The BioComposite Design Group

An Interdisciplinary Experiment in Research and Development

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Designers often discuss materials research as a method of inquiry into projects. As a proponent of the generative force of craft in design, I have often thrown around terms like *materiality* and *sustainability* with reckless abandon – assuming a moral high ground of indefensible certitude in the ability of designers to understand the nature of materials. This ended abruptly recently.

The Department of Agricultural Sciences at my university has been developing new materials based on organic waste fibers and plant-based adhesives. This raw material is being made into boards that by any standard can be called sustainable or ecologically responsible, as they use only biodegradable waste materials and non-petroleum based glues. The difficulty the researchers are having is what to do with the material to promote its use – this is where the designer (myself) is drawn into the discussion and the BioComposite Design Group was formed.

In order to frame the parameters of how to look at a new material as a designer, I looked to the Eames Office and the development of bent plywood furniture. This is the research model I'm using. The work consists of reproducing the first set of Eames experiments in forming the material. The results have been different due to the material properties of the BioComposite board. The lessons learned from each successive step have been carefully catalogued in an effort to progressively develop the next formal iteration on the experiment. The results are a series of chairs and components, both successes and failures, which tangibly demonstrate the possibilities of this new material.

Working with new and untested materials has required an interdisciplinary approach, the development of a research model and funding to enable grant driven researchers the ability to engage the process. This is work happening from scratch, fraught with mistakes and failures, and laden with layers of bureaucracy. It is slow moving, yet promises new ways of considering materials that are developed from their very origin by research scientists and designers working in tandem.

THE BIOCOMPOSITE DESIGN GROUP AN INTERDISCIPLINARY EXPERIMENT IN RESEARCH AND DEVELOPMENT

Materials research, as understood by most architects and designers, has two common meanings. The first is a search for new products. Not research as discovery of something entirely unique, rather an attempt to understand what is available as a standardized manufactured building component.

The second meaning deals with scientific research, the development and testing of newly created materials that can eventually be formed into standardized products. We engage in the first type of research and shy from the latter. This is because we're not scientists; our expertise is in design and assembly not chemical formation. However, there is an area that lies between the two disciplines that requires knowledge of design and assembly. This is the moment of translation between raw material and product, answering the essential question, "what do we do with this new stuff we've made?" As we desire to scrutinize the origin and impact of the products we use, it is inevitable that we'll become involved in the process at a much earlier stage. This is the only way to truly exert any control over how things are made and how they are used. Recently I found myself engaged in just this scenario, and the results have been difficult, frustrating and rewarding.

1. BACKGROUND:

The Biocomposite Design Group was formed within the College of Design at — University to study the possibilities of new materials being developed by the College of Agriculture. The Food Sciences Department has been able to produce from agricultural materials the two basic components of a building panel material – fiber and adhesive. The fiber comes from agricultural by-products or recycled materials; corn stalks, saw grass, burlap sacks, even cow manure can be used to provide the raw panel material. The adhesive resin has been developed from soybean oil, and can replace over 70% of the petroleum-based adhesives normally used to bind the fiber material into panels. The product created when the fibers are pressed with the adhesive resembles particleboard or *Masonite*, and can be molded into planar shapes. (*fig. 1*) A limited number of objects have been made by the Food Sciences Group using these materials and consist of various floor tiles, wall panels, ceiling tiles and a toilet seat. (*fig.2*) These have been presented to materials suppliers and manufacturers with little impact, making the research scientists curious about the apparent lack of interest in their products.

Currently absent is research into the unique nature and properties of the material. This is design research, based on a tradition of experimentation by designers into what possibilities each new material offers. It is important to be able to demonstrate that these new products are not simply amalgams of currently existing building materials, even if they are made in a novel and environmentally sensitive manner. There is tremendous resistance to new building products that replace the traditional standards. Each new product must be able to demonstrate how it is superior or more desirable than the existing standards, and that can only be established through hands-on experiments into what can be made from these new materials. This is fundamentally design-based research, and the particular expertise of colleges of design. We're working to not only determine the intrinsic design potential of the material, but to promote outlets for the potential uses of the product. This is done by expanding the range of possibilities through experimental prototyping and industry / public outreach. Demonstrating usefulness does not come from suggesting the specific products to be made to manufacturers and end users, but by demonstrating material versatility and generating interest about other new possibilities.

2. THE WORK:

The Eames Office undertook some of the most famous and important design materials research done in the 20th century. Working with high strength plywood technology developed during World War II they tried to make a chair. Very simply, they saw that plywood was strong and flexible and decided to try to form it into shapes using their Kazam machine and glue. (*fig.3*) This research eventually resulted in mass produced leg splints (*fig.4*), airplane components (*fig. 5*) and ultimately what *Time Magazine* has referred to as the most significant designed object of the 20th century, the LCW bent plywood chair. (*fig.6*)

This is the research model we're using. The basic properties of the biocomposite board are similar to plywood, and our University has the basic equipment needed to form the material. The work consists of constructing or borrowing bending apparatus, and then reproducing the first set of Eames experiments in forming the material. (*figs.7&8*) We started by working with conventional materials to understand the specific properties empirically. Standard plywood is quite predictable and can be fabricated in the woodshop with thin layers of laminate, or bent and re-laminated using a steam box. (*fig. 9*) *Masonite* and particleboard can be easily bent using the steam box, but are highly susceptible to de-lamination and cracking once they dry. (*fig.10*) These experiments led to our first set of decisions regarding the new material. The base material used for our panels would need to have enough strength to allow for bending while resisting cracking, so we needed it to have longer fibers in a woven pattern. We settled on burlap, due to its pre-assembled woven fibers, ability to absorb the adhesive easily, ready availability, and aesthetic potential. This decision created some difficulty, it was a convenient choice but what is the embodied energy in burlap? Is this a truly ecologically responsible choice given the “downcycled” nature of the base material? We quickly determined that in order to make any progress at all we would need to accept limitations that might affect the “purity” of our goals. Sustainability is not the goal of the Agricultural researchers, their understanding of the material is based more on the notion of alternative crop usage as a means of limiting petroleum imports, along with recycling base fiber materials. The idea that we wanted to use woven corn stalks rather than burlap, even though it would not have performed as well, struck them as odd. It might make the entire experiment fail before we could even produce a single panel. They pushed for, and easily won the argument for small incremental steps toward our goal.

The first sets of burlap panels were made in different thicknesses and densities to determine strength, texture, look, and flexibility. The results were rather stunning – we had used printed coffee bags as the top layer hoping some of the printed pattern and burlap texture would show through. (*fig.11*) It did quite remarkably, and the material was extremely strong. Twenty to forty layers of burlap had to be individually soaked in adhesive, hung to dry at less than 10% moisture content, then thermo-set in a 2 ton hydraulic press at 200 degrees. (*fig. 12*) This created 1/8” and 1/4” thick boards which were virtually inflexible and indestructible. The problem was that prototyping bent shapes would require custom steel or aluminum forms that could handle the hydraulic pressure and transmit the thermosetting heat. The cost and complexity of the formwork was financially prohibitive, but more importantly limited easy experimentation with shapes. Our next step was to work with the research team to develop an adhesive that would not require thermosetting, but could air dry in wooden forms held in a screw-type press. (*fig.13*) Our overall density would be lower, but we could make many variations of shapes quickly.

During the development of the raw material we also proceeded to design chairs. (*fig.14*) These varied from assembled shell forms to continuous bent planar shapes. Once we realized the pressure and type of press required to form the material, it was decided that individual smaller parts would need to make the chair. Going through the process, it’s almost certain the Eames arrived at the same decision in a similar fashion. The next decision was which of our designs would be best to start with. After an honest assessment of our goals and skills we decided to work on a version of the Eames LCW chair. Karim Rashid offered some guidance with his “kareames” chair – a variation based on the technology of forming plastic rather than plywood. (*fig.15*) The result from Rashid’s experiment is similar in form to the LCW, but is unique based on his choice of material. Our initial chair experiment is similar in spirit, but is a lesson in repetitive mistakes. The material delaminates, warps, is too flexible, and sometimes is simply the wrong shape. (*figs.16&17*) As each run in the press requires a new form to be built and can take a week to sufficiently dry, the work is frustratingly slow. Working on prototyping with limited means often raises more questions than providing answers. We continually wonder if each method we employ and each decision about shape or forming could have been done better using a different technique. As our research partners have reminded us, repeatedly, “Take small incremental steps and be relentless”. They have used this methodology for many years and find our design culture over paced and lacking rigor. We’re re-learning the fundamental scientific method of inquiry.

3. THE GOAL:

The results have been a series of basic chair-like components, mostly failures as final products, but tangible demonstrations of material possibilities. The research provides the basis for two activities we’re pursuing. First is a publication of the catalogued results that can be shared with other design organizations, potential manufacturers, and end users on the product possibilities. Second is a means to approach and discuss with manufacturers the potential of manufacturing with biocomposite materials. It’s never enough to just describe the possibilities of a new material; the case needs to be made in tangible and imaginative ways. This project intends to compel both manufacturers and the public to think about biocomposites as more than an alternative material, but as a whole new realm of opportunity for design. It is also teaching us how to engage other disciplines that do not share our particular way of viewing the world. We don't know the outcome of our project yet and frankly are just beginning to see the difficulties of pursuing this type of research. We are, however, encouraged by the progress to date and hope to make an impact by continuing in our relentless approach. Charles Eames provides some quotes that have assisted our pursuit. When asked the definition of design he provides this simple, yet elusive answer, "A plan for arranging elements in such a way as to best accomplish a particular purpose." Our goal is to make this kind of elegance apparent in what we make. When asked about the driving force of the Eames office he says, "If we have a slogan over the office it would be: Innovate as a last resort. More horrors are done in the name of innovation than any other." This goes to the core of our project - we desire to innovate as necessary, but then to refine through repetition and experimentation. Interestingly, our research partners immediately embraced this concept as a matter of obvious necessity. The last question and answer is possibly the most important skill we bring to the project. *Question*, "Can design be used to create objects reserved solely for pleasure?" *Answer,* "Who would say that pleasure is not useful?" The difficulties aside, we desire to show the joy evident in these basic acts of trying to make a chair.

Fig. 1

Fig. 2

Fig. 3

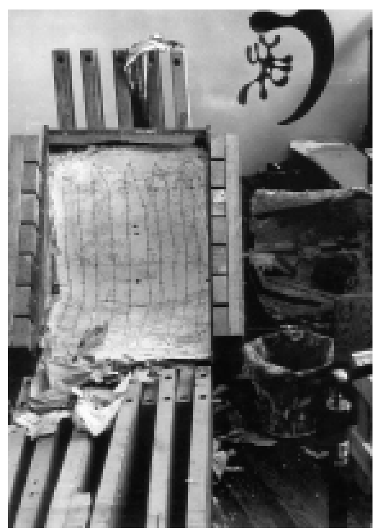
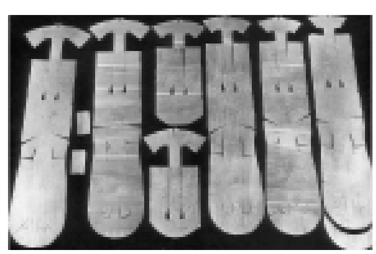


Fig. 4



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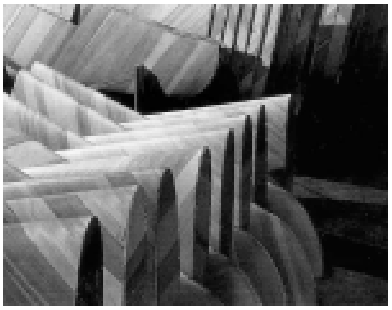

Fig. 6

Fig. 7

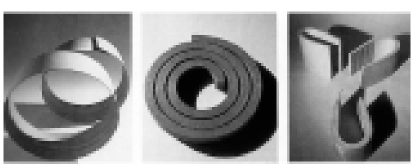

Fig. 8

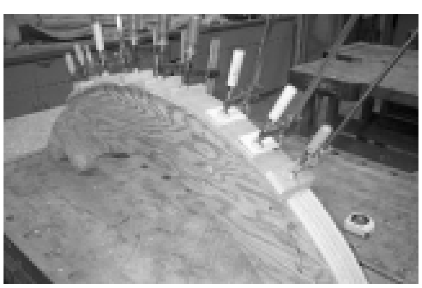

Fig. 9

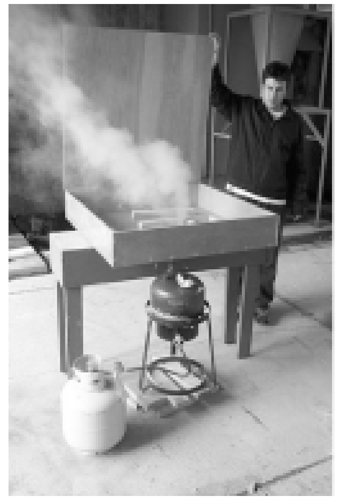

Fig. 10

Fig. 11

Fig. 12

Fig. 13

Fig. 14

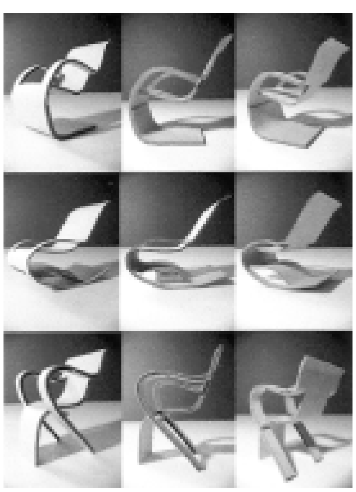

Fig. 15

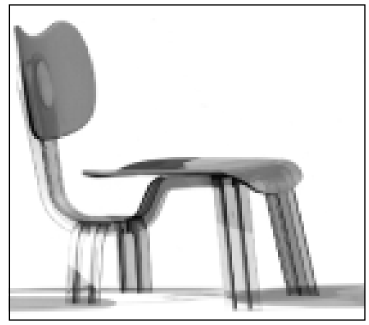

Fig. 16

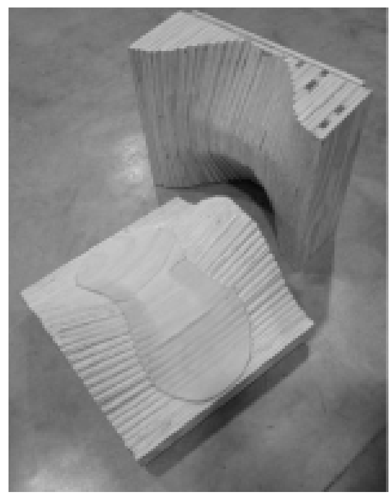

Fig. 17