

IPRO 312 Mid-Term Report

Applying Rapid Prototyping Techniques to Production Tooling

Fall 2006

Project Sponsors

Mr. Bob Pritzker and Colson Associates

Faculty Advisors

Professor Will Maurer
Professor Keith McKee

External Resources

Mr. Joe Arvin, president Arrowgear
Mr. Chuck Harris, Colson Associates

Students

Abdulkamal Abdullahi
Rachid Amine
Muhammad Atta
Oluwaseun Craig
Udit Dave
Chun Yiu Fu
Kenneth A. Hicks
Shan Iqbal Hussain
Sourabh Manjrekar
Daniel Nosse
Annie Ranttila
LaShawna Taylor

1.0 Revised Objectives

At the beginning of the IPRO this semester, the team was left with a wealth of information from the previous semester's group, from which we were able to extract all necessary data. Last semester, there were three caster design concepts that were submitted to Colson Associates. Initially, we had thought that our design would be based on one of the three designs. During the course of the first four weeks, a new caster design was suggested that contained significantly fewer components, and was much simpler to manufacture than any of the original three designs. This decision to do away with the original designs caused some changes in the team's objectives.

Some of the original objectives have been removed, but the following objectives were included in the original project plan:

- Tweaking caster component designs capable of being produced from flexible technologies that meet sponsor's performance and responsiveness requirements.
- Achieve caster production with a 24-hour turnaround time and a 48-hr maximum lead time.
- Determine the equipment required to produce caster components that meet quality, economic and flexibility requirements to produce casters.
- Determine the economics involved: equipment cost, cost per part, building and site costs, layout, staff, and return on investment.
- Meet or exceed the performance criteria set by ICWM (International Caster and Wheel Manufacturers).

The following objectives were added during the course of the first half of the IPRO:

- Using a virtual model of current chosen machinery, determine the lead time for an order of a dozen casters
- Establish the finishing process (coating for rust and corrosion prevention) required for the castors.
- Meet with Mr. Rob Hofman for selecting a building site.
- Create an in-depth cost model of the project (including equipment depreciation, initial investment cost, payback period, e.t.c.)

2.0 Results to Date

- **Held a meeting with Mr. Arvin (President of Arrowgear)**

In lieu of the great difficulty experienced during sourcing for equipment prices and specifications, in addition to an obvious need for input from an expert in acquiring tooling equipment, Mr. Joe Arvin, president of Arrowgear met with the team and after giving a small presentation, sat in on one of our meetings. Having had over 40 years experience in the acquisition of equipment, Mr. Arvin's input proved invaluable. He was able to review our caster designs and help decide which would be the best to work with. He also offered a lot of advice on what companies to contact for quotes on equipment that we would require. For someone as respected as himself, it was an honor to hear Mr. Arvin say that he was excited to be involved in a project such as this (IPRO 312).

- **Selected best possible design for the caster**

Due to professional feedback and in-depth analysis of the three original caster designs, it was decided that none of the three original designs would suit our purposes of creating a quality caster within the stipulated time frame. As a result, a fourth conceptual design was born and after review and scrutiny by the team and Messrs Arvin, McKee and Maurer, it was decided that CONCEPT 4 would be our focus design.

- **Created a working prototype using the selected design**

At the team meeting on Monday, October 9, 2006, a functional prototype caster, based on CONCEPT 4 was unveiled (one week ahead of schedule). It consists of only six main parts (the fork, top plate, king pin, thrust bearing, brass bushing and holding nut). This is a serious cut down on components as compared to the previous concepts. Being a prototype, no metal treating process was applied to it for rust and corrosion proofing. When we meet with Mr. Chuck Harris, he would be able to give us his thoughts, and, hopefully, his blessings. Then, performance and structural tests can be carried out on the caster.

- **Gathered information for required machinery**

The equipment team has been able to identify virtually all equipment that would be required for the rapid manufacturing of caster CONCEPT 4. Actual quotes for three of the six major pieces of equipment have been obtained from Mitsubishi Systems and Mori-Seiki. With Mr. Arvin's influence, we would be taken more seriously when making cost and performance enquiries.

- **Gathered information on possible sites for the manufacturing plant in Illinois**

The Factory Design team has made significant headway in locating sites for the proposed factory in Illinois. One of these potential sites is located in Chicago.

- **Acquired information on building codes for manufacturing plants in Chicago**

The Factory Design team has conducted extensive research on building codes and regulations in Chicago.

- **Begun preliminary designs for the factory based on different equipment layout scenarios**

The Factory design team has begun drafting and sizing plans for different factory layouts based on the two main possible scenarios:

(i) Purchasing a new plot of land and build a factory

(ii) Purchasing an existing facility and converting it to suit our needs

Of the several challenges being faced by the team, the most important would be Mr. Chuck Harris' evaluation of our design. One of the major problems last semester's IPRO team faced was that the customer focus group and staff members of Albion (sister company of Colson Casters) didn't think the conceptual designs were too similar to the caster families currently being offered by Colson. CONCEPT 4 was designed with that in mind and tackles the issue, hopefully to the satisfaction of Mr. Harris and the focus group that it would be presented to. If the prototype passes the 'look-alike' test, then the team can be rest assured that only tweaking, and not re-design, would be required. Consequently, it would be possible to put more focus on the other aspects of the project.

3.0 Revised Task / Events Schedule

Week	Tasks and Deliverables
Oct 9 – Week 7	<p>Equipment</p> <ul style="list-style-type: none"> ● Update list of available equipment ● Research on what finishing techniques would be most appropriate and the necessary machinery ● Analyze the delay caused by each finishing process to determine the best possible option ● PROTOTYPE CASTER UNVEILED <p>Design</p> <ul style="list-style-type: none"> ● Review performance ratings of manufacturing equipment and come up with first guess of turnaround time
Oct 16 – Week 8	<p>Equipment</p> <ul style="list-style-type: none"> ● Caster physical tests ● Caster performance tests <p>Design, Equipment</p> <ul style="list-style-type: none"> ● Review of caster test results ● Making necessary modifications <p>Factory Design</p> <ul style="list-style-type: none"> ● Build on preliminary research into factory design based on chosen equipment <p>Business</p> <ul style="list-style-type: none"> ● Mid-Term Progress Report (w/ optional presentation)
Oct 23 – Week 9	<p>All</p> <ul style="list-style-type: none"> ● Field trip to Arrow Gear Corporation ● Meeting with Chuck Harris of Colson Associates <p>Equipment</p> <ul style="list-style-type: none"> ● Final review of equipment and equipment surveying at Colson

	<p>Design</p> <ul style="list-style-type: none"> ● Retesting of design at Colson – thorough performance and design tests. <p>Factory Design</p> <ul style="list-style-type: none"> ● Visit to Colson to study current equipment and layout ● Preliminary layout and design work for the proposed new factory <p>Business</p> <ul style="list-style-type: none"> ● Co-ordinate website development ● Look into poster requirements and start planning a timeline for Colson and IPRO deliverables ● Begin in-depth cost analysis of the project
Oct 30 – Week 10	<p>Equipment</p> <ul style="list-style-type: none"> ● Work with ‘factory design’ on the layout exact placement of equipment <p>Design</p> <ul style="list-style-type: none"> ● Final modifying of design, if necessary ● Final testing and documentation for deliverables <p>Factory Design</p> <ul style="list-style-type: none"> ● Work on equipment placement and factory layout ● Begin conclusions - layout and design work for the proposed new facility <p>Business</p> <ul style="list-style-type: none"> ● Co-ordinate website development ● Start working on both Colson and IPRO deliverables ● Work on in-depth cost analysis of the project
Nov 6 – Week 11	<p>Equipment</p> <ul style="list-style-type: none"> ● Complete working ‘factory design’ on the layout and exact placement of equipment <p>Design</p> <ul style="list-style-type: none"> ● Work specifically towards documentation for deliverables to Colson Associates

	<p>Factory Design</p> <ul style="list-style-type: none"> ● Complete and finalize exact equipment placement and factory layout <p>Business</p> <ul style="list-style-type: none"> ● Work on website development ● Co-ordinate and work specifically towards documentation for deliverables to Colson ● Work on in-depth cost analysis of the project
Nov 13– Week 12	<p>All</p> <ul style="list-style-type: none"> ● Complete and finalize all documentation and deliverables for Colson and IPRO ● Presentation to Faculty Advisors
Nov 20 – Week 13	<p>All</p> <ul style="list-style-type: none"> ● Review and finalize all documentation and deliverables for Colson and IPRO, according to faculty advisor recommendations ● Preparation, co-ordination and completion of all final deliverables for the IPRO office ● Complete and finalize website ● Presentation to Colson Associates personnel – Bob Pritzker and Chuck Harris ● Project Exhibit due ● Project Abstract due
Nov 27 – Week 14	<p>All</p> <ul style="list-style-type: none"> ● Finalize all documentation and deliverables for IPRO Day ● Prepare and rehearse presentation for IPRO DAY ● Final Website due ● Final Oral Presentation to Faculty ● Final Report due ● Team Information due ● Comprehensive Deliverables CD due ● IPRO Day
Dec 4 – Week 15	<p>All</p> <ul style="list-style-type: none"> ● Finalize all documents and upload to iKNOW ● Organize all materials for next semester’s IPRO team ● IPRO Debriefing ● Peer Evaluations online <p>Business</p>

- Write Thank you notes to everyone concerned

4.0 Updated Task Assignments and Designation of Roles

At the beginning of the IPRO, we had split up into four main groups. **The administrative group** (involved in liaising with the IPRO office, and ensuring that the deliverables followed the formatting rules and were submitted on time), **the design group** (involved in choosing and validating the caster design), **the equipment group** (involved in selecting machinery for the project) and **the factory design group** (involved in site selection, building plans, factory layout for the project).

During the course of the IPRO, however, we have realized that this setup is not the most effective one. Since the IPRO team consists of people with different capabilities, we decided that in order to optimize brainpower, members can move between groups as long as deadlines are met. As a result of choosing a design and fabrication of the prototype caster, the design group has been dissolved. We have also expanded the business team's duties to involve a detailed cost analysis of what embarking on the project would entail.

I. Abdulkamal Abdullahi

In addition to liaising with the IPRO office and working with Annie and Sourabh on finalizing the deliverables, I have researched on several metal-finishing methods, including powder coating, zinc coating, anodizing e.t.c. I have gathered substantial information on both the laser and abrasive jet cutting methods. I would be working with Sourabh on the economic feasibility and cost analyses.

II. Rachid Amine

In addition to looking into CNC machining and laser cutter prices, tolerances e.t.c., I have also made 2-D and 3-D models of the prototype caster.

III. Muhammad Atta

Being a member of the equipment team, I have sourced for information on the equipment train that would be required for this process. I am also in charge of designing the project website.

IV. Oluwaseun Craig

I have worked with AutoCAD in rendering of the caster design to include the dimensions, hardness and other properties. I would be working with Rachid in using Pro-Engineer to render the caster design in 3-D as well as to inspect the caster design as a whole. I also contacted two companies in order to gather more information on equipment.

V. Udit Dave

As a member of this IPRO last semester, I provide lots of advice on the actual caster design. I verified the practicality of our chosen caster concept, based on feedback from the project sponsors on last semester's designs.

VI. Chun Yiu Fu

I have researched on various Chicago building codes and am still in the process of gathering more information. I am working on building cost estimates, the building program and building renderings

VII. Kenneth A. Hicks

I manufactured the prototype caster. I researched the best possible machinery for fabricating casters (lathes, mills, shear press) and am still in the process. I assisted in drawing up prints with respective tolerances.

VIII. Shan Iqbal Hussain

I have been conducting research on machinery and equipment performance and costs, with most of my efforts directed towards the CNC lathe, CNC mill, laser cutter and the hydraulic press.

IX. Sourabh Manjrekar

I have worked on developing and finalizing all the reports, deliverables, project plans e.t.c. I am currently researching zinc coating as one of many possible metal finishing procedures. I would also be heavily involved in the economic feasibility and cost analysis, namely the amortization schedule, break-even analysis, target per unit cost e.t.c. of the project.

X. Daniel Nosse

In addition to being the moderator at the IPRO team meetings, I am and would be working on gathering more information for the building site, size and layout. I would also be lending my artistic talents to the design of the project poster.

XI. Annie Ranttila

I take the minutes at the IPRO team meetings. I have drawn up a list of potential sites for this project. I have made preliminary drafts of the building plan, conducted building code research and enforcement.

XII. LaShawna Taylor

I am conducting research on metal finishing requirements as required by Colson. I am also heavily involved in the drafting of reports and would be ensuring that IPRO deliverables are ready and submitted on time.

5.0 Barriers and Obstacles

1. It took our current team a significant amount of time (2 weeks), to get a good background and grip over the IPRO objectives and results achieved so far by the team last semester.
2. It also took us a while to get a good understanding of what exactly our objectives this semester were and how our objectives were different from the objectives last semester.
3. After reviewing our current objectives and our project in detail, we realized that we had a lot more objectives that needed to be accomplished in order to present a complete solution to Colson. This increase in the number of objectives to be achieved in the same amount of time has put a lot of pressure on our team. Hence, the larger deliverables-to-time ratio is a huge obstacle.
4. It took a significant amount of time to finalize the caster design. The main reason for this is that Colson made it clear, last semester, that the concepts presented at the time were too different from the casters that Colson provides. As such, in designing the new caster, we had to follow the design guidelines provided by Colson, but still significantly reduce the complexity of the concept so that the casters can be produced with the equipment we plan to use, within the stipulated time frame.
5. As a result of the delay in finalizing the design, research about other aspects such as, equipment selection, materials, finishing, etc., also got delayed.
6. So far, we haven't had sufficient communication with Colson Associates; hence, we still have many questions unanswered such as the number of casters that Colson would like to be able to manufacture per shift, how many shifts in a day they would like to run and, most importantly, if they fully approve of our concept. (This, however, will be resolved soon, as we will be meeting with the engineering manager at Colson, Mr. Chuck Harris next week.)
7. One of our biggest barriers was gathering current information on equipment. Most equipment companies didn't help us out with equipment details and price quotes, because they knew that we were just college students and not actual buyers. (This issue is already being tackled by Mr. Arvin's presence and Ken's contacts