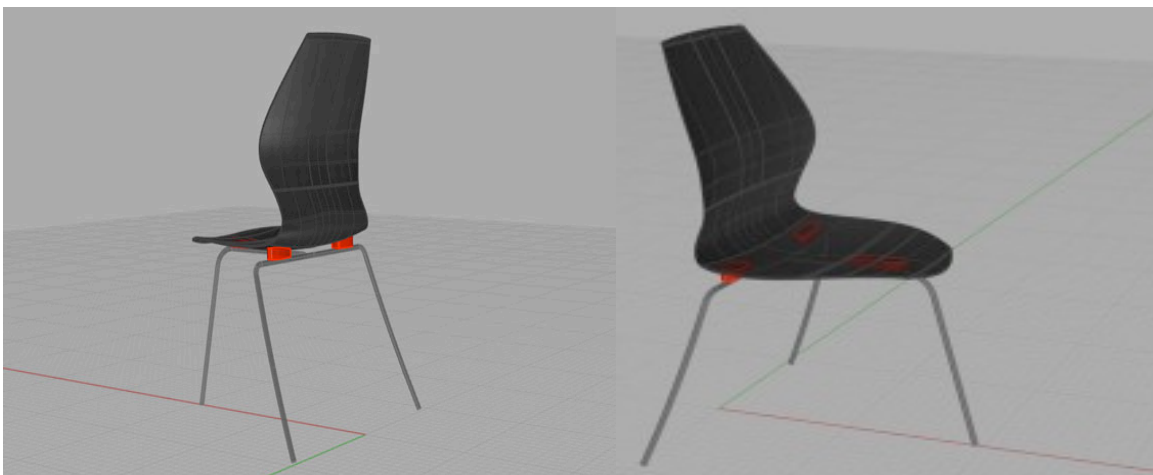


Illustration 3: The Rhino CAD designs show the tri-legged chair form.

Though the decision was made to use a tri-leg design; the curvature of the legs had to be designed and strictly calculated. The use of the Rhino CAD (Illustration 3) to design the legs provided the ability to blend the seat structure with the legs. Once the leg structure was designed in Rhino, the file was transferred to the CNC router and a mold was created to be used as the base form to weld the steel rods around to form the leg structure (Illustration 4). The leg structure was securely welded together to form the base of the Café Chair. To perfect the aesthetics of the steel it was powder coated, which simplistically speaking entails static charging the steel and then applying the powder coating; the powder coated steel is then placed in the kiln melting the powder, creating a plasticized laminating effect on the steel.



Illustration 4: Once the tri-legged design was created in the Rhino CAD the file was transferred to the CNC Router where a mold was created that was used as a base to weld the steel rods around.

Process – Creating the Connection

An important aspect in the design of the Café Chair was to connect the leg base to the seat without penetrating the seat itself with the hardware used in connecting the pieces. This

required a further design aspect on the underside of the chair, or a shock mount that would be the connecting feature for the chair pieces. The shock mount was designed using the leg base and seat files from the Rhino CAD to develop a piece that would meet the functionality requirement, and maintain the aesthetic look of the chair (Illustration5).

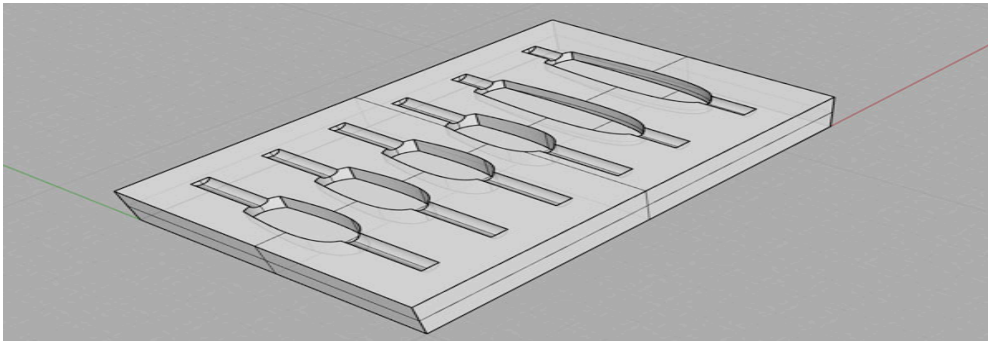
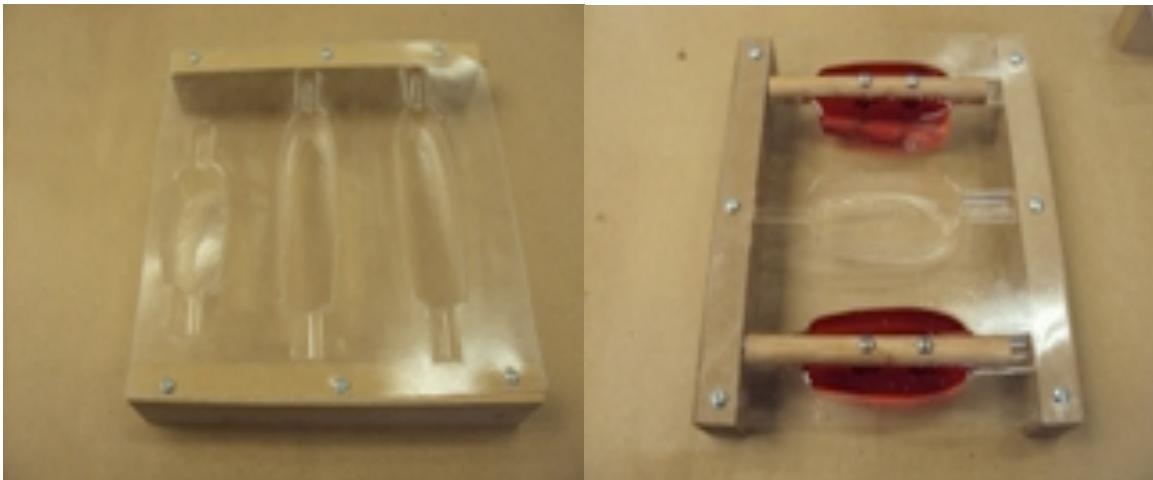


Illustration 5: The shock mount design was created using Rhino CAD

The file of the shock mount was transferred to the CNC Router to create the mold that would be used for constructing the shock mount (Illustration 6). The substance used in constructing the shock mount was a dyed rubber that was poured into the mold that was cured and then glued to the underside of the chair and used as the base to connect the structures. The use of the shock mount to connect the chair provided an aesthetic appeal because it in essence hides the hardware; and further it provides a more comfortable seat because the hardware does not penetrate the seat itself, so the seat has a totally smooth contour.



Illustration 6: The Shock Mount file was transferred to the CNC Router where the mold was created. The wood mold was then used to create a plastic mold using the vacuum forming procedure. The dyed rubber was poured into the plastic mold creating the shock mounts.



Process - Ergonomics and Form

The seat and back of the chair is one continuous piece. The ergonomics of this aspect of the Café Chair was precisely designed and re-designed and perfected in the Rhino CAD system, and then a mold was created using the CNC Router (Illustration 1 & 2). The mold was then used to provide the basis for the plastic form. Flat sheets of ABS plastic were vacuum formed to the mold to create the seat of the chair. Plastic was used in two of the chairs to demonstrate the form

and stackability of the Café Chair. The stackability of the chair is demonstrated in the CAD drawing in Illustration 7.

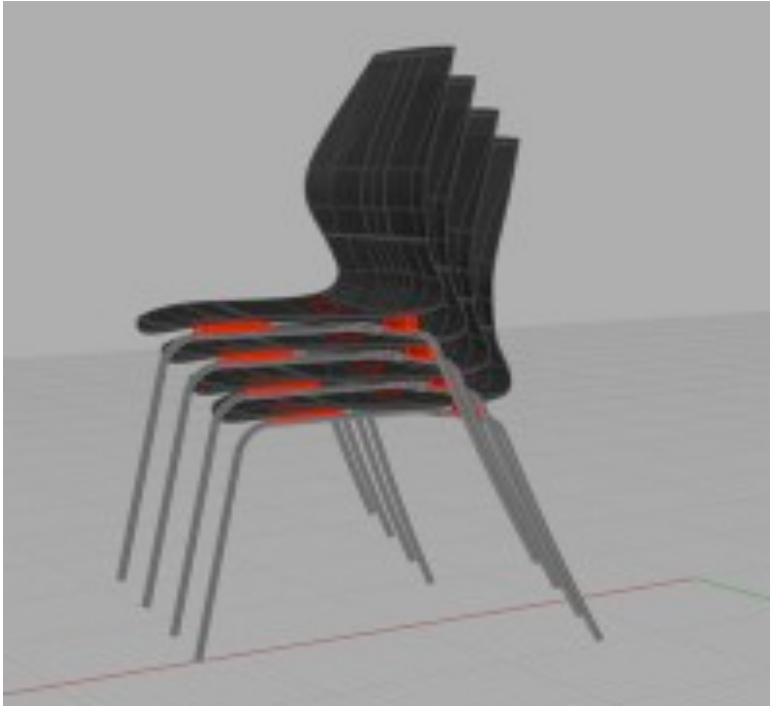


Illustration 7:
The CAD drawing depicts the stackability of the Café Chair design.

The chairs that were made using plastic are the prototypes of the Café Chair design. The ABS plastic was vacuum formed using the mold designed in the Rhino CAD (Illustration 2). The ABS plastic sheet was heated to a forming temperature and then stretched onto the surface of the mold. The plastic was formed over the mold by applying a vacuum between the mold surface and the sheet of plastic; the result is the plastic taking on the shape of the mold (Illustration 8). Utilizing the ABS plastic for the chair seat and back gives the Café Chair design the ability of being mass produced at a very reasonable cost.



Illustration 8: The vacuum form process was used to create the ABS Plastic seat.

Process – Final Product

To produce an artistic piece a variation in the materials was used; specifically a mixture of carbon fiber fabric and epoxy was used to create the seat and backing of the Café Chair. The mold design for the chair (Illustration 2) was again used as the basis to form the seat. However, instead of using a vacuum form procedure, as was done in creating the plastic prototype, the mold was used to form the carbon fiber and epoxy (Illustration 9).



Illustration 9: The mold was used to place layer of carbon fiber over to create the chair seat and back.

The mold was waxed to prevent materials from adhering to the mold. Then a layer of epoxy was applied to the mold, once the epoxy took on a tacky texture a layer of carbon fiber fabric was applied (Illustration 10). There were several layers of carbon fiber employed, alternating layers of epoxy between each. Once there were sufficient layers of carbon fiber fabric and epoxy, there were numerous layers of epoxy applied over the entire mold.



Illustration 10: The layers of carbon fiber fabric and epoxy were alternated and formed to the mold to create the Café Chair seat and back.

The combination in layers of carbon fiber fabric and epoxy along with the required curing between each layer, created the final seat and back form, as is shown in Illustration 11.



Illustration 11: The final product of layers upon layers of carbon fiber material and epoxy is the one piece seat and back created for the Café Chair.

Conclusion

Furniture form, design and aesthetics are an intriguing combination. To use the knowledge gained during my studies at the University of Michigan School of Art & Design, while creating a functional resolve to a real life problem is the culmination to my undergrad studies. The design (Illustration 12) imposed on the Café Chair is aesthetically pleasing and provides specific ergonomic form and comfort for the user. The impact my Senior IP is twofold; first it provides the café entrepreneur with an aesthetically pleasing unique design, that is light weight, stackable and reasonably priced; and second it provides the user with an ergonomically

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effective chair providing extended comfort. Using the knowledge I have gained in art and design to create a chair that would be sought after for its' design, aesthetics and comfort would impart a feeling of personal success in the completion of my Senior Integrative Project.

Illustration 12: The Café Chair – front and back



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