

Leveraging Institute of Technology Incubation Centres in the Teaching of Innovation: A Case Study

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Abstract

The overriding purpose of this on-going work is to contribute to the debate on the best pedagogical approach to developing undergraduate Mechanical Engineering skills to meet the requirements of contemporary complex working environments. The particular focus of this study is to develop the students' appreciation of entrepreneurship and the development of a new venture. Enterprise Ireland has funded business incubation centres on college campuses across Ireland in order to provide a supportive environment for start-up companies and two centres have been located in the Galway-Mayo Institute of Technology (GMIT). The paper provides an example of collaboration between the Incubation Centre managers and a lecturer in GMIT in the teaching of innovation modules to final year students. The methodology of the paper involved a structured questionnaire followed by an interview with the management of the Innovation Hubs (the name given to the GMIT incubation centres). Working directly with the Innovation Hubs is a novel pedagogical approach that fosters entrepreneurial thinking and behaviour among the students. Furthermore key stakeholders (in this case the managers and staff of the Innovation Hubs) have engaged in the learning process. Both managers have been very supportive of the process as it meets their remit to involve the Innovation Hubs with the GMIT campus. The response to the structured questionnaire was positive but also provided suggestions for improving the process. Furthermore, the project supports a targeted action of the Campus Entrepreneurship Enterprise Network program, a partnership between a number of Institutes of Technology and Universities in Ireland.

Keywords: incubation centre, pedagogy, teaching, innovation, education

This paper will provide an example of collaboration between the Enterprise Ireland Incubation Centres at the Galway-Mayo Institute of Technology (GMIT) and a lecturer in Mechanical/Industrial Engineering when teaching product design and innovation to final year students. Enterprise Ireland has funded business incubation centres on college campuses across Ireland in order to provide a supportive environment for start-up companies and two centres have been located in GMIT (Hub, 2014). These Innovation Centres have a twofold objective; to support and facilitate the emergence of new market-led and knowledge-based companies in the region and, forge strategic links between the college and the world of industry and commerce. The Centres, at GMIT Mayo and Galway, offer facilities and a supportive environment to potential entrepreneurs in order to assist them in taking their ideas from concept to full commercialization and are known as the “Innovation Hubs”. The Campus Entrepreneurship Enterprise Network (CEEN) is a partnership between a number of Institutes of Technology and Universities in Ireland (CEEN, 2014). The aim of the CEEN is to create entrepreneurial graduates through a collaborative approach. This paper addresses one of the main objectives of the program namely:

Embedding technology entrepreneurship into Engineering Education through the leveraging of incubation centres and technology transfer offices.

According to Boud and Feletti (1998) “problem-based learning is the most significant innovation in the area of education for the professions in many years” (p. 1). The focus in this type of learning is to provide the students with problem scenarios so that they can learn through a process of action and reflection (Savin-Baden, 2003). However some scholars argue that such subjects as design or innovation “is hard to learn and harder still to teach” (Dym, Agogino, Eris, Frey, & Leifer, 2005). Furthermore organizations, such as Engineers Ireland, are calling for graduate engineers to have more rounded skills in the areas of presentation, communication and team-working (Engineers Ireland, 2013). This paper builds on design thinking (Cross, 2000; Otto & Wood, 2001; Ulrich & Eppinger, 2000) and brings it to a new level by directly interfacing with the innovation centres and simulating a real-life entrepreneur interaction for the students. The purpose of the work is to contribute to the debate on the best pedagogical approach to developing undergraduate skills to meet the requirements of contemporary complex working environments. Consequently the author has developed a seven step process to embed the methodology in the curriculum. The process outlines the interaction between the lecturer and students, the Innovation Centres and the entrepreneurs. Furthermore key stakeholders (in this case the managers and staff of the Innovation Centres) engage in the learning process. Both managers have been very supportive of the process as it meets their remit to involve the centres with the main GMIT campus. Previous publications have focused on the learning process (Costello, 2014b) and the perspective of the students (Costello, 2014a). This paper proposes to make a unique contribution by focussing on the interaction by the incubation managers with the teaching objectives of the Institute. The paper will be structured as follows. Firstly a background to the study will be provided by describing Enterprise Ireland’s incubation centre vision and giving an overview of the Innovation Hubs in GMIT. Then the structured process developed through the collaboration between the Hub managers and the lecturer is outlined. The results of reflection by the lecturer and innovation centre managers will then be presented. Finally conclusions and recommendation for future work will be proposed.

Background

Enterprise Ireland is a government agency responsible for the development and growth of Irish enterprises in world markets and achieving global success (Enterprise Ireland, 2015). According to its annual report, Enterprise Ireland companies achieved a record €17.1 billion in export sales and created 18,033 new jobs in 2013. Furthermore pay and purchases of raw materials and services produced in Ireland accounted for over €20 billion expenditure in the Irish economy. In this section I will look at the rationale and vision behind the Enterprise Ireland incubation centres and in particular the centres in GMIT situated on both the Galway campus and the Mayo campus.

Enterprise Ireland Incubation Centres

Since 1997 Enterprise Ireland has invested approximately €50 million in providing incubation centres to the third-level sector, located in both Universities and Institutes of Technology. This has resulted in sixteen centres attached to Institutes of Technology and four to the Universities. The aim is to encourage the set-up of high-tech, knowledge-intensive enterprises. Currently this translates into over 200 companies employing over one thousand people. Enterprise Ireland aims to support firms that have the ambition to become a high-potential start up (HPSU) with the prospect of growth and to export. Furthermore they encourage prospective enterprises to develop a strategic relationship with the host institution. They also provide a “modern, safe and dynamic work environment” for fledgling enterprises. However it is important to differentiate incubation centres from office rental space. Incubators provide assistance and management services that add value to their client enterprises through an array of business support mechanisms.

Enterprise Ireland outlines the following benefits of basing a new company in a campus incubation centre:

- Access to mentoring on key aspects of business development, such as market research and finance.
- A prestigious address with high quality office space.
- Proximity to research teams in the college and the use of research and development (R&D) facilities on-campus.
- Peer-to-peer learning from other ambitious start-ups located in your incubation centre.
- Access to a pool of students for placements and recruitment.

This paper argues that there are a number of other benefits that include:

- Synergy with students and lecturers when collaborating on business problems and design challenges.
- Contributing the experience of being an entrepreneur to the student population and motivating them to consider entrepreneurship as a career option.
- Building the entrepreneurs network and access to expertise in an area such as engineering which could be outside the entrepreneur’s field of expertise.

Now I will provide a brief history of the GMIT incubation centres.

GMIT Innovation Hubs

As an introduction to this section, let us first offer the following definition of Incubation Centres by Albert, Bernasconi, & Gaynor (2004):

Incubators are places of communication and synergy, making them effective in numerous environments. They enable public and private stakeholders to gather round a common interest. They often are at the crossroads of important networks. They are also places of collective learning not only for the entrepreneurs but also for external stakeholders who come to appreciate the entrepreneurial reality better.

Enterprise Ireland funded two incubation centres in GMIT in late 2005 and mid-2006. Figure 1 shows the geographical location of the two Innovation Hubs- formerly known as the Innovation in Business Centres (IiBC) - one on the Galway campus and the other on the Mayo campus. The funding was provided under the Regional Operational Programmes for the BMW (Border Midland and Western Region) and was co-financed by the European Union Structural Funds. The establishment of the Galway and Mayo incubation centres was part of an overall strategy of building regional innovation capability through Institutes of Technology. Also the Innovation Hubs are located adjacent to the main buildings of the Galway and Mayo campuses.



Fig 1: Location of GMIT Innovation Hubs

The impact of the incubation centres has resulted in sixteen high-potential start-ups (HPSU) and thirty three successful spin-outs. This translates in approximately €63 million being raised by client companies and the creation of over three hundred jobs. The Hubs provide start-up services and business development supports in a number of areas: financial, legal, sales and marketing, strategic planning, mentoring and networking. Furthermore assistance is provided for the development of export strategies and expertise in the provision of Intellectual Property (IP), Patenting, Copyright and Trademarks. A feature of the Galway Hub is that the building has been designed with the incorporation of sustainable energy systems and performs the function of a living lab for research on renewable energy systems. Figure 2 summaries the achievements to date of the GMIT Innovation Hubs.



Fig 2: GMIT Innovation Hubs summary

As well as incubation business units for start-up companies that range from 18 to 60 meters sq., the Hubs incorporate a concept desk facility and virtual incubation services. Facilities

include reception, boardroom, cafeteria, networking area and an IT communications room. In addition the Hubs provide twenty four hour secure access for clients. The business structure of the Hubs has an advisory board, a management committee and a centre manager. The mission of the Incubation Hubs is as follows:

To support the development of New Enterprises in the region by providing incubation space and business development support for the nurturing of new ideas and the commercialisation of applied research.

Now I will outline the structured process developed as part of the collaboration between the Hubs and the lecturer.

Structured Process

Arising from reflection by the lecturer, the product design module taught to the mechanical engineering students can be described in a number of steps which are presented in figure 3 together with the high-level timeline. The process has been distilled from collaboration with entrepreneurs and the Hub managers over a number of years.

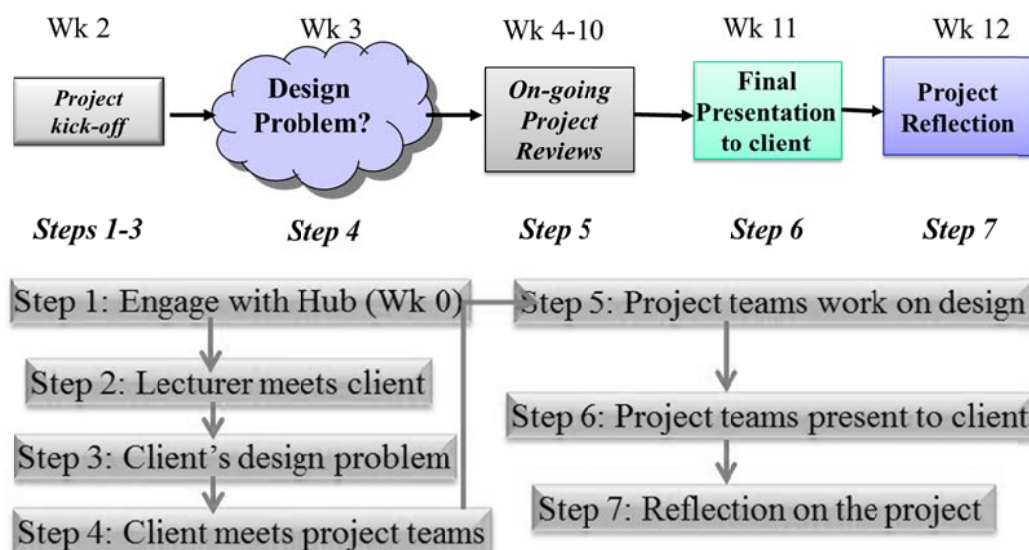


Fig 3: High Level Module Roadmap

Step 1: The lecturer makes contact with the Hub management to establish possible projects in advance of the commencement of the term. The centre administrator contacts all the companies in the Hubs by email outlining the proposed format of the module and enquiring if any company would be willing to take part in the exercise. Another method of engaging with the start-ups was through a networking lunch organized twice per year by the Hub and attended by the lecturer.

Step 2: The lecturer meets with the client to further explain the pedagogical approach and to clarify requirements and deliverables. This is an important stage in developing a relationship with the client at the beginning of a three month interaction. However it is worth stressing that work for the client is kept at a very reasonable amount given the busy workload associated with start-up of a new venture.

Step 3: The client completes a short description of the design problem (approximately half-page) and sends it to the lecturer to review. This draft design brief is made available to the students via Moodle (an on-line eLearning application). The lecturer meets with the class and presents an overview of the module learning outcomes and the structure of the project as well as assessment criteria and expected project logistics. Then the class is divided into project teams (normally three students per team) and they review the draft design problem and prepare for a meeting with the client on the following week.

Step 4: The class project teams meet the client face-to face. The client presents the design problem to the class verbally with more detailed description than in the design brief. This provides an opportunity for the class to get a more in-depth view of the clients thinking and to put themselves in the client's shoes (Leonard & Rayport, 1997). Also the project teams have time to question the client based on their initial week long research into the problem domain. At this stage a date will be set on which each project team will present their design solution to the client at the end of the semester (Week 12). Also issues like Intellectual Property (IP) are discussed at this point and in some cases the students are asked to sign a non-disclosure agreement (NDA).

Step 5: Each week the project teams present a status of their work to the lecturer who in this type of pedagogy acts as a coach and advisor rather than the conventional lecturing mode. The project teams work on the design problem during the semester using academic and industry standard product design methodologies (Cooper, 2001; Eppinger, 2001; Ulrich & Eppinger, 2000). The project teams complete a variety of tasks *inter alia*: a detailed project plan in the form of a Gantt chart, market research, customer needs analysis, developing and sketching design concepts, ranking and choosing of the optimum solution, business case development.

Step 6: The class project teams present their design solutions to the client through oral presentation and a project report. These deliverables include: a full set of working drawings, computer-aided design (CAD) models, detailed target specifications, a human factors analysis of the proposed design solution, computer rendering of the proposed design, and an artefact such as a mock-up of the design in cardboard or other materials. This early development of an artefact is now sometimes called proto-typing in the literature.

Step 7: Reflection and feedback from the students is built into the module review process. In the week 12 class of the module each student is required to do a computer based assessment of their own contribution to the project. The template used for this is based on the lecturer's experience (twenty years as an engineering and management practitioner) of having to complete end of year reviews. Items that the students are required to report on include: the research he/she has carried out, the responsibilities that he/she undertook during the project, the significant contribution, what was particularly innovative in what he/she has done, a development needs assessment, an indicative performance rating, a project evaluation (positives and recommendations for the improvement of the project). In summary the focus in this step is to distinguish how an individual contributed to the success of the team.

Each team project is assessed and the same mark given to all students in a project team. However the reflection of each student in step 7 is given an individual mark.

Now I will proceed to the main contribution of this paper –the reflection by the Hub managers on the process outlined in figure 3 above and in this section.

Reflection by the Hub Managers

There is wide agreement in the literature that *reflection* is critical to meeting the dual mandate of practice based research: addressing a real-life problem through intervention together with the research objective of making a contribution to knowledge (Avison, Lau, Myers, & Nielsen, 1999; Baskerville & Myers, 2004; Coghlan & Brannick, 2005; Davison, Martinsons, & Kock, 2004). Furthermore Cunliffe (2002) has argued convincingly of the need for reflective practice and proposes to “reconstruct learning as reflective/reflexive dialogue” (p.35). Braa and Vidgen (2000) make the salient point that in the course of research, in addition to learning from the research content, there should also be learning about the process of inquiry. The latter point is one of the main objectives of this paper which is being presented as a reflection by the Hub managers on the academic collaboration together with a reflection by the researcher on the *process of reflection* in the study. In relation to this, Coghlan and Brannick (2005, p. 25), drawing from a number of antecedent publications by authors such as Argyris and Mezirow, propose that this “reflection on reflection” results in “learning about learning”. They call this process *meta-learning* which consists of three types of critical reflection:

- *Content reflection*: this is where you think about the issues and what is happening
- *Process Reflection*: this is where you think about strategies, procedures and how things are being done
- *Premise reflection*: this is where you critique underlying assumptions and perspectives

In the Greek tradition and in particular the program proposed by Socrates, Plato and Aristotle, the search for knowledge consisted of pursuing philosophy through dialogue and engagement with the practical. Both Plato and Aristotle saw “philosophy as engaging with practice” (Moran, 2000, p. 268). Indeed Tredennick (1969) points out that Socrates insisted that he was not a teacher but a sort of intellectual mid-wife who helped “others to bring their thoughts to birth”. Socrates did not write any books but instead lead the life of an itinerant philosopher and left us a question and answer methodology that I will use in this section of the paper. Indeed Kraut (1999) says that his “daily occupation was adversarial public conversation with anyone willing to argue with him” (p. 859). Furthermore this unusual approach to an academic paper provides a novel contribution and is proposed as a basis for further examination and debate.

A structured questionnaire was given to the Hub managers and followed up with an interview. The responses are shown in italics. This feedback is important for the lecturer who is continually endeavouring to improve the module content and process year-on-year. To ensure that this study adhered to ethical standards, the managers were asked for consent to use their feedback for research purposes. The managers’ comments are provided verbatim as it is considered that this approach allows the voice of the managers to be adequately heard. Furthermore it was considered that all the comments are self-explanatory.

Q. How does this project collaboration fit in with the strategic objectives of the HUB?

- *Very well. [It] links these students to real world projects and gets them to see what it is like to start-up an enterprise.*
- *Promoters of companies get access to GMIT students and some have resulted in part time and full time jobs.*
- *Fits with the aims of the Innovation Hubs. Our clients are often looking at developing new products and doing prototypes and testing.*

Q. How much did you know about the mechanical engineering programme before the projects started?

- *I had a good idea of what the students would be taught.*
- *Getting the right fit between student and company project is critical.*
- *However have learned a lot over the last few years.*

Q. Have you done a similar kind of project collaboration with other departments in the past?

- *Yes. School of Science and Business, but none as well structured as this.*
- *I like the process flow and steps in this as everyone knows what is next and what is expected etc.*

Q. In what ways do you think we need to improve?

- *Process works very well. Do more projects if possible.*
- *Make sure students leverage this experience in interviews etc. and I think this is happening.*
- *Need to have two way flow of information. Need to get better list of issues from clients and then from students. Need timing to be more open also.*

Q. What problems did you encounter in the logistics and operation of this module?

- *Big thing is managing expectations between Company and what they want to get done versus what the student can deliver in the timeframe involved.*
- *[The lecturer] manages this well for these Mech Eng projects and it is part of the reason why they are successful interactions on several levels – for Company, Student, GMIT, Lecturer, Hub Manager*

Q. What did you learn from this project?

- *Several projects have been completed in the Hub across a number of years with different companies*
- *Interaction and learning experience is maximised due to process steps in setting each project up and on-going reviews during assignment*

Q. Have you changed any ideas you used to have about mechanical engineering or engineers?

- *Validated the very high level of knowledge that the students have from the course and that it can be put to use in a team environment*
- *Important for Engineers to learn communication, inter-personal skills and Leadership, working on their own initiative which these projects give them, to complement and unleash the core engineering talent*
- *Very open to new ideas and helping to solve problems.*

Q. What would you suggest we do differently in future?

- *I want to try and use this student-company model as a foundation to build increased levels of student projects across several disciplines*
- *Just meet more regularly and have a better system in place. Maybe competitions for best design*

Q. Did you receive any feedback from the incubation start-ups that took part in the module projects?

- *Yes. Almost all the promoters and people involved in these projects got value out of them.*
- *It is a vehicle that enables students to get an early taste of industry in a semi-controlled environment where the students have no baggage and the promoters want them to innovate in the start-up enterprise.*

Q. Do academic aims such as peer-reviewed publications have any relevance to the Hub or to external contacts such as Enterprise Ireland?

- *In the extent that they can provide new learning or concepts or ideas then; yes.*

Any other comments

- *[I would encourage you to] use the case study of [Company Name] where the student is now their Product Manager and never had any other job. A win-win for everyone. (Note: This case study is not outlined here and has potential for another paper as part of future work)*

In this section I have outlined the responses from the Hub manager to the structured questionnaire presented to them. The responses were generally positive but they also provided suggestions for improving the process. Now the conclusions of the paper will be presented.

Conclusions

The purpose of this work is to contribute to the debate on the best pedagogical approach to developing undergraduate mechanical engineering skills to meet the requirements of contemporary complex working environments. The particular focus of this study was to develop the students' appreciation of entrepreneurship and the development of a new venture. The paper provides an example of collaboration between the Enterprise Ireland Incubation Centres at GMIT and a lecturer in GMIT in the teaching of modules to Mechanical Engineering final year students. There were a number of learning experiences in this study:

principally by the lecturer (and by extension the students) but also by the incubation centre managers. Additionally, the act of writing of this paper provided a reflective learning experience for the lecturer. The module structure, described here, has embedded entrepreneurial learning in the GMIT department of Mechanical/Industrial engineering. Working directly with the entrepreneur is a novel pedagogical approach that fosters entrepreneurial thinking and behaviour among the students. Furthermore key stakeholders (in this case the managers and staff of the Innovation Hubs) have been persuaded to engage in the learning process. Both managers have been very supportive of the process as it meets their remit to involve the Innovation Hubs with the GMIT campus. The response to the structured questionnaire was positive but also provided suggestions for improving the process. Furthermore, the project meets a targeted action of the Campus Entrepreneurship Enterprise Network program as outlined in the introduction above. Future work is proposed to capture case studies of the impact of the collaboration on the students and on the entrepreneurs.

References

- Albert, P., Bernasconi, M., & Gaynor, L. (2004). *Incubation in Evolution: Strategies & Lessons Learned in Four Countries, France, Germany, United Kingdom & United States of America*. Athens, OH: National Business Incubation Association.
- Avison, D. E., Lau, F., Myers, M. D., & Nielsen, P. A. (1999). Action research. *Communications of the ACM*, 42(1), 94-97.
- Baskerville, R., & Myers, M. D. (2004). Special Issue on Action Research in Information Systems: Making IS Research Relevant to Practice—Foreword. *MIS Quarterly*, 28(3), 329-335.
- Boud, D., & Feletti, G. (1998). Changing Problem-based Learning. Introduction to the Second Edition. In D. Boud & G. I. Feletti (Eds.), *The challenge of problem-based learning*. London Kogan Page.
- Braa, K., & Vidgen, R. (2000). Research: From observation to intervention. In K. Braa, C. Sørensen & B. Dahlbom (Eds.), *Chapter 12. Planet Internet*. Studentlitteratur, Lund, Sweden. Previously published as: Braa & Vidgen, (1999) Interpretation, intervention, and reduction in the organizational laboratory: a framework for in-context information system research, *Accounting, Management and Information Technologies*, Issue 9 pp 25-47. Elsevier Science Ltd.
- CEEN. (2014). Campus Entrepreneurship Enterprise Network available on-line through <http://www.ceen.ie/> accessed October 2014.
- Coghlan, D., & Brannick, T. (2005). *Doing Action Research in Your Own Organization* (Second Edition ed.). London: Sage Publications.
- Cooper, R. G. (2001). *Winning at New Products : Accelerating the process from idea to launch*. New York: Perseus Publishing.
- Costello, G. J. (2014a). *Incubating Engineers: Entrepreneur-student collaboration in the teaching of entrepreneurship to Mechanical Engineers*. Paper presented at the ICSB 2014 World Conference on Entrepreneurship Dublin (Ireland) from June 11th-14th 2014.

- Costello, G. J. (2014b). *Teaching product design through industry collaboration*. Paper presented at the Proceedings of the ASME 2014 12th Biennial Conference on Engineering Systems Design and Analysis ESDA2014 Volume 1, June 25-27, 2014, Copenhagen, Denmark.
- Cross, N. (2000). *Engineering Design Methods: Strategies for Product Design*. Chichester: John Wiley & Sons Ltd.
- Cunliffe, A. L. (2002). Reflexive dialogical practice in management learning. *Management Learning*, 33(1), 35-61.
- Davison, R. M., Martinsons, M. G., & Kock, N. (2004). Principles of canonical action research. *Information Systems Journal*, 14(1), 43-63.
- Dym, C. L., Agogino, A. M., Eris, O., Frey, D. D., & Leifer, L. J. (2005). Engineering Design Thinking, Teaching, and Learning. *Journal of Engineering Education*.
- Engineers Ireland. (2013). Engineers Ireland website <http://www.engineersireland.ie> accessed December 2013
- Enterprise Ireland. (2015). Enterprise Ireland Website <http://www.enterprise-ireland.com/en/> accessed January 9th 2015.
- Eppinger, S. D. (2001). Innovation at the Speed of Information *Harvard Business Review*, 79(1), 149-158.
- Hub. (2014). Innovation Hubs in the Galway-Mayo Institute of Technology available on-line through <http://www.gmit.ie/iibc/> accessed October 2014
- Kraut, R. (1999). Socrates. In R. Audi (Ed.), *The Cambridge Dictionary of Philosophy* (pp. 610). New York Cambridge University Press.
- Leonard, D. A., & Rayport, J. (1997). Spark Innovation Through Empathic Design." *Harvard Business Review*, 75(6 November-December), 102-113.
- Moran, D. (2000). *Introduction to Phenomenology*. London ; New York :: Routledge.
- Otto, K., & Wood, K. (2001). *Product Design : Techniques in Reverse Engineering and New Product Development*. New Jersey: Prentice Hall.
- Savin-Baden, M. (2003). *Facilitating problem-based learning : illuminating perspectives*. Maidenhead: Society for Research into Higher Education & Open University Press,.
- Tredennick, H. (1969). Introduction *Plato: The Last Days of Socrates*: Penguin Classics.
- Ulrich, K. T., & Eppinger, S. D. (2000). *Product Design and Development* (2nd Edition ed.): Irwin McGraw-Hill.