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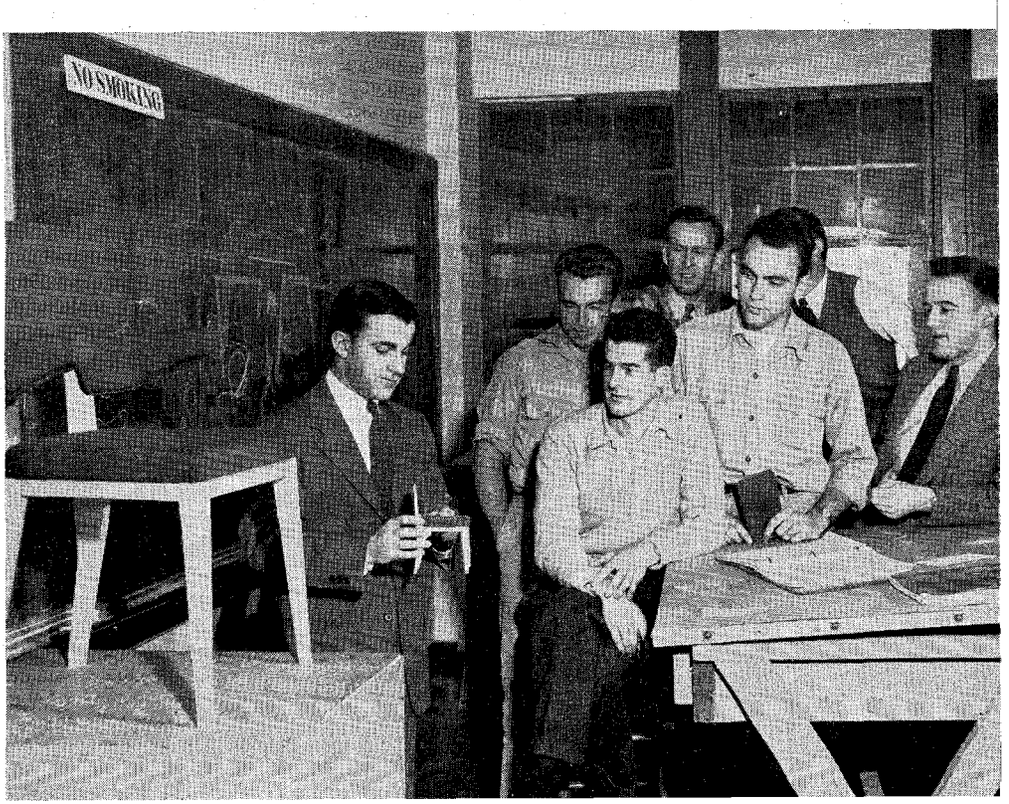
Industrial Design at the California Institute

By DAVID F. WELCH

THE question has often been asked as to how the Industrial Designer fits into a product development program, particularly in a large manufacturing organization with a competent staff of research engineers and machine designers within its own engineering department. To answer this question it is first necessary to define n a broad sense the generally accepted meaning of Industrial Design. Then we may illustrate specifically how the Industrial Designer's services are integrated into a well thought out development program for any product from a machine tool to a household vacuum cleaner. The term Industrial Design, relative to consumer products, has come to mean design for mass production with particular emphasis on appearance and consumer needs. These needs or functional requirements and trends in aesthetic tastes are established by careful selective research, not by whim or fancy on the part of the designer. Today, the manufacturer cannot afford to gamble on the marketability of a particular model or product which may have cost thousands or even millions of dollars to "tool up" for production.

As an analogy we might compare the relationship of the Industrial Designer to the Product Engineer or Machine Designer with that of the modern Architect to the Structural Engineer. The good architect designs his building about its functional requirements and above all about the human activities which it is going to enclose. He is deeply conscious of proportional relationships in the structure itself and is an expert in fully utilizing the inherent beauty of his building materials. He is definitely not trying to apply period ornament to achieve a beautiful building. His work is done in conjunction with that of the structural engineer, not before or after the basic structure has been designed. It is not the architect's job to beautify a reenforced concrete building designed only from a structural standpoint by an engineer, nor is it the engineer's lot to devise some elaborate structural scheme to make an architect's dream possible to construct.



Design lecture in the drafting room. The instructor and students discuss design features involved in comfortable seating as part of the development of the problem in wooden furniture.

Working together they have achieved a dynamic beauty which we find in many of our skyscrapers, bridges, and super-highways.

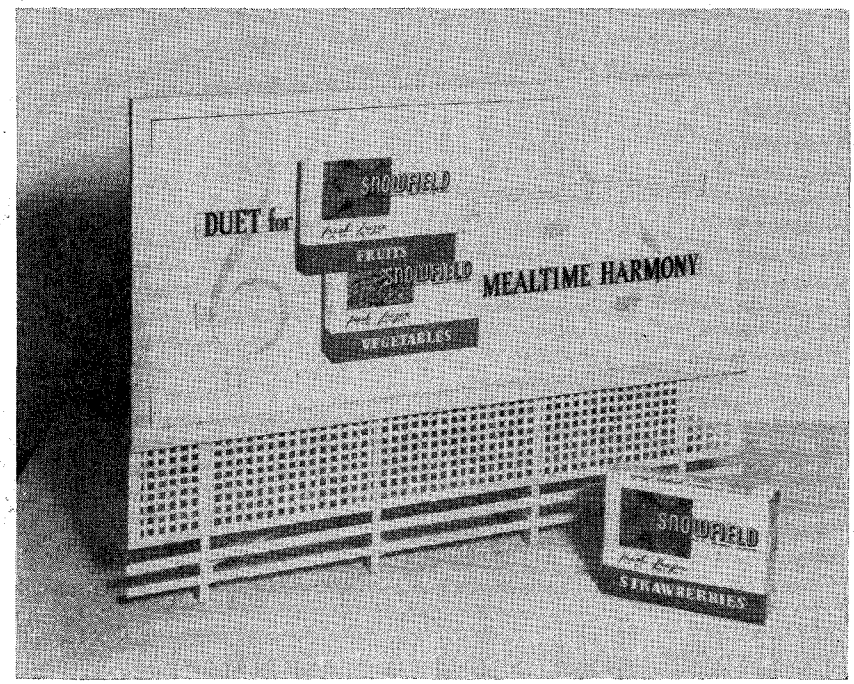
The Industrial Designer brings a thorough consideration of the human elements and consumer preferences into product design. It is his part to incorporate in the design all factors which will make the product safer, more convenient, easier to use, and more attractive to the potential consumer. These factors he determines from a careful study of the product in use as well as from other research data he may gather. Again, his specialized training in aesthetics, in addition to a fundamental knowledge of materials and processes, enables him to achieve a beauty of form and texture in the finished product which is not mere coincidence. Working with the engineer from the earliest design conception is essential in order to approach an ultimate in good design. The Industrial Designer today does far more than merely styling or dressing up an engineer's working model. An engineering department consisting of research men, machine designers, and draftsmen is no more qualified to completely design a household appliance for competitive marketing than an Industrial Designer would be able to design a centrifugal pump or some highly specialized electronic device. Together, they can attain the same degree of perfection in product design that the architect and the structural engineer have accomplished in many of their works. To work effectively together, each must have a clear understanding and a sincere appreciation of the other's problems.

Industrial Design is a relatively new profession. In fact it has been legally established as a profession only since 1944. Instead of its arising during the early years of the Industrial Revolution, as one might think, it was not until the year 1919 that the beginnings of Industrial Design could be perceived. At the Bauhaus in Weimar, Germany, a progressive group of artists, architects, and craftsmen made the first organized effort toward utilizing some of the aethetic possibilities in new materials and mass production methods. The first tubular furniture and so-called "modern" lighting fixtures were designed and fabricated in quantities by the Bauhaus group. Chrome tubing and spun sheet metal were used for the first time as materials beautiful in themselves without any effort to imitate traditional wood furniture or ornate candelabra. America did not feel the influence of this group to any extent until the middle twenties, when a few manufacturers began to call in artists, sculptors and stage designers to help them improve the appearance of their products. From this phase the profession developed rapidly, until today we find a number from this original group, particularly those who were quick to learn manufacturing techniques in evaluating new materials, and who were sympathetic to manufacturing problems, as leaders in the profession.

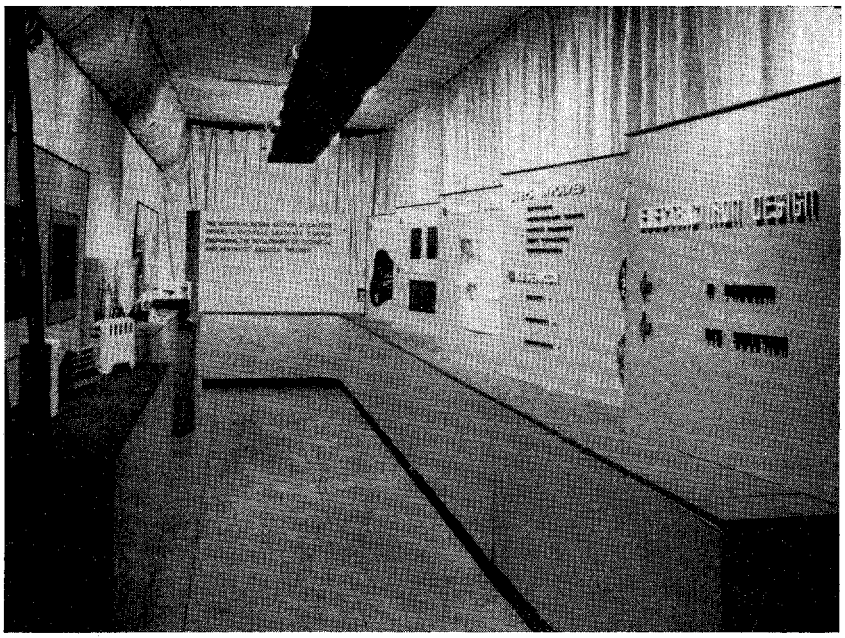
In 1944, the ground work was laid for a professional organization, the Society of Industrial Designers, whose purpose was to raise the general quality of design work done in this country, and to protect manufacturers as well as the profession itself by limiting membership to qualified designers. There are approximately fifty members of the Society at the present time, with the large majority in the New York and Detroit areas. The Society is definitely encouraging education in the field of Industrial Design and is strongly advocating technical training in engineering or architecture as a background for further study rather than in commercial or fine arts.

The scope of services offered by the Industrial Designer varies widely. Many of the larger offices now handle product development from the research stage through to production, package design, advertising, and even designing the merchandising outlets. Many specialize in the design of transportation equipment and interiors, including aircraft, ships, trains, buses, and automobiles.

Most of our very large corporations have found it necessary to establish their own Industrial Design departments. Many other organizations, large and small, will call in an Industrial Designer on individual products and in some cases even send out several key engineers to work in the Designer's office as the project is carried on. Today, the small manufacturer is finding it more necessary than ever to call on the services of an Industrial Designer. His need is almost



Package and billboard, representing the solution of a problem involving co-relationships between the product, the package, and its advertising medium. This problem marks the transition point between two and three dimensional design discussion in the classroom.

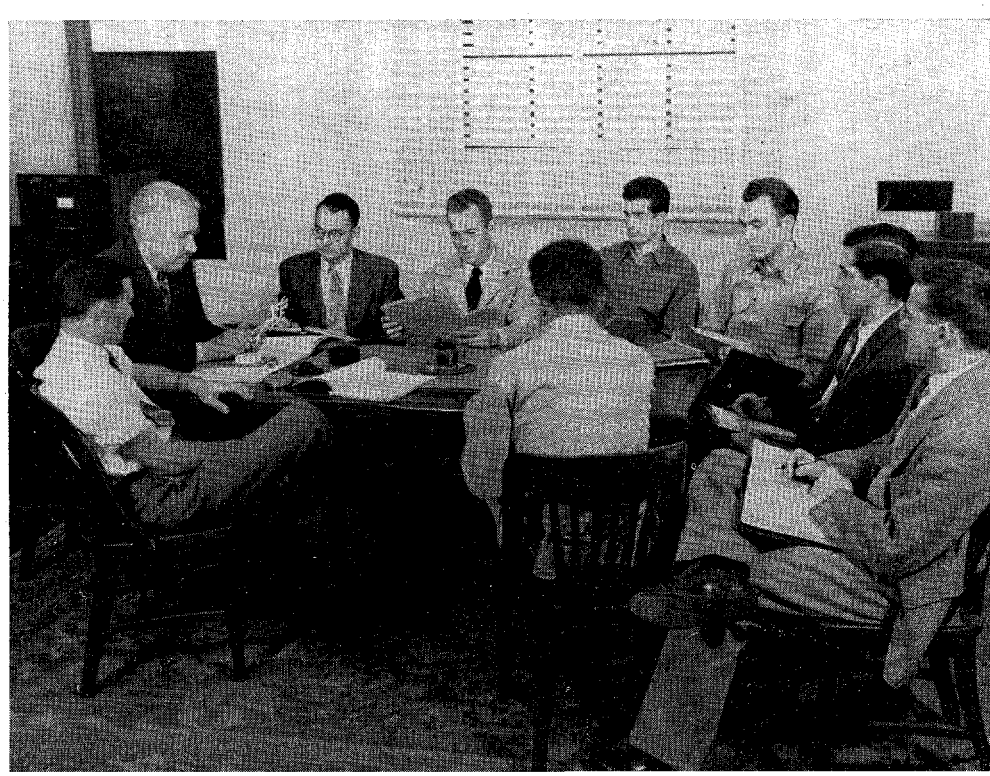


Problem solution of the presentation of a series of exhibits designed to show the idea of the steps in developing all of the phases of a product design. This exhibit was a group project.

imperative because of his difficulty in competing with the large manufacturer on purely a price basis. Even now, our consumers and particularly the buyers for large organizations are becoming much more critical and demanding more quality and consumer appeal in their goods. Soon price will again play its important part in a highly competitive market, and the small manufacturer's only hope is to have an entirely unique, a better, or a more attractive product to justify his higher manufacturing costs. A good many small manufacturers, particularly those who have grown up during the war, are planning ahead wisely and are now anticipating this inevitable highly competitive market and calling in the Industrial Designer.

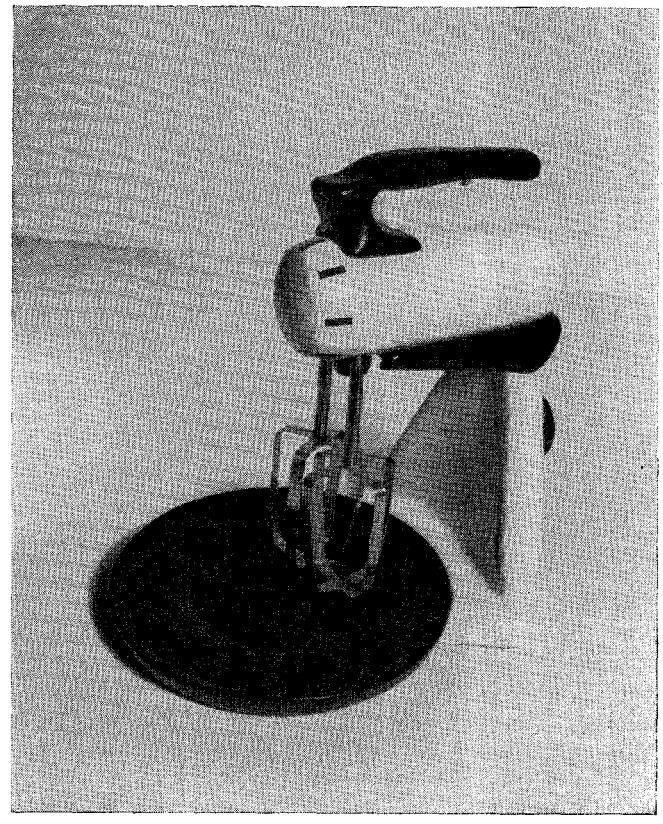
To illustrate specifically how the Industrial Designer fits into a product development program let us break down a typical program into its various stages, showing his relationship to each. Assuming that a large organization manufacturing commercial refrigerators is interested in producing a small household deep freeze unit, a development program might be set up as follows:

1. **Market Research:** Carried on by Sales Department.
   Purpose: To evaluate competition, anticipate prospective volume of sales and locate best markets.
2. **Consumer Survey:** Carried on by Sales Department under guidance of Industrial Design.
   Purpose: To determine popular sizes, price ranges, details of usage such as which foods are most frequently stored, which most frequently sought, location of unit kitchen, porch, garage, color preferences, etc.
3. **Engineering Research:** Engineering and Research Departments.
   Purpose: To study physical principles, materials, processes, etc.
4. **Report and Conference Integrating all Facts Found:** Sales, Engineering, and Industrial Design.
   Purpose: To provide a sound basic foundation for preliminary design.



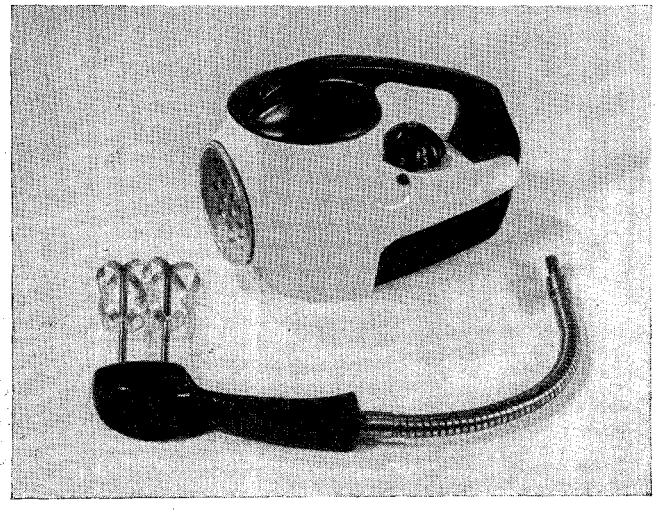
Discussion of new materials and merchandising methods around the conference table as a preliminary to their selection for a newly designed product.

Redesign from a functional point of view of the conventional electric food mixer.



5. **Preliminary Design:** Engineering and Industrial Design.
   Purpose: Formulation of basic ideas into a working design to incorporate all practical sales features advocated in research.
6. **Conference:** Executive, Sales, Engineering, and Industrial Design.
   Purpose: Modification and suggestions on preliminary design.
7. **Layout Drawings:** Engineering and Industrial Design.
   Purpose: Completion of mechanical design, development of basic form, specification of hardware trim, and finishes.
8. **Detail Drawings:** Engineering.
   Purpose: Preparation of production drawings.
9. **Cost Estimates:** Engineering.
10. **Working Model:** Engineering.
11. **Presentation Drawings:** Industrial Design.
12. **Full Scale Appearance Model:** Industrial Design.
13. **Conference:** Evecutive, Sales, Engineering and Industrial Design.
14. **Pilot Production Model:** Engineering and Industrial Design.
15. **Design Modifications or Changes:** Engineering.
16. **Final Product.**

It can be readily seen from the rather typical program outlined above how the Industrial Designer works along with the Sales and Engineering Departments from the very earliest stages through supervision of any final changes necessary on the production model which may affect the appearance of the product. Experience has proven this type of relationship between the Industrial Designer and manufacturing organizations to be by far the most satisfactory, whether the Industrial Designer is a part of the organization's staff or is called in as a consultant.



In a bulletin on the subject of Design Education sent out by the Society of Industrial Designers, Mr. Philip McConnell, Executive Secretary, has indicated a growing demand for designers who have a sound technical background along with their more specialized training in design. This bulletin was based on information obtained from questionnaires sent out to a number of Industrial Design firms throughout the country in an effort to estimate the recent growth of the field and probable future expansions. Mr. McConnell states in his bulletin, "The mere fact that in 22 firms which answered our questionnaire there were positions (available) for 66 trained designers is an indication that sufficient training is not available." Elaborating on that training he further states, "An Industrial Designer's training must make him a specialist in forms and shapes and their historical development, an imaginative specialist in the psychological problems of the consumer and consumer's relationship to the things he uses, and an expert on materials and processes of manufacturing. Any course of training which purports to prepare a student for a career as an Industrial Designer is seriously deficient if it does not equip (him) to work in each of the three branches of the field, and to synthesize them in his own practice."

Redesign of the electric food mixer as the result of a study of the operations required in the preperation of a meal. This appliance incorporates a food grater.

Emphatic criticism of many schools offering Industrial Design has been made by heads of some of the large design organizations on the grounds that so many recent graduates are no more than accomplished renderers. Some have stated preferences for architectural or engineering graduates as being better material for their staff, despite their lack of training in Industrial Design. In his book **Design This Day,** published in 1940, Walter Dorwin Teague gives the following advice to prospective students in Industrial Design: "Take your technical training as architect or engineer, and franchise that is necessary, still, to practice in these fields. But keep your mind on general principles rather than on minute details, and keep your eyes on everything that is going on around you in the world of beautiful—significant—form. So into factories, work in modern industrial plants, study machines and learn how things are made today, and for God's sake remember that slide rules and handbooks are tools and not vocations."

The two-year graduate course given in Industrial Design at the California Institute of Technology is the most advanced in this country. It has been very carefully planned to meet the high requirements demanded by the profession today and offers a working solution for the many legitimate objections to the numerous art school courses being given in Industrial Design. To qualify for admission the student must not only have a natural aptitude for art and design, but must also be a graduate of high standing in engineering or architecture, which provides a good background in fundamental engineering. As a rule the student with this undergraduate background has had little or no formal training in art, presentation of techniques, design, or aesthetics, so rather intensive study in these fields is emphasized in conjunction with each design problem.

The two-year course itself is planned around a series of design problems beginning with a two-dimensional problem on paper, such as an advertising poster, and progressing on to design problems in wood, ceramics, glass, plastic, die casting, and sheet metal. Second-year work consists of more complex problems involving many combinations of materials in the fields of heating, ventilating, lighting, interior and exhibition layouts, and is climaxed by a thesis problem of the student's own selection, to be very thoroughly developed from the first market survey through a final working model.

A sound basic approach applicable to any design problem is introduced at the very beginning and stressed over and over again in each problem as outlined below:

1. Careful study and analysis of the problem at hand
2. Fundamental Research
3. Market and Consumer Research
4. Preliminary Design
5. Engineering Layouts
6. Final Presentation of Color Rendering
7. Full Scale Model
8. Cost Estimates
9. Seminar Presentation to a jury of Experts.

Coordinated with the work in each design, the student simultaneously receives instruction in other phases of the problem, such as the physical characteristics, the production aspects, aesthetic possibilities and relative costs of the materials being utilized. The merchandising problems, business aspects and current design trends are also studied in conjunction with the problems. For example, during the development of a wood frame dinette chair, first the basic problem of comfortably supporting the averaged-sized body is thoroughly analyzed: then the physical properties of various woods, structural joints, lamination techinques, relative costs and surface finishes, as well as various cushioning and covering materials are taken up in the non-metallic materials course. Mass production methods in furniture manufacture are studied and an actual full scale model is fabricated. This model is finally rated by a group of experts for comfort, aesthetic appeal, strength, and relative cost. Visits are also made to one or more local furniture manufacturing plants and furniture retailing establishments in order to gain additional background for the problem.

The following typical problem recently completed by students in the Industrial Design Section will serve to illustrate graphically how the student is brought into close touch with actual problems he will be encountering later as a professional man. This particular problem was carried out in conjunction with the Plumbing Division of the General Tire & Rubber Company in Pasadena, over a period of five weeks. Several representative solutions in the form of full scale models, each worked out by an individual student, are shown in the accompanying illustrations. It is the be noted that definite requirements have

Model development in the Industrial Design Laboratory as a test of the preliminary research and drafting room studies.

been set up for the completion of every problem and a complete solution is required in each case. Upon completion of each problem the student presents the results of his work to a jury composed of experts in each phase of the problem from the technical end through merchandising. A major difficulty in problem planning has been to encourage initiative and ingenuity on one hand and yet to end up with a sound and thorough solution, perhaps a little in advance of what production economics might allow today, but definitely more than a dream of things to come. In each problem, the limitations which industry would place on the particular design are pointed out, not in a restrictive sense but as more essential factors to consider in the design process. During his training the student can afford to, and definitely must, design a step or two ahead of what he might be allowed in actual practice.

PROBLEM IN CHAIR DESIGN

INDUSTRIAL DESIGN SECTION

CALIFORNIA INSTITUTE OF TECHNOLOGY

I.D. 101 A — DESIGN PROBLEM II — FIRST YEAR

WOOD FRAME DINETTE SET

PRESENTED: NOVEMBER 8, 1946
DUE: DECEMBER 11, 1946
SEMINAR: DECEMBER 20, 1946

STATEMENT OF THE PROBLEM: A FURNITURE MANUFACTURER IS PLANNING A LOW PRICED WOOD DINETTE SET CONSISTING OF A TABLE AND FOUR CHAIRS. THE SET IS TO BE DESIGNED PARTICULARLY TO MEET THE NEEDS OF THE RETURNING VETERANS WHO ARE FURNISHING THEIR OWN SMALL HOMES OR DWELLING UNITS. COMFORT, STURDY CONSTRUCTION, LOW COST, AND ATTRACTIVE APPEARANCE ARE PRIMARY REQUISITES OF THE DESIGN. THE CHAIR SHOULD BE DESIGNED FIRST AND WILL BE USED AS A BASIS FOR THE STYLE OR FEELING TO BE CARRIED OUT IN THE CONSTRUCTION OF THE TABLE. THE SEAT OF THE CHAIR AND POSSIBLY THE BACK SUPPORT MAY BE CUSHIONED FOR ADDITIONAL COMFORT.

REQUIREMENTS:

1. RESEARCH
   - A. STUDY OF GENERAL REQUIREMENTS FOR COMFORTABLE SEATING.
   - B. STUDY OF BASIC DIMENSIONS TO BE CONSIDERED IN DESIGNING FOR THE AVERAGE SIZED HUMAN BODY.
   - C. STUDY OF HISTORICAL AND CONTEMPORARY CHAIR DESIGN.
   - D. STUDY OF LOW PRICED WOODS, JOINT CONSTRUCTION, LAMINATION TECHNIQUES, SURFACE FINISHES, PADDING OR CUSHION MATERIAL, UPHOLSTRY FABRICS AND MASS PRODUCTION METHODS IN FURNITURE MANUFACTURE.
2. PRELIMINARY SKETCHES ON 8 1/2 x 11 SHEETS.
3. QUARTER SIZE DIMENSIONED LAYOUT DRAWINGS OF CHAIR AND TABLE ON TRACING VELLUM.
4. FULL SCALE MODEL OF CHAIR.
5. COLOR RENDERING OF TABLE.
6. PRESENTATION AT THE SEMINAR FRIDAY EVENING, DECEMBER 20, 1946.

STUDY FOLLOWED IN DEVELOPING THE DINETTE SET

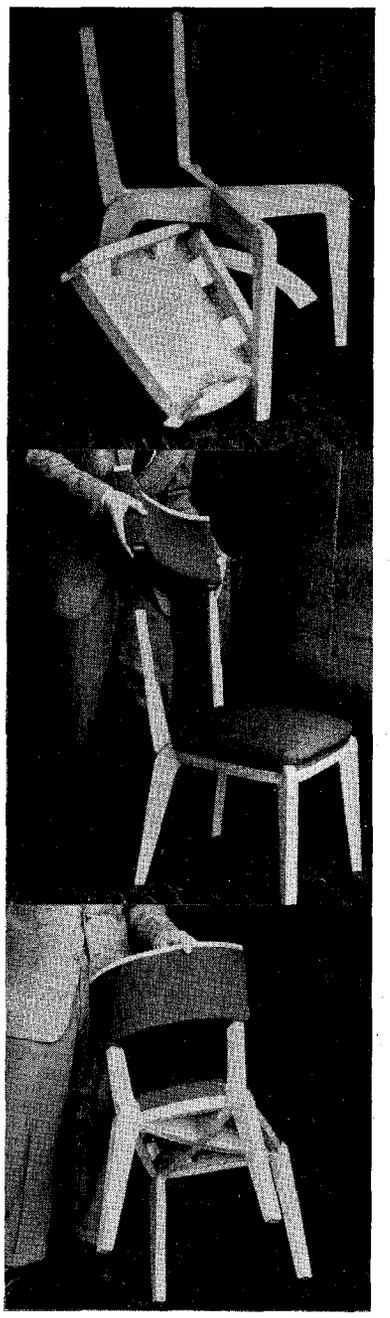
Research came first. The general requirements for comfortable seating, the basic dimensions to be considered in designing for the average-sized human body, historical and contemporary chair design had to be learned. This was followed by a study of low-priced woods, joint construction, lamination techniques, surface finishes, padding or cushion materials, upholstery fabrics and mass production methods in furniture manufacture.

Lectures were given before the class. "Moulded Plywood Furniture" by Charles Eames, considered the foremost designer in this relatively new field, was one.

The class took field trips to furniture manufacturers and dealers. Brown-Saltman Furniture, S. Karpen & Brothers, and the Gillespie Furniture Company were visited.

After much research by individual class members and teams, conferences, model making, and more conferences, students constructed full-sized chairs in the laboratory.

At the December seminar, a presentation of final designs was made to a jury consisting of Mr. Percy Solotoy of Brown-Saltman, Mr. Charles Eames, Mr. H. W. Anderson of Gillespie Furniture, and faculty members. Class members showed their chairs and the pictorial renderings of matching tables, and defended their designs. Presentation techniques as well as development were criticized. The industrial designer often has to sell his product.



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STEPS IN THE DESIGN OF A KNOCKDOWN CHAIR

Local interviews and market research revealed that in the small home the dinette chair often doubles for living room use. This indicated that the design should be more formal and dressier than the usual kitchen chair. This con-

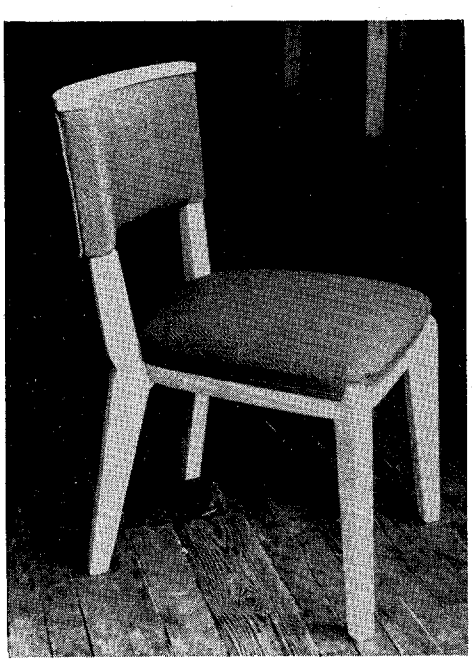
An example of the problem approach given the student is the following study of sink hardware design. The student was asked to consider a local division of a large corporation which is equipped to mass produce sink hardware, utilizing only metal stampings and screw-machine parts in a furnace-brazed assembly. This is a radical departure from the conventional sand or die-cast fixture and the organization wants a distinctive line of fixtures designed around its basic idea for manufacture. The first items to be brought out will be a "swing spout" for the kitchen sink, a lavatory faucet, and tub fixtures. The designs must incoporate the following features:

1. Functional Improvements over competitive lines
2. Low Cost
3. Distinctive appearance based on functional requirements and the logical use of materials and the manufacturing process.

clusion, along with data gathered on the sitting habits and dimensions of the average person served as a basis for the design. The height, size, and tilt of the seat and back were established, and the application of slight padding upholstered with a washable fabric was decided upon.

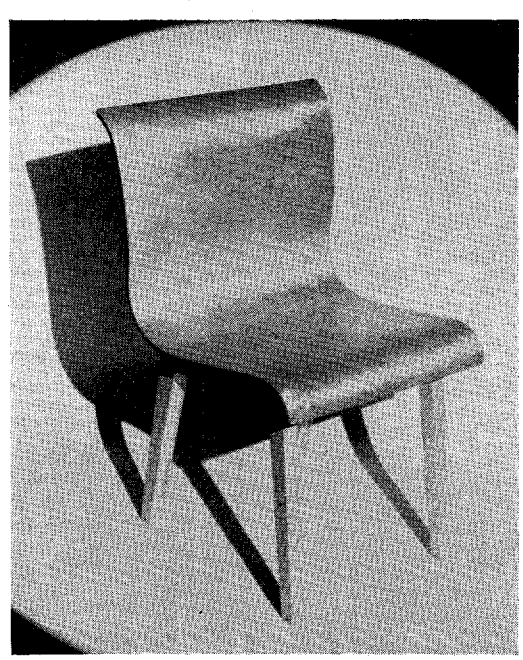
Materials and methods of manufacture were next considered, from which three premises were evolved. First, it was found that the modern large-scale furniture manufacturer prefers to buy his lumber in trimmed short lengths under three feet, for economies in handling, shipping, and scrap disposal. Therefore each part of the chair was designed to be cut in pairs from a piece 24″x 4″x 1″. Secondly, new superior glues and high-frequency curing methods favored an all-glued chair, devoid of screws or dowels. Therefore all joints were designed for mortise or side gluing. Thirdly, the high cost of crating and shipping, combined with the problem of storage space in the small home, indicated that a knock-down chair was desirable. The chair was therefore designed to disassemble into four major sections which could fit into a small carton 4″x 27″x 30″. In this way mass production at low cost was made possible.

Based on these premises, the form of the finished model rapidly took shape. The need for a diagonal brace between the legs suggested the formation of the cross-frame made by the two leg sections, achieving maximum rigidity. Each joint was designed to give the most direct support and the greatest gluing surface. Finally, the radii of the curves and the degree of taper were adjusted to produce the most harmonious effect, and the chair took on the appearance of comfort and stability.



The model proved successful, and a local manufacturer undertook to develop it as a commercial project. Subsequent models were built in his plant with progressive refinements in design and the chair is now being considered for large-scale production.

Chair with wood back and leatherette seat.



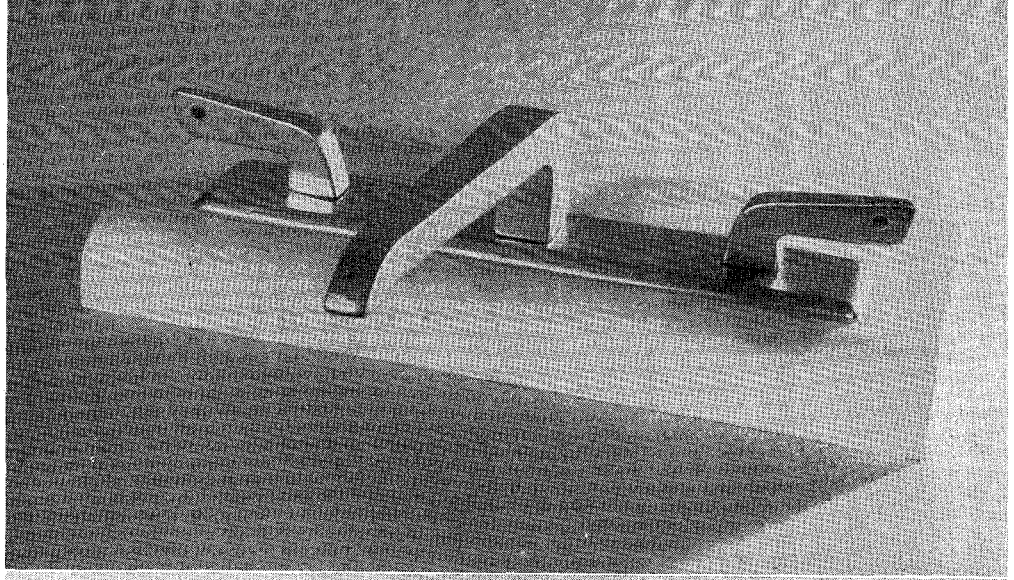
Molded plywood chair.

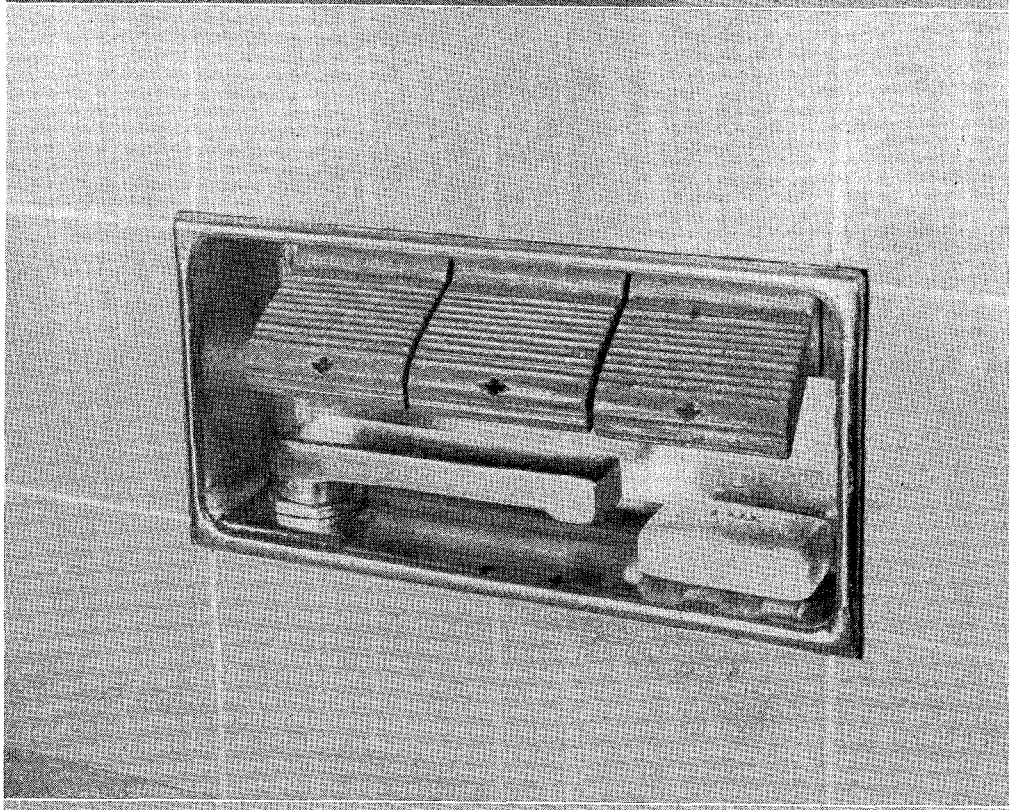
Preliminary sketches must be ready to show the client on May 24, 1946. The student is to consider himself a staff designer in a large office and is to be personally responsible for the complete development of one of the three units listed above. The staff will be divided into three groups. The first group, consisting of two men, will be working on the swing spout, while the remaining two groups, consisting of three men each, will work on individual solutions for the faucet and tub fixtures.

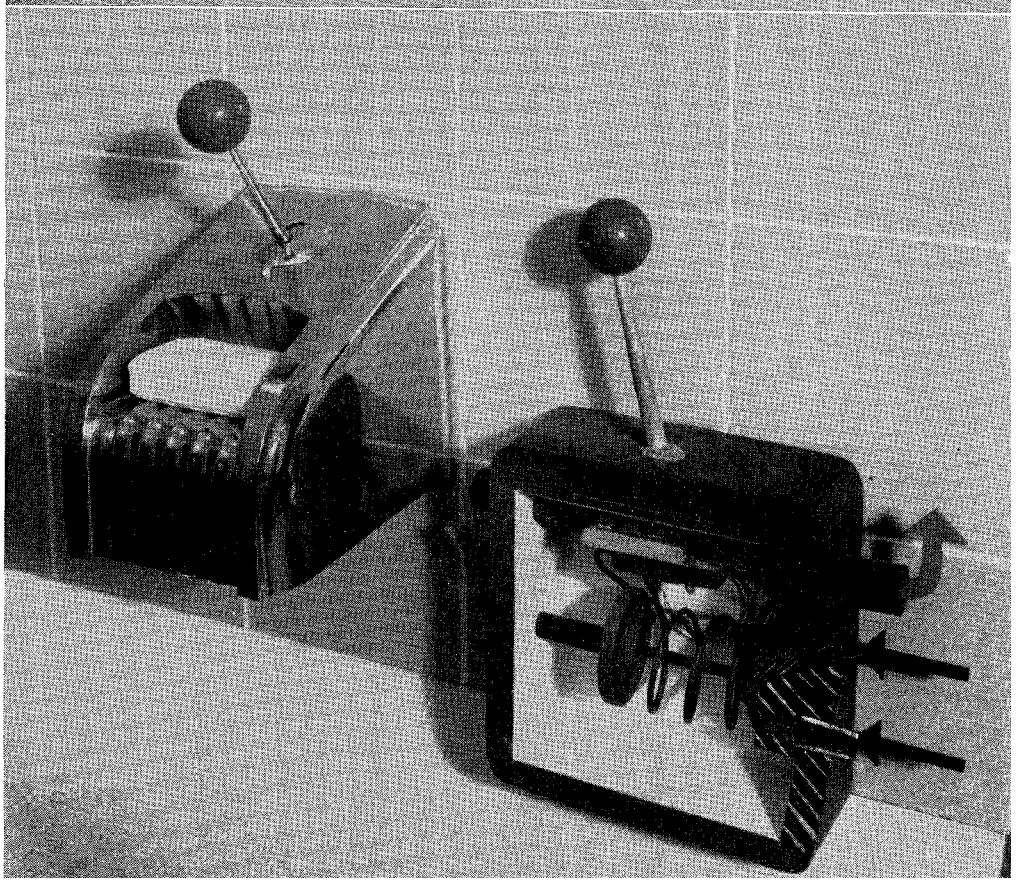
Requirements:

1. Preliminary Research
2. Preliminary Sketches
3. Conference with Client
4. Full size Layout Drawing
5. Presentation Rendering
6. Full Size Mock-up
7. Cost Estimate
8. Presentation Seminar.

There are few aspects of the complex procedure of designing for mass production which the Institute program is not examining. This two-year graduate course in Industrial Design gives the student the opportunity to devote full time to intensive study, and to gather a matured perspective view of the profession's many sides which it might take years to amass in industry itself, or in the employ of other designers. Collaboration with industry itself is constantly maintained in current problems, not only through field trips into factories of the area which are actually producing products similar to those on the Section's drawing boards, but also by participation of experts from those factories in seminars, where the students' solutions are analyzed critically. In addition, consultants are being drawn in frequently from the fields of advertising, merchandising, photography and other subjects as needed for a rounded picture. Another unique aspect of the Institute's program is that all work is being carried on under the guidance and close supervision of practicing Industrial Designers. Student reception has been more than gratifying during the past year, and with the opening of the current year, and with the opening of the current year, applications for admission far exceeded the number of openings available.







UPPER: Model of kitchen swing spout. CENTER: Model of built-in bathtub fixture with swing spout. LOWER: Models of bathtub fixtures and enlarged schematic layout of proposed thermostatically-controlled mixing valve.