Desktop Manufacturing

Educational Products & Services

Entrepreneurship and New Ventures- Prof. Santinelli

Fall 2009
Engineering Education is in Trouble

- Declining Enrollment[^1]
- Low Retention – 56%[^2]
- Decreasing practicality of in-class lecture learning[^3]

Educational Foundations (ASEE, NSF, PLTW, ASME, IEEE, NAE, NAS, ABET, NCSSSMST) have been pushing for changes in engineering education for years. \cite{1} \cite{2}

One of the ideas proposed to is to incorporate project based learning (PjBL) \cite{3} \cite{4} \cite{5}

\begin{thebibliography}{5}
\bibitem{1} WA Wulf "The urgency of engineering education reform" the New Paradigm for Engineering Education, 1998
\bibitem{2} Lr Lattuca, Pt Terenzini, Jf Volkwein Engineering Change A Study Of The Impact Of Ec2000, Baltimore, Md: Abet Inc, 2006
\bibitem{3} LP Maletsky, RD Hale "The Practical Integration of Rapid Prototyping Technology into Engineering Curricula
\bibitem{4} J. S. Lamancusa, J. E. Jorgensen, and J. L. ZayasCastro, The learning factory - a new approach to integrating design and manufacturing into the engineering curriculum, J Eng Educ 86(2) (1997), 103-112
\bibitem{5} Wingspread Group on Higher Education, An american imperative: higher expectations for high education, Racine, 1993
\end{thebibliography}
Solution: PjBL

- Provides Perspective on lecture
- Ownership of project engages students
- Better prepares students for careers
- Allows students to share hands-on learning experiences

Chart Source: http://www.profoundlearning.com/Content/EducationSolutions/projectBasedLearning.jpg
Business Concept

Desktop Manufacturing (Us)

Influence Design & Purchase of user-friendly computer-aided manufacturing (CAM) software

Develop low-cost CNC machines made abroad

Sell/Lease our CNC machines with accompanying software and curriculum to high schools and universities worldwide

Work with Engineering & Science Educational foundations/organizations, as well as schools to promote Project-Based Learning
CNC Manufacturing Process

1. Model Generation
2. Toolpath Generation
3. Finished Part
4. Machining Process
Low Cost Desktop CNC

Cheaper: $800 compared to ~$3000\(^1\)[2]

- Lower precision and accuracy: .005” instead of .0005”

We will offer curriculum supplements and guides with our products:

- Lab guides, testing procedures, handouts, administration suggestions
- This will assist educators in implementing the software and CNC mills

Why?

- Engineering professors are incentivized to research not to teach.
Market Study

Educational Institutions: High Inertia

Students: Low Budget, Space Concerns

Hobbyists: Small market, Low Budget

Design firms: High Budget, Low time
Customer Value Proposition

Value
- Provide schools with marketing asset
- Adding value to education
- Improving the manufacturing industry form the ground up

Benefits
- Improve student enrollment/retention rate for schools
- Provides marketable skills to engineering students

Attributes
- Easy user interface, students can easily get their models made
- Provide curriculum suggestions to faculty
- Offer product support and maintenance
Number of Engineering Undergrads and High School Students

![Graph showing the number of engineering undergrads and high school students by region.]

- **Asia**: Total engineering undergrads = 4,500,000
  - Engineering High School: 2,500,000
  - Total engineering undergrads: 2,000,000

- **Europe**: Total engineering undergrads = 2,000,000
  - Engineering High School: 1,000,000
  - Total engineering undergrads: 1,000,000

- **North and Central America**: Total engineering undergrads = 500,000
  - Engineering High School: 500,000
  - Total engineering undergrads: 500,000

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**National Science Foundation** – Figure 2-34 [http://www.nsf.gov/statistics/seind08/c2/c2s5.htm]
Engineering Student Degree Breakdown

38% Could use our services

Course Machine Requirement

Case of Boston University

- ENG ME 345 Automation and Manufacturing Methods: 4 machines, 40 enrollment
- ENG ME 312 Fundamentals of Engineering Design: 9.9 machines, 99 enrollment
- ENG ME 311 Engineering Design Using CAD: 5.9 machines, 59 enrollment
- ENG ME 305 Mechanics of Materials: 8.1 machines, 81 enrollment
- ENG ME 303 Fluid Mechanics: 3.8 machines, 38 enrollment
- ENG ME 302 Engineering Mechanics II: 6.1 machines, 61 enrollment
- ENG EK 301 Engineering Mechanics I: 4.2 machines, 42 enrollment
- ENG EK 156 Design and Manufacture: 5 machines, 50 enrollment

Range of 5-20 students per machine depending on school analyzed

Source: http://www.bu.edu/eng/facts/
Available Market for Machines

Available market = 327000 × $800 = $261 million
Aiming for 20% market share in 5 years, assuming a 5-year product life cycle.

<table>
<thead>
<tr>
<th>Year</th>
<th>Annual Sales</th>
<th>Revenue (million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8,788</td>
<td>$7.0</td>
</tr>
<tr>
<td>2</td>
<td>10,546</td>
<td>$8.4</td>
</tr>
<tr>
<td>3</td>
<td>12,655</td>
<td>$10.1</td>
</tr>
<tr>
<td>4</td>
<td>15,186</td>
<td>$12.1</td>
</tr>
<tr>
<td>5</td>
<td>18,223</td>
<td>$14.6</td>
</tr>
<tr>
<td>Total 20% Market Share</td>
<td>65,398</td>
<td>$52.3</td>
</tr>
</tbody>
</table>
Competition

- Minitech Machinery Corp
- Denford
- CharlyRobot
- Labvolt
- Tech Ed Systems
- Pasco
- MaxNC

Price of cheapest machine (USD)

Number of Different Products Offered

Future Growth
The desktop CNC belongs to the low volume manufacturing industry

- $2 billion annual revenue
- 20% annual growth rate

### Porter’s 5 Forces

<table>
<thead>
<tr>
<th></th>
<th>Favorable</th>
<th>Moderate</th>
<th>Unfavorable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Threat of new entrants</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Bargaining power of buyers</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Threat of substitutes</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Bargaining power of suppliers</td>
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<td>X</td>
<td></td>
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<tr>
<td>Intensity of rivalry</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

NONE of Porter’s 5 forces are considered favorable, indicating the sustainability of this venture is limited.
Critical Risk Factors

- Slow adoption of idea that engineering reform is needed.
- Schools not having enough funds available to invest in new programming.
- User misuse/abuse would affect products’ reputation & require high support.
Critical Success Factors

- Partnering with a PjBL Organization such as Project Lead The Way
- Establishing an early partnership with one or more universities, educational foundations, engineering firms, and large institutional donors.
- Offering curriculum guidance that encourages use of the products
- Getting a suitable manufacturing partner to make the CNC machine at a competitive cost
- Low cost encouraging high product redundancy
Potentials for Growth

- Adding additional products
  - Different types of machines and accompanying software (Routers, Lathes, Presses, RP Machines)

- Complete K-12/HS/University curriculum development

- Building low-price high-quality CNC machines for sale to the general market (Dental, Hobby, Personal, Designers... )
Our Decision

Can we do it – YES
Is it worth doing – YES
Should we do it – NO

NO...GO