Brinkman Lab Product Portfolio Development
Multi-Disciplinary Senior Design Project: 04017

PRELIMINARY DESIGN REVIEW REPORT

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2. Introduction

The purpose of this project is to develop a portfolio of products to be manufactured in the Brinkman Manufacturing Laboratory. These products will be designed, manufactured and marketed by the project team. The products will be available for sale to the Rochester Institute of Technology campus population by the end of May 2004.

The portfolio of products includes the design, manufacturing, and business documentation for the set of concepts developed by this project. This portfolio will be the ultimate deliverable of the project. It will also serve as the source of information for future production of these designs.

The products are designed to be manufactured within the current capabilities of the lab. The lab is equipped with two CNC milling machines and three CNC lathes. The lab is also equipped with a die sinking EDM and an injection-molding machine. The machine tools in the lab allow us the capability of producing high quality machined parts. The high quality of our products will be an advantage over our competitors’ products.

All of the designs developed as a part of this project, will appeal to the RIT campus population. Market research will provide the style preferences of the customers. Historical data, surveys, and focus groups will verify the demand for the products considered. This demand data will be used in the financial analysis of the project.

The preliminary product concepts were developed using a variety of creative activities. These activities promoted an open-minded approach to the problem and lead to a multitude of imaginative design ideas. Brainstorming, sketching, and 3-dimensional modeling, were some of the activities that encouraged concept generation.
The most desirable concepts will be selected using a structured methodology. The Weighted Concept Selection method uses a rating system to evaluate each concept based on a set of measurable attributes. Performing this analysis requires the design team to question the feasibility and desirability of each product idea.

The detailed design of each concept evolved through an iterative process. Design for manufacturing, assembly, machining, injection-molding, functionality and aesthetics were considered during the detailed engineering design stage. The products requiring the analysis of mechanical properties were also performed at this stage.

This report will show the progress of the product development process. The preliminary design review will serve as a gateway to the second half of the project. Feedback from the review will be used to refine the product designs as well as the planning for the future of this project.

3. Needs Assessment

Before beginning the design work of an engineering project the needs of the project should to be evaluated. These needs will define the nature of the project, including the scope, schedule, and budget. The needs of the client, the project team, and the overall need for the developed products will be studied.

3.1. Needs of the Client

The needs of the client are what the client expects from the project team. The client needs serve as the primary requirements of a project. They define the general path the project will take and determine the ultimate deliverables. During the phase of identifying the needs of the client, latent or hidden needs should be clarified. It should also be made certain that no critical client need is missed or forgotten. Overall, the product should be focused on customer needs and the specifications for the product should be justified by the customer.

This project was commissioned by the Industrial and Systems Engineering department at Rochester Institute of Technology. A need for the services of the project team began with the submission of a request for the project to be completed through a Multi-Disciplinary Senior Design Project. This request, in the form of the client statement, shown in Figure 1, summarizes the initial needs of the client.
Client Statement:
The student team will develop, design, manufacture and market a portfolio of products that are to be fabricated in the Brinkman Manufacturing Lab and sold at the RIT bookstore and through university catalogs. The students will redesign and optimize current products (business cardholders, pen holders, and paper weights) as well as develop new ones to conform a complete portfolio that can be manufactured with current capabilities. In addition to product development, design, and manufacturing/assembly planning, the team should develop a complete business plan that includes investment, cost estimates, project management, marketing strategy, as well as pricing. Additional issues on personnel requirements, training, fixture development, product customization, etc are to be considered. The team is expected to deliver this portfolio of products to the RIT bookstore before commencement day (2004) and prove feasibility of the project.

The design team will be provided with
- Appropriate CNC and manual machines for product manufacturing (mills, lathes, EDM, etc). If needed, training on these equipment will also be provided.
- A budget for any hardware or software purchases that are necessary for the successful completion of the project.

The design team should
- Development and Design: Develop a portfolio of several products that can be manufactured in the lab. This includes
- Design of new products. Redesign and optimization of existing products. Market research (demand forecast, etc) and product features (aesthetics, materials selection, customizable, DFX, packaging, etc).
- Product documentation: drawings, bill of materials, operations chart, assembly chart, precedence diagram, parts list, etc.
- Process documentation: process plan, production planning, scheduling, time studies, personnel requirements, line balancing (if needed), etc.
- Develop a complete business plan as well as project management
- Prototyping: Fabricate prototypes of each product. Incorporate feedback from customer (RIT bookstore) and from manufacturing/assembly.
- Full Scale Production.
- Design and fabricate appropriate fixtures.
- Purchase materials and train people.
- Production run: fabricate and assemble products to meet forecast.
- Sales: Prepare all the documentation and administrative procedures for commercializing the products.

Figure 1. Client Statement

As specified, the client requires complete documentation of newly developed products, production plans for each product, and a business plan that includes the marketing, sales, and commercialization strategy for the products.

3.2. Needs of the Project Team

The needs of the project team are the resources and time required to complete the work of the project. The initial project description includes some of the needs of the project team. First, the team needs a budget to develop and manufacture the products. Second, the team needs access to the means of production – the machines in the Brinkman Lab. Third, the team needs access to faculty advisors and staff members to resolve technical issues and to learn how to program and operate the manufacturing equipment. The team also needs time to plan the progression of the project.

3.2.1. Statement of Work

The first meeting with the team mentors, Dr. James Taylor and Dr. Andres Carrano, clarified the requirements of the project, the requirements of the team, and the requirements of the client. The needs of both parties were discussed and a formal statement of work was agreed to. The statement of work is reproduced below.
Statement of Work – Brinkman Lab Product Portfolio Development – 12/14/03

The student team composed of the members listed below will develop, design, manufacture and market a portfolio of products that are to be fabricated in the Brinkman Manufacturing Lab and sold at the RIT Bookstore and through campus catalogs. The team members will develop a business plan after evaluating investment, costs, marketing potential, and pricing. Additional issues of personnel requirements, training, fixture development, and product customization will be evaluated and documented. Full documentation of all products and processes will be included in the final report. These tasks will be completed by commencement 2004.

Order Qualifiers

- Develop a portfolio of several products that can be manufactured in the Brinkman Lab
- Design new products
- Redesign existing card holder
- Complete business plan based on market research, investment analysis, cost analysis, pricing analysis, forecasting.
- Complete Product Documentation including drawings, bill of materials, operations chart, assembly chart, precedence diagram, and parts list
- Complete Process Documentation including process plan, production planning, scheduling, time studies, personnel requirements, and line balancing (if needed)
- Software and Hardware prototypes of concepts
- Full scale production of concepts. Including design and fabrication of fixtures, material purchases, and operator training, and production to meet forecasted demand.
- Prepare all the documentation and administrative procedures for commercializing the products

Order Winners

- Profitable business to provide income to the Brinkman Lab
- Provide products that can serve as case studies for course work

Figure 2. Statement of Work.

3.2.2. Problem Statement

Design a portfolio of 3-5 products that can be manufactured in the Brinkman Lab and sold on campus. Develop new designs as well as redesign and optimize existing products. Perform market research, cost analysis, customer expectations, feasibility analyses to verify the success of the developed products.
3.2.3. Project Scope

The portfolio of 3-5 products will be fabricated in the Brinkman Lab and sold on campus. The project deliverables will be complete by the end of May 2004.

3.2.4. Stakeholders

The stakeholders for this project are listed below. Stakeholders are all of the parties with a direct interest and influence on the project.

- Primary Stakeholders
  - Dr. Jacqueline Mozrall, Client/Project Coordinator
  - Dr. Andres Carrano, Project Advisor
  - Dr. James Taylor, Project Advisor

- Secondary Stakeholders
  - Campus Connections
  - RIT Departments and Offices

- Tertiary Stakeholders – End Users
  - Ultimate Consumers

3.2.5. Budgetary Parameters

A source of startup funding for this project is required. The agreement reached between the client and the project team is that funds would be made available from the ISE department as needed. The requirement was that justification be shown prior to any expenditures, and that all purchases be approved by Dr. Mozrall. There is not a budget set by the client for this project. However, the project team developed a startup cost model. This information is included in the financial section of the business plan document.

3.3. Product Need Evaluation

The information from the client provided the project team with a starting point for assessing the needs of the project and the needs for the products to be developed. It is the responsibility of the project team to assess the needs in the market for the concepts that were being developed. It should be noted that the concept development phase of the
project was running concurrently to the needs assessment phase. These two phases provided input to each other, and concurrent activities accelerate the product development process.

A preliminary meeting, at this point, was made with John Romans, Director of Stores for Campus Connections. Campus Connections will be one of the projects’ wholesale customers. It was important to get the input from this client as soon in the design process as possible. The results of this meeting were that there was an opportunity for the sale of products on campus, and possibly a need for customized products.

3.3.1. Market Analysis

The need for the products that will be developed by the team is established through market research. Market research for this project includes research of existing similar products for sale in Campus Connections, as well as customer surveys performed specifically regarding the concepts developed for this project.

The team collected data on gift and desk-top products, such as business card holders, pen sets, and picture frames currently sold in campus connections. Data was also collected on lower end products such as key chains and magnets. The Campus Connections research is included in Appendix A.

The initial survey questioned customer willingness to purchase products, or the desire to receive products as a gift. The results of the survey validated the demand in the market for the concepts specified. The summary of the survey data is included in Figure 3 and Figure 4.
Figure 3. Chart of survey responses. What product would you consider buying as a gift for someone else?

Figure 4. Chart of survey responses. What product would you buy for yourself or like to receive as a gift?
This survey was completed by 87 graduating engineering seniors. According to the information from the survey, there is significant interest in these products. A more detailed discussion of the survey data and results is found in the Business Plan document.

4. Concept Development

The purpose of the concept development process is to generate potential product ideas based on customer needs, target specifications, and team experience. The focus of this process is on generating ideas and not on selecting ideas. The development process utilizes a set of tools, or methods, to facilitate the generation of product concepts. A concept is a rough idea representing one solution to the needs and requirements of the project.

4.1. Concept Development Process

There are five steps in the concept development process – clarify the problem, search externally, search internally, explore systematically, and reflect on the results and the process.

4.1.1. Clarify the problem

To begin the process of generating concept ideas, the project team must first understand the problem statement, the customer needs, and the preliminary product specifications. These documents are still being refined in the beginning of the development phase. Understanding the problem to be solved will guide the project team towards solutions to the right problem.

In the case of this project, the team reviewed the Client Statement, shown in Figure 1, and agreed upon a Statement of Work, shown in Figure 2. Examining this document guided the team on the following steps of the concept development process.

4.1.2. Search Externally

Before generating concept ideas from scratch, the team should research the possibility of existing solutions or products. This step is essentially gathering research towards competitive products, technologies and processes, and products with related functions.

For this project, this stage includes patent research, existing product research, and client input.
4.1.3. Search internally

This process uses personal and team knowledge and creativity to generate concept solutions. It is an open ended creative activity for new product development. The process can involve group activities such as brainstorming, group drawing, and empathy sessions. Individual activities include sketching and 3-D models.

For this project, several methods were used to develop as many product concepts as possible. Brainstorming was the first method used to develop ideas. Brainstorming is based on suspending judgment and striving for a large number of ideas without weighing the feasibility of each idea. The process encourages individuals to be creative and stretches the boundaries of the solution space. The list of product concepts developed during this phase is included in Appendix B.

The activities outlined below were used to both develop new design concepts and to further refine the existing designs. The process for the detailed design of these concepts is discussed in a later section.

Graphical media was used to clarify and refine the ideas developed in the brainstorming session. These methods were used to make up for the inaccuracy of verbal and textual descriptions of ideas. Team members were assigned several concepts and asked to draw at least three sketches for each. These sketches formed the basis for the next activity, which is 3-D software models.

The physical media including clay and foam board 3-D models enabled the team to reevaluate the designs through hands on experience. Creating physical models reinforced the successful features of each design, and also lead to improvements of inferior features. This activity also generated new designs and lead to the next stage of development.

4.1.4. Reflect on results

These idea generating activities resulted in preliminary engineering drawings and high fidelity prototypes.

During the concept development phase, it was decided to group the concepts in to two categories - high end products and low end products. High end products, sold at a price greater than $10, will appeal mostly to a professional customer group, and will be produced in low volumes to be sold as gift items. Low end products will fill the niche for less expensive products. These products are intended to be purchased by students, or by RIT departments as promotional gifts. These parts will be produced in a higher volume than the high end products.
4.2. Material Selection

Materials were selected for the product concepts based on knowledge of material properties, expert recommendations, research into suppliers and cost, and design requirements. For machined parts, aluminum was chosen for its ease of machining, relatively low cost, and corrosion resistance. 6061 Aluminum was selected based on its low cost, availability, and wide range of use.

Acrylic plastic was chosen for the diploma frame based on its low cost, clarity, durability, and availability. The plastic for injection-molded parts will be selected to result in higher quality parts. However, a specific type of plastic has not been selected at this time, due to continuing material and process research.

5. Design Objectives and Performance Specifications

The purpose of this facet is to establish the intention and scope of each product design activity. The design objectives are the higher level requirements of the designs. In the case of the products developed for this project, the same design objectives will apply to all products. The performance specifications define quantifiable aspects of the functionality of each concept.

5.1. Design Objectives/Critical Performance Parameters

The design objectives for the products to be developed and produced for this project are listed below.

5.1.1. Order Qualifiers

- Products shall be aesthetically pleasing to end customers.
- High end products shall have a substantial look and feel.
- Products shall be of high quality.
- Products shall sell for a price that will allow for moderate sales volume of the product.
- Products shall be designed with manufacturing efficiency in mind.
- Products shall fully perform their intended functions.
5.1.2. Order Winners

- Products should be able to be custom engraved per customer requests.
- Products should be appealing as gift items.
- Products should have sufficient quality to compete with existing products in the market.

5.2. Performance Specifications

The performance specifications for the products to be developed are listed below. This list was developed concurrently with the progress of the concept development activities. At this time, not all specifications are completely quantified.

1. Curved Ball Card Holder
   a. Shall hold at least 50 standard business cards.
   b. Angle of ball rolling down hill shall be between 2° - 6°.
   c. Cards shall be held in the holder at an angle between 75° - 85°.

2. Cylindrical Card Holder
   a. Shall hold at least 50 standard business cards.
   b. Shall not roll forward or backward easily.

3. Bottle Opener
   a. Bottle opener shall withstand the force required to open a standard bottle (about 10 lbs applied at key ring hole).

4. Bookends
   a. Bookends shall withstand a horizontal force required to hold up 5 average size books.
   b. Bookends shall not tip over under the weight of a large sized book.

5. Picture Frame
   a. Picture frame shall hold a 4 x 6 in. picture.
   b. Frame shall stand solidly under its own support.

6. Diploma Frame
   a. Diploma Frame shall hold a standard RIT diploma (10 x 12 in.)
   b. Frame shall be able to mount on a wall.
7. Magnet/Key chain/Coaster
   a. The strength of the magnet shall be sufficient to support the weight of the magnet on a refrigerator door.
   b. The finish on these products will be durable enough for use as a key chain and a coaster.

5.3 Evaluation Criteria
All designs will be considered adequate and complete when the majority of group members agree that the design is final. Final designs are measured against design objectives and performance specifications. When designs meet all specifications and expectations, they are released for manufacturing. However, designs will continue to be eligible for revision due to unforeseen manufacturing issues.

6. Analysis of Problems and Synthesis of Design
For the purposes of this project, the Analysis of Problems and Synthesis of Design facet was not performed explicitly due to the nature of the project. However, the methods recommended by this phase were used elsewhere in the development of the project. The cost and price analyses performed in the business plan used the structured problem solving method commonly used in this phase. Additional design and manufacturing problems may be analyzed for this facet in the future.

7. Detailed Design Process
Once the concept development phase of the project is underway, the ideas for products begin to evolve into increasingly more defined designs. The development of the detailed designs is guided by considerations into the functionality of the products, aesthetic appeal, and the manufacturing ease of each component.

7.1. Design for Functionality
The function of each product was determined during the concept development process. The functionality refers to how well the product will perform this function. The design philosophy of this project is that the function is more important than design. All of our products perform simple functions – and are expected to perform these functions flawlessly.

The functionality of our products are evaluated with respect to the design objectives and performance specifications discussed in the previous section. However, functionality is assessed in common sense terms as well.
7.2. Design for Aesthetics

Every revision of every design was developed with both the function and look of the product in mind. Therefore, once the function has been incorporated into the design, the aesthetic appeal of the product is the next area of importance.

Aesthetic appeal is important due to the nature of selling consumer products. Consumers value the visual appeal of a product when deciding on purchasing the item. The products developed for this project feature an elegant and bold look. The shape and size of each design was generated to achieve the desired appearance. The solid design motif serves as a competitive advantage for our products.

During the design process, the shape and size of each concept was carefully selected with the overall appearance in mind.

7.3. Design for Machinability

The third consideration made during the detailed design phase of the project is machinability. The machinability analysis keeps the aesthetic and functional features of the product in check with the cost of manufacturing these features. The general category of machinability includes machining time, material holding and fixturing, and the tolerance placed on the geometric features of the component. Material selection is also a concern of machinability. Material selection was previously discussed in the Concept Development section.

The machining time of a part is based on the complexity of the geometry, the amount of material removed, and the number of setups required to machine all of the features of the part. During the detailed design process, the ease of machining was, considered by the designer, and estimated by consulting with experts.

The means of holding the raw material and the in-process components is also a consideration of the detailed design process. While designing a part, understanding how the part will be held in the machine, will prevent the designer from including features that are not feasible to machine.

The tolerances placed on the geometric features of the component will affect the machining time of the part. The tolerances specified by the designer on the engineering drawing should represent the widest range possible to maintain the functionality of the product.
8. Concept Selection & Feasibility Assessment

Concept selection and feasibility analysis were important phases of this project. It was critical to be able to systematically select the concepts that would be developed in further detail. There are limited resources for developing, prototyping, and manufacturing product ideas. This requires that a select few concepts continue through each stage of development. Structured and informal selection and evaluation techniques allowed the team to focus on the concepts that have the best chance of success.

Concept selection is the process of narrowing down a broad list of concepts with respect to customer needs and attributes by comparing the relative strengths and weaknesses. One or more concepts are selected for further testing and development. Feasibility Assessment is also performed during this stage. Feasibility assessment refers to eliminating designs that are not feasible according to schedule, economic, technical, or resource constraints.

8.1. Methods of Concept Selection

The following concept selection methods were used to narrow down the list of initial concepts that were developed during brainstorming activities.

- **External decisions**: Concepts are presented to the customer for their selection. The customer suggested that the project team continue the development of the concepts that were currently manufactured by the Brinkman Lab.

- **Product Champion**: An influential member of the group chooses a product personal preference. Several team members voiced opinions positively and negatively toward some concepts. Although, their opinions did not automatically affect the status of a concept, it did influence other selection decisions.

- **Intuition**: When one concept just seems better. This method does not take into consideration any criteria or trade-offs. Some of the ideas developed in the early stages of concept development made sense to be developed further.

- **Multivoting**: Each member of the team votes and the concept with the most votes is chosen. This method was used right after the brainstorming to narrow down the long list of product ideas to a manageable list of concepts.

After this initial selection process, the narrowed down list was developed to the stage of preliminary engineering drawings. At this point, a structured concept selection method was used to choose the potentially most successful ideas from this group of products.
8.2. Structured Concept Selection

The purpose of a formal discussion and documentation of concept selection is to carefully compare each product concept against the performance attributes and to compel the group to carefully consider each concept against these metrics. There are two stages of the concept selection process. The first step is to screen out obviously inferior concepts. This step is used to produce a few viable alternatives. The second stage involves the scoring of alternatives. This stage is a more careful analysis of concepts to choose the most successful product concepts.

During the development of the engineering drawings, several versions of some of the concepts evolved. The Pugh’s method was used to screen out the less desirable versions of the concept drawings. This method was performed on the Business Card Holder and the Bookend concept variations. The results of the Pugh’s method analysis are shown below.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>S-Curve Front Bookend</th>
<th>Angular Design Bookend</th>
<th>Curved Design Bookend</th>
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<td>+</td>
</tr>
<tr>
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<td>0</td>
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<tr>
<td>-Unique Design</td>
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<td>0</td>
<td>+</td>
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<td>Functionality</td>
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<td>0</td>
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</tr>
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Table 1. Pugh’s Method Design Selection for Bookends.
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<th>Baseline - Original Card Holder (Vertical)</th>
<th>Straight Ball Bearing Card Holder</th>
<th>Two-piece Horizontal</th>
<th>Trapezoidal Card Holder</th>
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Table 2. Pugh’s Method Design Selection for Business Card Holders.

The concept selection method used for this project was the weighted comparison method. This method uses a rating scale for measuring the importance of the design attributes for each concept. The first step of this method is to define the attributes that each concept will be measured against. The relative importance of each attribute is evaluated using the Attribute Importance Matrix shown in Table 1. The matrix totals the results of pair-wise comparisons of all attributes. The result is a relative weighting on a scale of zero to one.

The attributes used for analysis were chosen by the group to represent the decision criteria to eliminate the concepts. The attributes used for measuring feasibility of the concepts were estimated sales–cost ratio, manufacturability, estimated sales volume, sufficient design and production skills, sufficient number of production personnel, overall aesthetics of the design, and survey data support. However, the skills and number of personnel metrics were later found to have little relative importance compared to the other attributes.
### Attribute Importance Matrix

<table>
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<th>Estimated Sales Volume</th>
<th>Sufficient Number of People</th>
<th>Survey Data Support</th>
<th>Estimated Sales - Cost Ratio</th>
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**Table 3. Relative Attribute Importance Matrix**
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Table 4. Concept Selection and Feasibility Assessment.
Table 5. Concept Selection Radar Chart

The Attribute Importance Matrix yielded the weights of each of the attributes. These weightings were used in the concept selection table, Table 3. The baseline concept for this analysis was the existing two-piece business card holder. This card holder was being produced at the rate of about 50 units per year for distribution as “give-aways” by the ISE department.

The ratings are based on a scale of 1 to 5, where a value of 5 represents a high rating. A score of 3 represents a comparable value of the attribute to that of the baseline concept. The attribute ratings are multiplied by the relative weights calculated in Table 4 and summed. The design concepts are then ordered by their ranking.

The top six products according to this analysis will continue to be developed through the manufacturing and production phases. The designs that were eliminated by this study will be held at the preliminary engineering drawing stage.

If new concept ideas arise, the concept selection process will be repeated and updated to evaluate the standing of the new concepts compared to the existing concepts.

9. Preliminary Design Documents

The preliminary design documents have been prepared for the review of the preliminary design review panel. These documents include engineering drawings, bills of material, and the business plan, all of which are included in the Technical Data Package. These collective documents demonstrate the development and selection activities of the project team. All document revisions, and background research is contained in the Technical Data Package.

9.1. Engineering Drawings

The majority of the products developed for this project were developed using CAD software from the early stages of development. These software models and drawings were created, reviewed and revised to generate the current package of assembly and component drawings. The current revision of the engineering drawings are attached in Appendix C.

9.2. Bill of Materials

The Bill of Materials for each product lists all of the raw material, components, prices and vendors required for manufacture of the product.

9.3. Technical Data Package (Project Notebook)

The technical data package consists of all of the drawings, sketches, analyses, and background research produced during the progression of the project.

9.4. Products

From our customer’s point of view, our high end products provide an elegant item for use on their desk or elsewhere in their office. The bold, solid design theme will appeal to the technical and functional minded population of RIT. Our low end products will appeal to the whole RIT community and to visitors. These less expensive items will all carry an RIT logo to display collegiate identity and school spirit.

The products listed below are those that were chosen by the Concept Selection Process. These products have complete design documentation, including engineering drawings and a bill of material.

9.4.1. Ball Bearing Business Card Holder

![3-D rendering of Ball Bearing Business Card Holder 04017-092](image)

- Features: Ball bearing or large marble rolls down towards the business cards through the semi-circular groove to hold the cards up. The product is made from machined aluminum and anodized black. An RIT logo is engraved on the center of the base. A logo will be selected from the approved RIT logos found in Appendix D.

9.4.2. Cylindrical Card Holder

Figure 6: 3-D rendering of Cylindrical Card Holder 04017-110

- Features: The cylindrical style card holder is solid aluminum desk accessory with room to hold 50 business cards and has the RIT logo displayed on the front surface.
9.4.3. Picture Frame

![Picture Frame 04017-030](image)

Figure 7: 3-D rendering of Picture Frame 04017-030

- Features: Designed to hold a 4” x 6” picture. Machined from a single piece of aluminum. The finish will either be anodized black, or polished aluminum. The frame will feature an engraved RIT logo. Custom engraving will be possible for an extra cost. Also included are the glass and easel stand back.
9.4.4. Book End

Figure 8: 3-D rendering of Book End 04017-002

- Features: The features of the bookends include two piece aluminum construction with a black anodized surface. Both sides of the bookend features an RIT logo.
9.4.5. Flat Bottle Opener

Figure 9: 3-D rendering of Flat Bottle Opener 04017-020

- Features: The bottle opener features a lightweight aluminum construction strong enough to withstand the forces of opening bottles. The design also includes space for an engraved RIT logo.
9.4.6. Plexiglas Diploma Frame

![3-D rendering of Plexiglas Diploma Frame 04017-041]

**Figure 10: 3-D rendering of Plexiglas Diploma Frame 04017-041**

- Features: This diploma frame features solid clear acrylic construction. The design is sized to fit a 10” x 12” RIT diploma. The front is engraved with an RIT logo. Additional engravings will be at an extra cost.
9.4.7. Injection Molded Concepts

The injection-molded parts that will make up the lower end part of our portfolio are currently in the early development stages. Research is being done in the areas of materials, process parameters, and mold designs. The results of this research will provide an estimate of the capabilities and quality of output of the injection molding process. Based on this analysis, the project team can evaluate the overall success of injection-molded parts. Also, understanding the capabilities of this process will feed into the concept and design generation for this class of products.

The concepts currently under development in the low-end category are magnets, key chains, coasters, and poker chips. These designs will be based on a common design motif, and the scale will be adjusted to match the function of the product.
10. Engineering Models: Hardware and Software

Engineering models are used to represent and validate the detailed designs. Software and hardware models are used to generate more accurate revisions of each concept. These models were also used for market analysis activities, such as survey data collection.

10.1. Prototypes

Prototypes are physical and analytical approximations of the products. They are used for communication of ideas, learning, and integration of components. Physical prototypes are used to investigate geometric issues and unforeseen manufacturing problems. Building prototypes in early stages of product development illuminates issues that need to be resolved. This can significantly reduce the number and cost of additional iterations.

10.2. FEA

A finite element analysis was performed on the flat bottle opener design. This analysis verified that the strength of design was sufficient to withstand the forces involved in opening a bottle. The FEA analysis output document is included in Appendix E.
11. Business Plan

The Business Plan is a separate document outlining the business side of this project. This plan lays out the analyses, forecasts, and recommendations for converting this design project into a profitable business. The intended audience for this document is the client, or investors of the project.

12. Appendix

A. Campus Connections Notes
B. List of Product Concepts
C. Engineering Drawings
D. Approved RIT Logos
E. FEA Analysis for Bottle Opener

References:


A. Campus Connections Notes

MEETING WITH CAMPUS CONNECTIONS
01/15.2004
John Roman and Ellen ??

Action Items:
- Evaluate concept designs/ prototypes in terms of:
  1. Asthetics
  2. Quality level
  3. Expected Sales volume
  4. Expected sales price
- Discuss advertisement options
  1. any publications by Campus Connections?
  2. Contact with admissions/ co-op office
  3. website
- Volume ordering
  1. their inventory policy
  2. order quantities
- Discuss official/approved RIT logos

Concept Designs:

Card Holder
- Needs to be more polished and shiny
- Logo should stand out more
- No sharp edges
- Anodized one not as ‘classy’
- Wide angle on the sides looks better
- The horizontal design is nicer, would sell more (most cards are horizontal)

Retail Price: $9.95
Their buying price: $4.50- $5
Quantity to be sold: 24 or 36/yr

Book End
- Not a big seller (existing wooden one is sold as a set has a laser engraved seal)
- Double the size of the prototype

Retail Price: $19.95 (set)
Their buying price: $10
Quantity to be sold: 6 sets

Desk Clock
- Looks bulky, needs to be smaller about ¾ of current height
- RIT logo on the bottom plate
• Clock size should be small, maybe as big as the logo diameter
• One option can be to have the Rochester Institute of Technology written around the clock face
• Clock mechanism has to be a decent one
  1. not brake in a few weeks
  2. easy to change the battery, have it similar to the current one where the front face comes out
  3. clock mechanism has to be made out of good material, shouldn’t look cheap (current ones sell for: acrylic-$15, marble-$40, cherry wood-$65)

Retail Price: $15.95-$20
Their buying price: $8-$10
Quantity to be sold: 12/yr

Pen Holder
• Very poor seller, people don’t use them anymore, especially young people don’t use them
• They have a marble and a wood one, they sell 2/yr

Picture Frame
• Current one is silver in 2 sizes: 4X6 and 5X7
• Current ones not a big seller, custom engraving can be a winner for us but Campus Connections doesn’t want to be involved in the logistics of it. All they can do is give the address for CIMS and have them bring the receipt with them (that should be an advantage for us, since engraving cost would be included in our price, if they don’t bring it for engraving, we can make more money)
• ‘Class of 2004’ should only be put on custom made ones, otherwise left over product??

Retail Price: $10-$25
Their buying price: $5 $10
Quantity to be sold: 12/yr (maybe 6 with graduation year)

Bottle opener
• the long thin ones come with many different designs and they are mostly given away
• the flat design is nice, ones with tiger head and tiger design would sell
• current one, ‘Bev key’ is smaller than our design

Retail Price: $5.95
Their buying price: $3
Quantity to be sold: 50-100/yr

Advertisement Options:
• Campus Connections have a brochure, but 4 vendors contribute for the publication for advertisement purposes
• Website is a good idea
• Depending on the product they have worked with admissions in the past. Ex. Sometimes they combined orders to get a discount. Otherwise admissions gets it outsourced

**Volume/ Ordering**

• If consignment purchase they are willing to order all 36 (as an example) at once, otherwise they would buy 6 at a time until the product holds
• They keep small quantities of inventory in the back room, more quantities with bigger sizes are kept in the storage in the basement
• She has limited display are, large items can be a problem

**Logo Requirements**

• They gave documentation on already approved logos
• Anything other than that will need to be approved, John Roman will help us get them approved
• If we decide to sell them outside RIT, a fee needs to be paid to Campus Connections (hence RIT) for using their logos.

**Additional notes:**

• Plastic key chains: volume about 50-100/yr, retail price about $3.95
• Metal magnets: good seller, retail price $5.95
• High volume sellers are mugs, key chains, glass ware
• Steel window-scraper would be a big seller. Seasonal sales are about 36. plastic one 8-9inches long sells for $1.95, but not a good design.
B. List of Product Concepts

- Ball Card Holder
- Picture Frame/Diploma Frame
- Tiger Bottle Opener
- Desk Clock
- Rings
- Letter Opener (sword-type)
- Pen/Desk Combo Set
- Wall Clock
- Tool Kit
- Metal Clip/Paper Holder
- Freshman Survival Kit
- Storage Lock Box
- Lamps
- Door Stop
- Pin
- License Plate Frame
- CD Case
- Glasses Case
- Name Plaque
- Portable Card Holder
- Key Chains
- Paper Weight
- Two Metal Strip Picture Holder
- Money Clip
- Photo Album
- Necklace
- Cup-Style Pen Holder
C. Engineering Drawings
D. Approved RIT Logos
E.  FEA Analysis for Bottle Opener

Top View:

Bottom View: