Lessons I Learned in

Timothy W. Simpson
Director, Learning Factory (2007-2012)
Professor of Mechanical & Industrial Engineering
The Pennsylvania State University, University Park, PA 16802

ASME Ben C. Sparks Medal Presentation
2014 ASME International Mechanical Engineering Education Leadership Summit
March 14, 2104 San Juan, Peurto Rico
The Learning Factory

LF founded in 1995 to meet industry needs

- Established with $2.5M grant from NSF/ARPA Technology Reinvestment Program

- Won 2006 NAE Gordon Prize for Innovation in Engineering Education

L to R: Jens Jorgenson (UW), Jose Zayas & Lueny Morell (UPRM), Al Soyter & John Lamancusa (PSU)
LF expansion doubled our footprint in 2007
Yet departments started leaving the program
Lesson 1:
A capstone program is more than a building
**Challenge:**
Develop efficient staffing model to provide best quality of care to patients

**Approach:**
- Review staff utilization reports
- ANOVA of demand vs. # patients
- Redesign staff modeling for demand
- Observe patient overflow practices
- Value stream mapping of layout
- Gather travel frequency data
- Study relationships/adjacencies
- Systematic layout planning

**Result:**
Reduce travel time between ED and radiology by 80%
**Challenge:** Design a device that can capture human energy while walking

**Result:** PZT plate that can clip onto the bottom of a shoe so that the pressure of walking generates electricity
Lesson 2:
Understand what “authentic” and “hands on” mean to other disciplines/departments
Team of project coordinators is key to success
Lesson 3: *Coordination at the college level, control at the department level*
Faculty select projects and form their teams
Learning Factory - Sponsors - Kick-Off

The Project Kick-Off Meeting happens the first week of the semester and is the official start of the project. Please see Important Dates to find out when and where the next Kick-Off is being held.

During the Project Kick-off, sponsors get to display and "sell" their projects to the students who will be picking from among 50-60 such projects each semester. Every student will receive a copy of the Project Description that is provided when each project is submitted.
Lesson 4:
Standardize as much as possible, but be flexible
Standard and non-negotiable IP & NDA forms

<table>
<thead>
<tr>
<th>Year</th>
<th>NDA Forms</th>
<th>IP Forms</th>
</tr>
</thead>
<tbody>
<tr>
<td>FA06</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>SP07</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>FA07</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>SP08</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>FA08</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td>SP09</td>
<td>9</td>
<td>17</td>
</tr>
<tr>
<td>FA09</td>
<td>13</td>
<td>19</td>
</tr>
<tr>
<td>SP10</td>
<td>31</td>
<td>36</td>
</tr>
<tr>
<td>FA10</td>
<td>17</td>
<td>45</td>
</tr>
<tr>
<td>SP11</td>
<td>37</td>
<td>45</td>
</tr>
<tr>
<td>FA11</td>
<td>32</td>
<td>22</td>
</tr>
<tr>
<td>SP11</td>
<td>32</td>
<td>17</td>
</tr>
<tr>
<td>FA12</td>
<td>21</td>
<td>17</td>
</tr>
<tr>
<td>SP13</td>
<td>38</td>
<td>32</td>
</tr>
</tbody>
</table>
Lesson 5:
Move beyond a “widget judging” contest
Judging Criteria

• **Technical Content (0-15 pts)**
  – Did the team approach the problem in a way that is consistent with the disciplinary expertise of its members?
  – Was appropriate modeling, analysis, and/or testing used to help identify and refine solutions?
  – Was the team creative in their solution and/or approach to the problem?

• **Customer Satisfaction (0-15 pts)**
  – Does the project solution directly address the customer's stated objectives (is the solution appropriate)?
  – Does the project solution meet/exceed customer's expectations (is the customer satisfied)?
  – Did the team demonstrate improvements in product/process quality or cost/time savings?
Judging Criteria

• **Project Management** (0-10 pts)
  – Is there evidence of strong team work and good communication among team members?
  – Did the team acknowledge and stay within design constraints (e.g., budget, schedule, cost)?

• **Oral Presentation & Display** (0-10 pts)
  – Did the oral presentation clearly convey the necessary background, approach, results, and recommendations?
  – Did the team's display (poster, simulation, prototype, etc.) clearly describe the technical project and solution?

• **Other** (5 pts)
  – Other noteworthy aspects not covered above that add value to the project quality and/or completeness?
Lesson 6:
Know your audience – your value proposition varies
Different people value different things

- Students
- Faculty/instructors
- Project Coordinators
- Administrative Staff
- Technical Staff
- Program Coordinators
- Department Heads
- Associate Deans
- Dean
- VP Research / Education
- Provost
- President

- Intellectual Property Office
- Industrial Research Office
- Sponsored Programs
- Technology Transfer
- Development
- Risk Management
- General Counsel
- SBDCs/Ben Franklin
- Economic Development
- Outreach/Engagement
- Industry Partners
- Project Sponsors
Lesson 7: Everyone needs to have “skin in the game”, sharing the costs and the rewards
Project sponsorship model

• Sponsor donates $3000 per project
  – $1000 goes to team for materials and travel
  – $500 goes to LF for events and promotions
  – $1500 goes to Dept to support facilities, equipment, faculty, etc.
  – Additional donation of $500 each for IP and NDA (optional)

• Industry provides liaison to work with team
  – Weekly telecons, site visit, 2 events at PSU (1-2 hrs/wk)

• College of Engineering covers:
  – LF staff support (2): admin asst and LF supervisor
  – 50% buy-out for Director + 1 month of summer

• Departments cover faculty and their facilities
Lesson 8:
Enhance your “design readiness”
Many factors contribute to “design readiness”
Learn from others to improve your “readiness”
Baobab processing project fabricated in LF
Challenge: Develop a device to help process baobab in African villages

Result: Machines deployed and in use in villages in Togo and Benin
Lesson 9:
Strive for multidisciplinary *projects*,
not multidisciplinary *teams*
70% of teams engage 2 or more disciplines/project
provides support for multidisciplinary capstone projects for aid people with disabilities
Doris Duke Creative Campus Project

- World premiere of *Transit Space*
- Student performances involving:
  - Architecture
  - Landscape Architecture
  - Engineering
  - Performing Arts Center
  - Dance
Lesson 10:
Interdisciplinary teams foster innovation
Entrepreneurial/start-up projects have grown

<table>
<thead>
<tr>
<th>Semester</th>
<th># Depts</th>
<th># E-Ship/SMEs</th>
<th>% of Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>FA04</td>
<td>3</td>
<td>7</td>
<td>20.6%</td>
</tr>
<tr>
<td>SP05</td>
<td>3</td>
<td>11</td>
<td>24.4%</td>
</tr>
<tr>
<td>FA05</td>
<td>3</td>
<td>4</td>
<td>11.4%</td>
</tr>
<tr>
<td>SP06</td>
<td>3</td>
<td>6</td>
<td>13.6%</td>
</tr>
<tr>
<td>FA06</td>
<td>2</td>
<td>4</td>
<td>16.0%</td>
</tr>
<tr>
<td>SP07</td>
<td>2</td>
<td>7</td>
<td>21.9%</td>
</tr>
<tr>
<td>FA07</td>
<td>3</td>
<td>6</td>
<td>26.1%</td>
</tr>
<tr>
<td>SP08</td>
<td>3</td>
<td>9</td>
<td>18.6%</td>
</tr>
<tr>
<td>FA09</td>
<td>4</td>
<td>9</td>
<td>22.0%</td>
</tr>
<tr>
<td>SP09</td>
<td>5</td>
<td>9</td>
<td>15.0%</td>
</tr>
<tr>
<td>FA10</td>
<td>6</td>
<td>12</td>
<td>27.9%</td>
</tr>
<tr>
<td>SP10</td>
<td>8</td>
<td>18</td>
<td>23.1%</td>
</tr>
<tr>
<td>FA11</td>
<td>9</td>
<td>33</td>
<td>39.3%</td>
</tr>
<tr>
<td>SP11</td>
<td>8</td>
<td>25</td>
<td>46.3%</td>
</tr>
<tr>
<td>FA12</td>
<td>9</td>
<td>18</td>
<td>30.5%</td>
</tr>
<tr>
<td>SP12</td>
<td>12</td>
<td>37</td>
<td>39.4%</td>
</tr>
<tr>
<td>FA13</td>
<td>9</td>
<td>18</td>
<td>30.5%</td>
</tr>
<tr>
<td>SP13</td>
<td>12</td>
<td>42</td>
<td>40.8%</td>
</tr>
</tbody>
</table>

$r = 0.94$
**Challenge:** Reduce quantity of plastic water bottles that end up in trash and landfills

**Result:** Engineering Prototype

**Engineering & Architecture**
How mechanical engineers do their analysis

CAD Modeling

Structural Analysis
Raised $10M+ in funding and is growing fast
Lesson 11:
Measure what you want to improve; reward what you want to see*

* Paul Silvis, Founder and President, SilcoTek, State College, PA
My metrics for Learning Factory

<table>
<thead>
<tr>
<th>Projects:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Number of industry-sponsored projects</td>
</tr>
<tr>
<td>• Number of interdisciplinary projects</td>
</tr>
<tr>
<td>• Number of international projects</td>
</tr>
<tr>
<td>• Number of solicited and unsolicited projects</td>
</tr>
<tr>
<td>• Number of projects involving other colleges (e.g., IST, Business)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Companies:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Number of companies sponsoring projects</td>
</tr>
<tr>
<td>• Percentage of satisfied or highly satisfied companies</td>
</tr>
<tr>
<td>• Number of industries represented on IAB</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Facilities:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Number of shared facilities available to support projects</td>
</tr>
<tr>
<td>• Number of student projects (e.g., SAE, Spirit Rocker) supported</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Courses:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Percentage of shared course content</td>
</tr>
<tr>
<td>• Number of Departments involved with projects</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Faculty:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Number of internal and external networking opportunities</td>
</tr>
<tr>
<td>• Number of research projects initiated with project-sponsoring companies</td>
</tr>
<tr>
<td>• Amount of externally-funded engineering design and education-related research integrated within Learning Factory</td>
</tr>
</tbody>
</table>
Awards and recognition

• Recognize faculty and staff contributions
  – College-wide awards received by 4 staff
  – Faculty display Best Project Awards

• Recognize industry sponsor efforts
  – Best Sponsor Award
  – Publicize and thank sponsors
  – Provide multiple branding opportunities

• Share the spotlight
  – Project coordinators and faculty recognized at events
  – Associate Dean emcees events
  – Deans and PSU senior leaders invited for keynotes
Industry Partners’ Day

- Dinner & Awards
  - South Annex Gym (in BJC)
  - 612 registered (faculty, staff, students, industry)
  - Awards Ceremony

- Keynote Speakers
  - Nick Deluliis, President Consol Energy
  - Dr. Barbara Korner, Dean College of Arts & Architecture
Lesson 12:
Everyone wants to be part of a success
Success creates a great “engineering fishbowl”

Spring 2014 Design Showcase will feature over 250 design projects from freshmen, sophomores, juniors, and seniors as well as graduate students.
Lessons I learned in the Learning Factory

1. A capstone program is more than a building
2. Understand what “authentic” means to other disciplines
3. Coordinate at college level; control at department level
4. Standardize as much as possible, but be flexible
5. Move beyond a “widget judging” contest
6. Know your audience – your value proposition varies
7. Everyone should have “skin in the game”
8. Enhance your “design readiness”
9. Strive for multidisciplinary projects not teams
10. Interdisciplinary teams foster innovation
11. Measure to improve; reward what you want to see
12. Everyone wants to be part of a success
Come and visit! Next Showcase is May 1, 2014