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Modern Engineering Sandwich: Management, Globalization and Entrepreneurship on Top of Product Development

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Introduction

As globalization leads to an internationally integrated production and consumption of goods, cultural products, and services, local and national identities are challenged. Globalization creates challenges and opportunities for companies providing goods or services. The course discussed in this paper reviews the impact of globalization on the industrial and systems engineering discipline, in a multidisciplinary and multinational context. For engineers to competently operate in a globalized environment, they must understand the context, methodologies content and outcomes. Critical thinking, systems thinking, integration of technical and, professional and business acumen is necessary. Stability requires knowledge about understanding the complexity involved and learning to manage it. The course also deals with: impact on industrial, production, and national systems. It aims to prepare students and giving them skills for solving complex systems, and life-long learning and continuous improvement. Simultaneously, it also intends to provide foundational entrepreneurial education to all engineering students.

Among the multiple and often contradictory drivers of current economies, a few are playing as significant role as the trend towards globalization. Globalization processes imply that not only large companies are becoming global in terms of worldwide distribution of their production facilities, but also that companies must offer an ever changing variety of products to meet customers' taste and preferences in different countries. This aspect of globalization, together with the e-business opportunities, makes it realistic to create new companies that aim at customization and personalization of consumer products and market them around the globe. Global competition, however, places such businesses under continuous pressure, which may lead to failure, unless they can become highly responsive in three key areas of activity:

- Product development and introduction,
- Manufacturing system adjustment (correlated to market-driven changes in volume and product switch-over), and
- Reliable and rapid delivery to consumers.

All these characteristics have to be combined with persistent ability to create, manufacture and deliver products with high quality and at low cost.

Globalization is also driving dramatic changes in the production systems of large companies, which are moving away from mass production methods towards more agile production approaches. Many firms are now striving to offer customers as much variety as it is practical, and to be able to introduce new goods quickly as technology and customer demands evolve. In other words, they have to achieve production agility and high responsiveness in three domains:

- Product design,
- Product manufacturing, and
- Company organization.

The vertical-integration of manufacturing companies effective in the past, is currently being transformed by concepts of virtual corporation and production networks. While such solutions allow enterprises to focus on their core competencies and better define their brands, they also rely quite heavily on collaboration and communication, facilitating reliable flow of ideas and goods. In such context design of supply chains and logistic processes grows in importance.

There are also other trends worth mentioning, in particular in the context of the most recent global industrial recession, such as:

- Growing anti-globalization and protectionist sentiments
- De-industrialization of the highly-developed economies
- Accelerated progress of technologies.

The extended world-wide effects of recession and what is referred to as a "jobless" recovery from it, bring into focus the skills that future engineers should acquire in the course of their studies in order to be successful over the lifespan of their professional careers. A good model to pursue in the curriculum updates or development is a T-shaped profile[1] of a future engineer. How such a profile in terms of educational experience should be achieved, is still a matter of an ongoing debate. For the past decade various efforts have been under way to define what is referred to as 21st Century Skills[2,3] and also align teaching and learning approaches accordingly[4]. Multiple frameworks have been proposed that are well summarized in Fig. 1.

It can be noted (see Fig. 1) that traditional engineering education concentrates on developing students' foundational knowledge, and only recently started paying attention to development of meta-skills (e.g., creative and communication skills), but still poorly connects these two areas with humanistic knowledge. The 21st Century Skills movement also emphasizes the need to develop skills particularly relevant to the following themes of:

- Global awareness
- Financial, economic, business and entrepreneurial literacy
- Civic literacy
- Health literacy
- Environmental literacy.

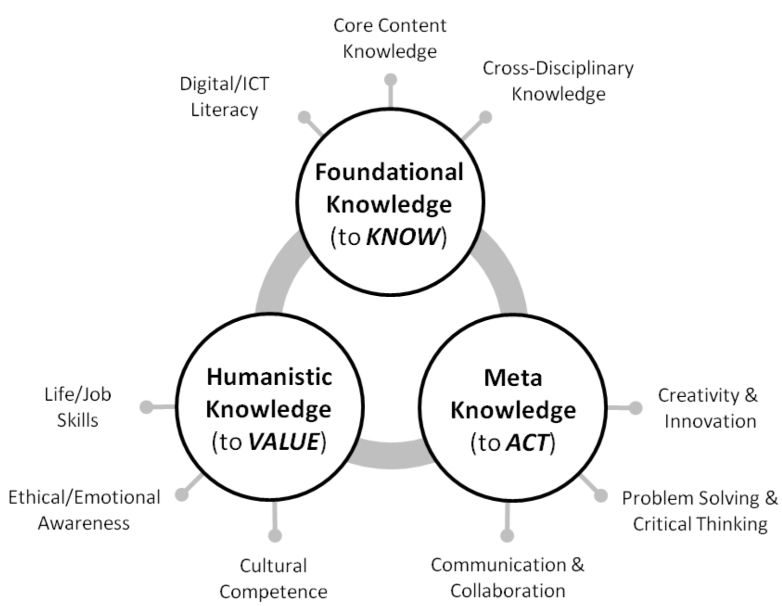

Figure 1 Summary synthesis of multiple 21st Century Learning frameworks[5]

Integrative Product Development Course

The main feature of the discussed course is a semester-long project in which students work in teams. Every team consists of up to 4-5 students, and it is preferred when - whenever possible - each student brings to the team a different background and experience. The team assignment is to create a start-up company offering a new product type that fits mass-customization markets on a global scale (e.g., has potential to be offered on multiple national markets). The team's key tasks are to:

1. Develop initial product idea and its design, including possible product variations,
2. Outline the manufacturing processes and a system necessary to make the product, and
3. Prepare a business plan elements, which cover delivery, organization and cost issues.

The course in its current form is designed to run on 12-week semester schedule typical in Canadian universities. The class meets three times a week: twice for 80-minutes lecture period and for one 110-minutes tutorial session. The content of the course is outlined in Table 1.

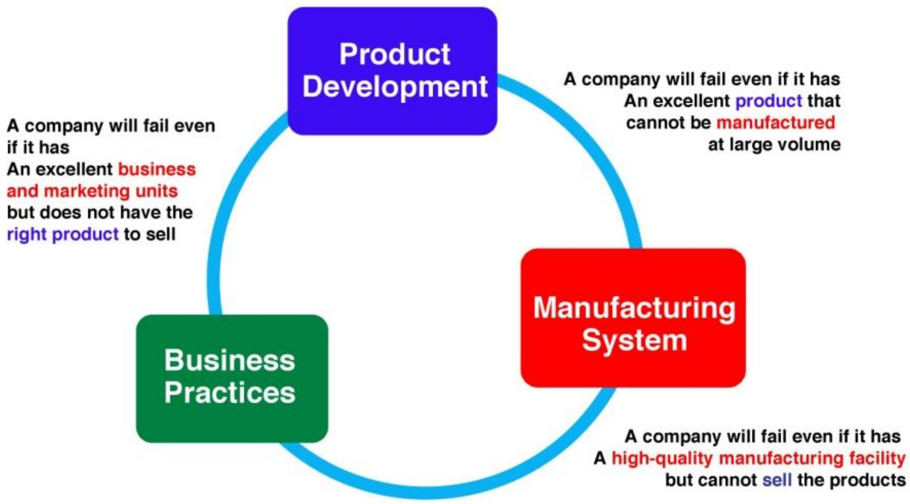

Figure 2 Integration of Product, Process and Business Practices

The course centers around the idea of integration of product development, manufacturing systems and business practices (see Figure 2). Therefore, it adopts a system-based approach, considering not only components (be it machines, processes, or knowledge) necessary in production of consumer goods, but also their interactions and impact on each other. While this idea is perhaps not entirely new, it is also set in context of the current market paradigm of Mass Customization[6,7,8].

Table 1 Abridged Course Syllabus

Week	Subject
1	Course overview and introduction. Engineering in a global world – an overview.
2	***T0:*** *Intro to Learning Mgmt. Syste., Collaboration tools. Team formation. Communication.*
	Business Model Canvas. Guest speaker: Lean Startup Advisor
	Interview skills development. New venture teams and creativity
	Team development: **Scavenger Hunt** with prizes & Tech Mixer party
3	***T1:*** *Creativity & paradoxical products.*
	Ideation UWindsor start-ups. Guest speaker: Creativity expert.
	Product-market fit. Customer discovery.
4	***T2:*** *Design process and tools.*
	Competitors. Unique value proposition. Guest speaker: Local entrepreneur 1.
	Finding info on patents and market. Guest speakers: IP Expert; Business Librarian
5	***T3:*** *Quality Function Deployment (QFD) and Pugh chart.*
	Project Clinic
	Project Review I: Video Pitch Festival.
6	***T4:*** *Introduction to manufacturing. Process mapping.*
	Engineering management. Introduction to manufacturing.
	Manufacturing processes overview. Intro to Cambridge Engineering Selector (CES) software.
7	***Thanksgiving Day*** *(holiday)*
	Manufacturing machines and systems.
	Manufacturing automation. Lean manufacturing. Introduction to Operations Management.
8	***T6:*** *Production capacity, inventory, cost.* **Test I**
	Inventory and EOQ. Quality management. Continuous improvement.
	Estimation. Product lifecycle assessment. Social responsibility.
9	***T7:*** *Lean manufacturing: batch vs. one-piece-flow.*
	Customer experience.
	Customer experience. Intro to 6-sigma.
10	***T8:*** *Resume workshop. Anatomy of a business plan.*
	Business models, plans and strategies.
	Organizational structures of enterprises.
11	***T9: Review II:*** *Product manufacturing.*
	Financial planning. Funding sources.
	Supply chain management. Logistics.
12	***T10:*** *Putting it all together - feature film "The Man in the White Coat"*
	Make vs. buy decisions.
	Marketing essentials.
13	***T11:*** *Product commercialization.* **Test II**
	Cultural awareness and diversity. Finding global customers.
	Human resources, skill sets and workforce. Life-long learning.
14	***T12:*** Project clinic. Course summary & evaluations
	FINAL PRESENTATIONS *(in lieu if Final Exam)*

However, to understand properly the framework of Mass Customization, one has to understand previous paradigms from which it has evolved (see Figure 3). Thus initially, the course reviews evolution of production paradigms and, analyzes their enablers, principles and the essence of the accompanying business models[9]. Mass Customization is presented as a process of producing a wide variety of customized products at mass production cost as a strategy (or a business model) that allows quick response to changes in customer demands. With this background, the course then proceeds to address three primary activities, essential for any manufacturing enterprise: (1) product development, (2) manufacturing, and (3) business and marketing.

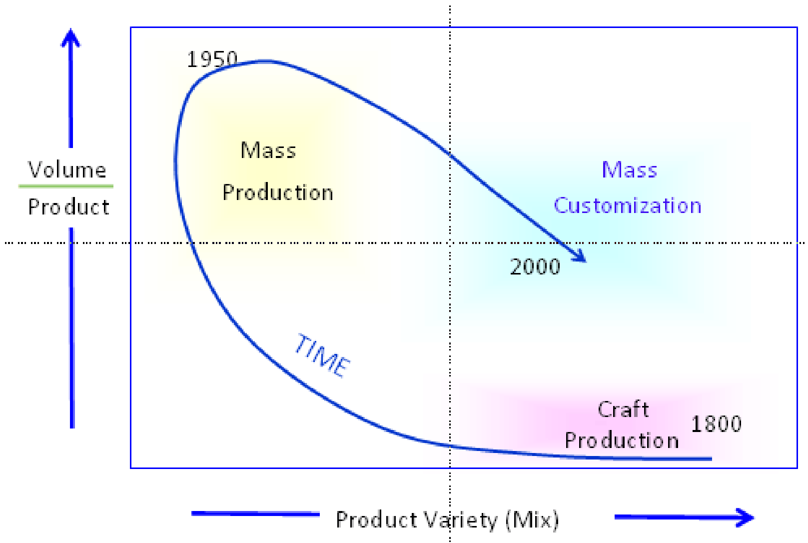

Figure 3 Historical Development of Manufacturing Enterprise Paradigms[9]

Product Development

Product Development is explained as a set of activities beginning with the identification of a market opportunity and continuing with the (i) design, (ii) manufacturing, and (iii) marketing, sale, and delivery of a product. Customer-driven product development plays an important role in the market. Identification of customer needs is continuously performed by all manufacturers. One of the leading methods is based on collection and analysis of customer surveys (students are asked to go through that exercise within the classroom boundaries). While customer-driven development leads to valuable improvements in existing products, the revolutionary products are usually based on breakthrough ideas and inventions that cannot be uncovered though customer feedback. Thus creativity is an indispensable component of strategy in any enterprise. To address that point, a concept of Paradoxical Products is introduced in the class. Paradoxical Products are new products obtained by removing a vital function from an existing product. For example, when a transport function is removed from a bike, a stationary (exercise) bike is created. The students are then required to come up with similar conceptual ideas by themselves.

The product development part of the course is concluded with the discussion of product development process in a start-up company, and a review of the typical phases in any product development:

- Phase 1: Concept assessment (market, product concept, manufacturing, business)
- Phase 2: Conceptual product design and product specifications
- Phase 3: Detailed product design and engineering
- Phase 4: Testing and refinement
- Phase 5: Production preparations.

Relevance of product architecture in the context of Mass Customization is explored on existing product examples. The advantages and drawbacks of product modularity (e.g., commonality vs. differentiation) are discussed in the context of cost-effectiveness and timeliness. The issue of available product variations and resulting implications for manufacturing and supply chain are also covered.

Manufacturing

While primary production paradigms were introduced earlier, this section of the course provides more detailed technical contents on underlying manufacturing systems. It starts with the Mass Production, where standardized products were produced in very high volumes by dedicated manufacturing systems. In mass production a clear connection between the type of manufacturing system and the business model can be established due to the fact that when prices were lowered, more people could afford to buy the products, resulting in more sales, and therefore greater production at even lower costs and lower prices and so on. Discussion of Mass Production systems creates a background for discussion of current practices based on Lean Manufacturing approaches[10], but more importantly, also provides a contrasting example necessary for introduction of manufacturing systems needs for Mass Customization. The advantages and shortcomings of dedicated and flexible system solutions are discussed, leading to introduction of the basic concepts of Reconfigurable Manufacturing Systems[9]. Reconfigurable manufacturing deals with the issue of how to cope with unexpected future changes in product demand, mix, and product type from the manufacturing system perspective. The manufacturing system should be designed to be adaptable to unexpected changes by altering its structure, including the structure of its machines and controls.

The main challenge in covering the manufacturing issues in a class of 2nd year undergraduate students was their relative inexperience and lack of prior exposure to the issues of manufacturing processes and systems. To fill that gap (not to mention also the vast amount of material that may in any case involve the effort to cover these subjects), the instructors have turned to the resources available on the web in the form of books (turned into web pages) from a book series “How Products Are Made”[11]. These materials contain a few thousands examples of manufacturing processes for a variety of consumer and industrial products, illustrated and summarized in a relatively non-technical form.

Business and Marketing: In the final phase of the course focus turns to the business issues. The concept of business models is introduced and defined as a statement of how an idea actually becomes a business that is profitable. The same product or service may be brought to market with several business models. Elements of the business models (see Figure 4) are discussed and analyzed based on examples of actual companies[12]. The corresponding financial concepts, including drivers of financial performance, Return on Investment, etc. are explained, illustrated with current industry data, and interpreted. Students are required to develop elements of a Business Plan for their class project and carry out corresponding (rough and simplified) financial analysis.

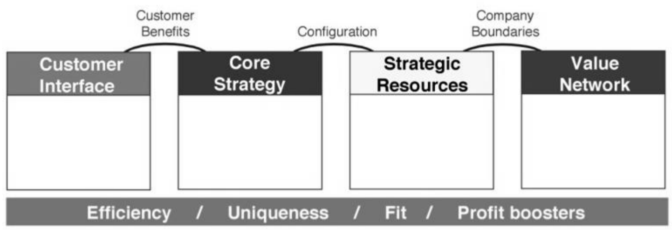

Figure 4 Components of a Business Model and Their Interactions[12]

While in the past offerings of the course a typical approach to developing business plan was adopted, in the F13 it was modified to include recently developed and publicized concepts of Lean Startup[13,14] and Business Model Canvas[15] (BMC). As a result instead of a full-blown Business Plan students were asked to develop an abridged business model using BMC approach and then verify its assumptions by performing multiple interviews with potential customers. An example business model in BMC format is shown in Fig. 4.

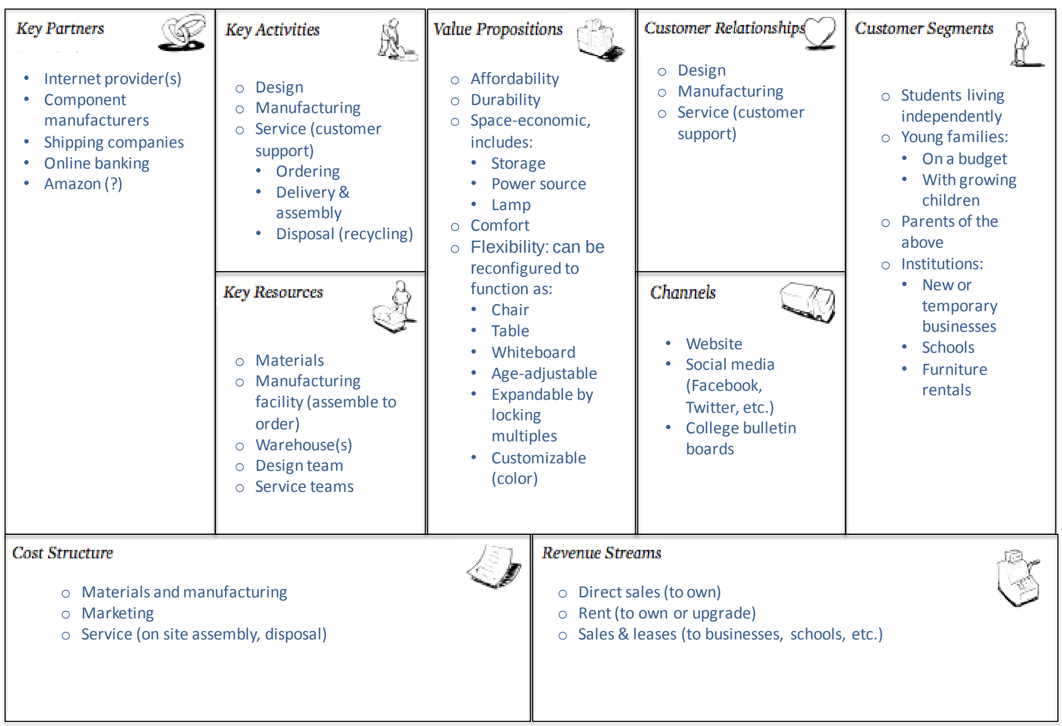

Figure 5 Business Model Canvas (BMC) example: Wri-Table (convertible furniture)

Class Project

Team-based class projects are the primary activity of students' experience and the main basis for final assessment. The primary focus of the student team projects is the Development of a New Product for Mass-Customization. The student team has to:

- Identify a product whose market share could be significantly increased if designed with variations that fit the needs of various customers (i.e., mass customization), and whose price would be attractive if its production is done with a reconfigurable, flexible manufacturing approach.
- Create a company that produces and sells the product. Develop a corporate identity (a name, logo, etc.) and its organizational structure.
- Write a report in the form of a business plan and evaluate the potential profitability of this company. By contrast to business plans offered in business schools emphasize market analysis and finance models, the focus here is primarily on product innovation, product design for mass-customization, and manufacturing systems that can cope with turbulent markets.

In the first part of the project students propose a product, carry out Product Design and perform initial market analysis. They have to describe the product on a fairly detailed technical level (including technical specifications and particular, innovative technologies involved), its advantages over existing, potentially competing products, and how the selected product fits the concept of mass customization. In particular, they have to analyze the number and need for proposed product variations. The market analysis has to include total market value (overall customer needs), the market share expected to be captured, and identification of potential customers.

Examples of products selected by students span a fairly wide range, from products that have low-tech contents, such as, luggage or clothing, to products with high level of technology contents, such as stereo systems or smart automotive mirrors. Other examples of products selected by the students in the past course offerings included wheelchairs, bicycles, special engines, car seats, watches, backpacks, sport equipment, sunglasses, skateboards, office furniture, golf clubs, electronic equipment, and health foods. An example of a product description is shown in Figure 6.

Soccer Club Fan Customizable Alarm Clock

Customers can make a choice between two kinds of shapes: cube or sphere in five basic colors. This customized model shown is customized for specific team fans but it`s case can be painted in the colors of any soccer team in the world.

Main features:

- Radio
- MP3 player
- Night light
- Thermometer

Figure 6 Example of a product concept developed in a student project

In the second phase of the project, teams focus on designing the manufacturing system to make the selected product. This includes a thorough description of the production system, including the various pieces of equipment, discussion of system configurations, floor layout, and estimates of investment costs. For a particular process design, the teams also explore performance specifications of the production facility, such as production capacity strategies and quality issues. The use of outside suppliers is also discussed (in-house vs. outsourced activities), as well as the size and skills of the necessary workforce.

Finally, the teams focus on the development of an overall vision of the company, describing the company growth goal, and the strategies for achieving this goal (strategies in product design, manufacturing, marketing, etc.). They also address product distribution and delivery methods, use of information technology, and financial issues (best and worst case scenarios in sales vs. expenses projections).

The primary challenge faced by the students preparing the outline of business strategies for their potential company is the fact that it is a start-up venture. Therefore, even though they may be fairly familiar on how to design a typical manufacturing facility, development of a strategy that deals with limited resources available for a start-up creates additional, non-technical constraints that they have to consider. The issues of core competencies[7], supply chain management[16] (in-house vs. outsourcing), and risk management come into play. The students also have to understand that start-ups are temporary organizations with high internal dynamics driven by the search for scalable solution to the original product idea.

All the work of project teams is documented in the form of two intermediate and one final report and corresponding presentations in Weeks 5, 11 and Final Presentation (see Table 1). Each team is granted a brief (10 minutes) time slot for its presentation (using a timed peach-kucha style[17]). In the future these requirements will be expanded to include corresponding reports (up to 25 pages for the final report, with intermediate reports becoming part of the final, complete report).

Team Forming and Assessment of Collaborative Efforts

Since the class project is the primary and term-long activity involving students, organization and composition of the project teams plays critical role in the course. Teams are formed at the first class meeting and get to work right away. Students are offered some background on the team organization and roles they may play to help them self-organize and divide the workload within teams. Students should preferably have a variety of backgrounds and come from many engineering specialties (e.g., product design, business/marketing, manufacturing) and have prior work experience.

In the most recent offering of the course (Fall 2013) a new element intended to accelerate the team integration was introduced. The instructional team has developed a Scavenger Hunt, a urban game, in which student teams had to answer multiple questions and locate various university and community resources and landmarks on campus – all within a 2-hour time window (Fig. 7). That effort also coincided with 50-th anniversary of creation of the university under its current name.

Figure 7 Student teams participate in Scavenger Hunt exercise on campus

Innovative Use of Video Materials

Many concepts in class are illustrated with short video clips, most of which come from the largest video depository – YouTube[18]. The instructors believe that use of visual materials, especially in a class consisting of non-native speakers helps them fill the comprehension gaps. Use of existing film materials also assures high quality and well-told stories[19]. As part of the course, towards the end the class a feature film is shown with a storyline emphasizing some of the critical issues highlighted in the course. In the last edition it was "The Man in the White Suit," a 1951 film emphasizing creativity and ethics in the product development activities.

In addition, in the recent offering of the course students were encouraged to create their own videos and also provided with a rudimentary instruction about the video creation process. All student teams were required to produce two videos. The first one was introducing the team and initial product idea. The second one was intended as a promotional material used for commercial purposes and had to be in a language other than English (preferable in the the language of the international market targeted by the team). Students were creating the video materials either as regular video clips (sometimes shot with a cellphone) or transformed their PowerPoint presentations into animated videos using available online tools[20].

Student Feedback

Overall, student response to the course has been very positive. The direct student feedback is collected twice during the course of the class: in mid-term and at the class end. The awareness of students concerns is important, because the open-ended format of the class raises concerns in particular with students who have no work experience and who are not used to course with such structure. Students play an active role in shaping the future course offerings by openly discussing ways to improve the course and its effectiveness. One of the issues brought up repeatedly is the question on how to effectively teach creativity. It also turns out that the most valued and popular class activities are those related to any kind of hands-on activities and exercises which illustrate more complex issues.

The most popular activity by far was a Lean Manufacturing exercise teaching and highlighting the difference between batch and one-piece flow in manufacturing processes. In the exercise each student team was provided with a bag of Lego blocks, from which they had to build small space robots, following strictly provided the required order amount and particular manufacturing process (see Fig. 7).

Figure 7 Hands-on exercise: building robots from Lego blocks

Assessment

The structure of the class to a large extent relies on the problem-based learning approach, where they are provided with only a sketchy initial problem definition (product with mass-customized market appeal) with a potential scenario (start-up) and they have to identify necessary facts (customer needs, technical solutions) and tools (engineering and management approaches), and successfully apply this new knowledge to create a solution. The process is hardly linear (see Fig. 8) and involves many iterative loops.

The primary learning objectives of the course was to expose 2nd year students to the integrative "big picture" of consumer product creation, development and delivery, and provide them with basic understanding of engineering activities required in each phase. Along the way a number of engineering tools necessary to effectively carry out these activities were also introduced (e.g., brainstorming and reverse brainstorming, SCAMPER[21], project management tools, QFD and Pugh chart, process mapping, business model canvas, etc.). Students had to get acquainted with these tools, related concepts and their application. Their understanding on a basic level was tested individually. A team-based use was then requiring effective application of newly acquired knowledge, and the results were provided in the consecutive (partial) project reports. Since the final report was integrative, students also had a chance to improve the final outcome by making revisions based on feedback and observation of their peers.

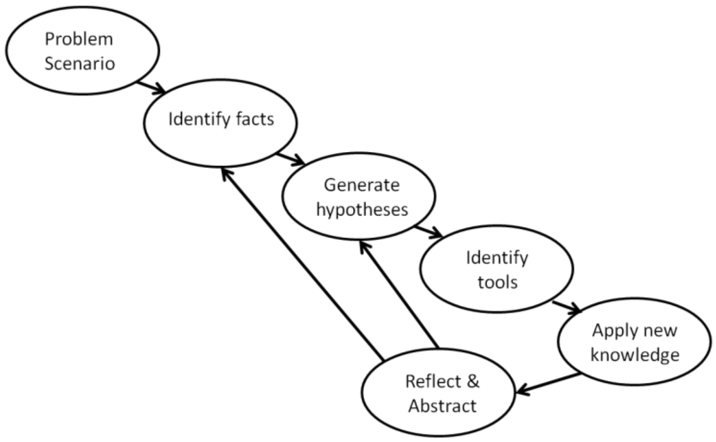

Figure 8 The problem-based learning cycle

Overall, assessment was divided into two categories of performance: (1) individual, and (2) team-based. Forms of assessment are summarized in Table 2.

Table 2 Forms of student assessment

Individual	**Weight**	**Team-Based**	**Weight**
In-class tests (2)	20%	Reports (3)	45%
Homework essays (4)	20%	Presentations (2)	5%
		Videos (2)	8%
		Team Evaluations	2%
Total	**40%**	**Total**	**60%**

Overall, while student were usually lagging on their individual performance, the results of their teamwork were always satisfactory (see Fig. 9).

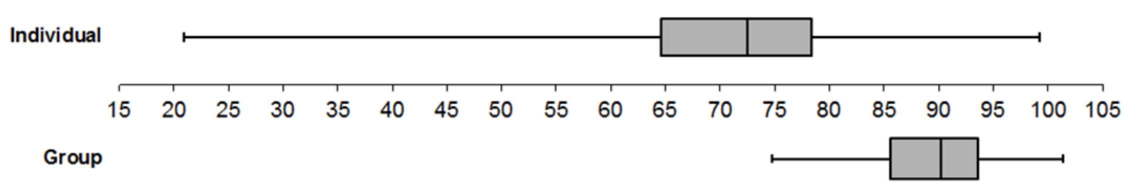

Figure 9 Student performance: individual vs. group-based

The Engineering-Business Integration Experiment

The course instructors have received a small grant from Ontario's Ministry of Education to promote entrepreneurial activities among the youth segment of the population (16-24 year olds). It allowed to support an educational experiment in which an undergraduate business class on Principles of Entrepreneurship and the Engineering Management & Globalization class described in the paper, were carried out jointly for a period of the first 4 weeks of the semester.

The class sizes differed (231 students in engineering and 55 students in business class), but it nevertheless allowed each engineering project team to be joined by a business student. While initially the potential outcome was highly uncertain, the basic assumption was that both student cohorts will be able to establish cross-disciplinary communication, eventually understand each other, and effectively learn from each other.

There were a number of unanticipated challenges, such as incompatibility of class schedules (business students had only 3 lecture hours per week, while engineers had 3 lecture hours enhanced by 2 more tutorial sessions). Only after-the-fact it also became obvious that the experiment should have lasted for the full duration of the semester to reap the full benefits. Nevertheless, despite these challenges, shortcomings and frustrations, students from both groups broadly admitted that it was worthwhile and that direct interactions exposed them to issues they would have never learned otherwise. They also recognized the need for joint team expertise in addressing complexities of product development and launching a new business.

Thanks to available funds from a Ministry of Education grant it was possible to conduct a small scope study of entrepreneurial attitudes among undergraduate students from both business and engineering faculties. The study was designed as a questionnaire survey. The measures used in the questionnaire were adapted from previous theoretical and empirical work, and included the following:

- Trust in teammates
- Opportunity recognition
- Mastery
- Multidisciplinary experiential learning
- Grit (perseverance)
- Learning goal orientation
- Psychological capital
- Creativity
- Interest in entrepreneurship

Table 3 Comparison of attitudes among business and engineering students (responses measured using 5-point Likert scale)

	Business (N=17)	**Engineering (N=120)**
	Mean (SD)	Mean (SD)
Trust in teammate	3.11 (0.479)	3.52 (0.603)
Learning orientation	3.80 (0.998)	3.98 (0.580)
Similarity	3.10 (0.288)	3.08 (0.488)
Psychological capital	3.50 (0.507)	3.63 (0.341)
Conflict approach	3.54 (0.514	3.55 (0.491
Role identity as creative student	3.50 (1.10)	3.50 (0.716
Perceived teammate expectation creativity	3.20 (0.676)	3.18 (0.472
Self views for past creative behaviour	3.29 (0.637)	3.38 (0.395)
Past organizational valuing for creativity	3.19 (0.847)	3.55 (0.564)
Interest in entrepreneurship	2.28 (0.847)	2.23 (0.564)

Questionnaires were distributed in two phases to the students in the classroom, at the beginning and end of joint effort period, where students from both faculties worked together in teams. Initial data analysis was not able to discern significant impact of independent variables on interest in entrepreneurship (dependent variable) using a linear regression model. There were, however, a few interesting findings in the early analysis, such as:

- Female students had higher expectations of creativity from team mates than their male counterparts
- Engineering students had higher trust (statistically significant) in team mates than business students, as the freshmen had over higher year students
- Younger students also exhibited stronger learning orientation than older students
- Students who previously owned a business showed significantly lower interest in entrepreneurship than those who had no prior business experience.
- Students from both groups expressed comparable, but relatively low interest in entrepreneurship.

Summary and Future Work

While the class has been offered since 2009, in its subsequent edition its contents go over multiple revisions and updates. The most recent modification consisted of merging the class (which usually has over 200 students enrolled) for part of the term with a class on entrepreneurship offered by a business school. As a result, each engineering team was enhanced by addition of an undergraduate student from business. Also, considering that class size has grown considerably, thanks to a ministry grant it was also possible to hire 25 student advisors (either senior or graduate students) that were working directly with 3-4 teams each.

As a result of these changes, new patterns in student behavior started to emerge. Presence of business students and senior advisors became a significant motivational factor. Interdisciplinary nature of the teams received natural boost, that eventually led to heightened creativity. Use of the Lean Startup methodology, which requires the participants continuously verify their design and market hypotheses, has also raised awareness among engineering students that in their professional development they need to broaden their scope and add management, communication and entrepreneurial abilities to their skill set.

Acknowledgments

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References

1. Spohrer, J. and Maglio, P. (2010) “Towards a Science of Service Systems,” in Handbook of Service Science, Springer, p. 157-194.
2. Griffin, P et al. (eds.), 2012, *Assessment and Teaching of 21st Century Skills*, Springer
3. Zhao, Y., 2012, *World Class Learners. Educating Creative and Entrepreneurial Students*, Corwin
4. Halpern, D. and Hakel, M. (2003) “Applying the Science of Learning to the University and Beyond: Teaching for Long-Term Retention and Transfer, Change, 35(4): 36-41.Hmelo-Silver, C. (2004) “Problem-Based Learning: What and How Do Students Learn?” Educational Psychology Review, 16(3): 235-266.
5. Kereluik, K. et al., 2013, “What Knowledge Is of Most Worth: Teacher Knowledge for 21st Century Learning,” Journal of Digital Learning in Teacher Education, 29(4): 127-140
6. Pine II B.J. (1999) *Mass Customization. The New Frontier in Business Competition*, Harvard Business School Press, Boston, MA
7. NN (1998) “The Right Stuff. America’s Move to Mass Customization,” Federal Reserve Bank of Dallas Annual Report
8. NN (2002) “A Mass Market of One”, Special Report, Business Week, Dec. 2
9. Koren, Y. (2010) *The Global Manufacturing Revolution*, Wiley, Hoboken, NJ
10. Womack J., et al. (1990) *The Machine that Changed the World*, Harper Perennial
11. <http://www.madehow.com>, accessed on March 26, 2014.
12. Hamel, G. (2002) *Leading the Revolution. How to Thrive in Turbulent Times by Making Innovation a Way of Life*, Harvard Business School Press
13. Ries, E. (2011) *The Lean Startup*, Crown Business, New York, NY
14. Blank, S. and Dorf. B. (2012) *The Startup Owner's Manual: The Step-By-Step Guide for Building a Great Company*, K & S Ranch
15. Osterwalder, A. and Pigneur, Y. (2010) *Business Model Generation*, Wiley, Hoboken, NJ
16. Chopra, S. and Meindl, P. (2010) *Supply Chain Management. Strategy, Planning and Operation*, 4th ed., Prentice Hall
17. <http://pechakucha.org>, accessed on March 26, 2014.
18. <http://youtube.com>, accessed on March 26, 2014.
19. Pasek, Z. J. (2013) “Reel Entrepreneurs: Illustrating Entrepreneurship with Feature Films,” ASEE Annual Conference and Exhibition
20. <http://Animoto.com>, accessed on March 26, 2014.
21. Eberle, B. (2008) *SCAMPER: Creative Games and Activities for Imagination Development*, Proofrock Press