Teaching Innovation through Interdisciplinary Courses and Programmes in Product Design and Development: An Analysis at 16 US Schools

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If innovation is understood as a process of inventing and commercializing new products and services, as a process that incorporates activities from multiple disciplines, and as a process that follows more heuristic than algorithmic rules, then perhaps this process can be taught in an interdisciplinary setting with a strong experiential emphasis, such as product design and development. In this paper, I compare and contrast 14 courses and three programmes in interdisciplinary product development at 16 leading US schools. The overall finding is that while the courses appear similar on a high level, there exists substantial variation in the details. In particular, the way in which multiple disciplines are involved in these courses and programmes varies substantially. Similarly, while a team-based term project tends to be the common element across the courses and programmes, the degree of fidelity to which the products and services are developed varies considerably. Overall, although these courses and programmes tend to be very labour and co-ordination intensive, their success has established the legitimacy of interdisciplinary, experiential product design and development education at leading schools in the US.

Introduction

Innovation is essential in today's business world, both for firms and individuals. More innovative firms tend to be more profitable than less innovative firms (McGregor, 2006, 2007). Recognizing the increasing importance of innovation for economic success, researchers have investigated how firms can organize themselves to become more innovative; marketing and market entry strategies that promote successful innovation; and which product development processes tend to produce more innovative products and services (Hauser, Tellis & Griffin, 2006).

At the level of the individual, innovation-related activities are emerging as a significant part of many job functions. In most developed economies, and increasingly in many developing economies, the share of jobs in services is growing relative to those in manufacturing (Roth & Menor, 2003). Also, in many organizations, work is becoming more service-oriented, more creative and more distributed. Some argue that rather than services in general, it will be creative work in particular that is the winning formula (Florida, 2003), while others observe that creative approaches such as design thinking are finding their way into more and more business processes (Dunne & Martin, 2006; Brown, 2008). Finally, the increasing pace of globalization and decreasing transaction costs – the latter largely due to the digitization of information exchanges and the Internet – have resulted in work processes that are more and more distributed: across firms, continents and cultures (Engardio, 2006).

If being able to innovate and be creative in a collaborative setting has become very relevant

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for individuals, then the question follows: how can these skills be learned and taught? Some have described innovation itself as a constant learning process, that 'moves its participants between the concrete and the abstract worlds' (Beckman & Barry, 2007, p. 29). In the world of higher education, some courses try to create an environment in which diverse teams learn by experiencing the key stages of innovation. A key example where the 'concrete and abstract worlds' are juxtaposed are interdisciplinary courses in product design and development.

The existing literature on higher education courses can be divided into two categories. Some scholars have examined multiple courses and programmes that are taught by a single discipline, e.g., operations management (Goffin, 1998), creativity (Xu, McDonnell & Nash, 2005), or entrepreneurship (Klandt, 2004). Others provide insights into the design of single exemplary courses, e.g., for product design and development courses at Carnegie Mellon University (CMU) (Cagan, Vogel & Weingart, 2003), Massachusetts Institute of Technology – Rhode Island School of Design (MIT-RISD) (Ulrich & Eppinger, 1992; Eppinger & Kressy, 2002), Stanford University and the University of Michigan (Lovejoy & Srinivasan, 2002), Rensselaer Polytechnic Institute (Silvester et al., 2002), and the University of Minnesota (Cardozo et al., 2002). Only two previous studies have looked at how interdisciplinary aspects of product development are taught at different schools (Hustad, 1977; Lawrence, 1994). As these studies are now dated, it is appropriate to understand how product design and development is taught in the 21st century, which this paper strives to accomplish.

Teaching Innovation through Product Design and Development Courses and Programmes

Can innovation be taught? If innovation is understood as the process of inventing, developing and commercializing new products and services, then perhaps this process *can* be taught. This innovation process comprises various activities that are typically taught in individual disciplines (e.g., developing is often taught in engineering courses, commercialization in marketing courses, etc.). Considering that a substantial part of product design and development involves creativity and iteration, it lends itself to being taught in an experiential fashion (Beard & Wilson, 2006). Consequently, the interdisciplinary and experiential aspects of product design and development courses warrant particular attention in this study.

Product Design and Development as an Interdisciplinary Activity

There are many opinions on the various activities that are integral to the product development process, but it is clear that the process encompasses activities from several distinct disciplines such as marketing, organizational behaviour, engineering and operations management (Krishnan & Ulrich, 2001). Most definitions of new product development (NPD) include stages such as product opportunity identification, market and user analysis, idea generation, concept generation, concept refinement and selection, industrial design, prototyping, testing, financial evaluation and market introduction. Broader definitions of NPD also include topics such as market planning, product strategy, product line extension, market forecasting, product abandonment and product liability (Hustad, 1977). Whether one starts with the narrower or the broader definition, it is clear that the activities required for successful product design and development are strewn across multiple disciplines, disciplines that in most educational institutions are organized in separate, specialized units such as marketing, operations, engineering or design. This separation is intentional, since establishing high-level expertise in any one subject requires – at least initially – a strong focus on that individual subject.

The level of competition in most of today's markets, however, calls for a different approach. Successful products and services simultaneously delight customers, are affordable and are available on time. Creating such products is only possible if the entire product design and development process is integrated, and experts from various disciplines form integrated teams (Smith & Reinertsen, 1998). Careful consideration of a team's characteristics, such as its diversity and interests, increases its creative ability to develop better products (Amabile, 1997; DeCusatis, 2008), and it enables the team to approach the development process in a more integrated fashion which in turn helps accelerate development projects (Smith & Reinertsen, 1998). At the same time, while the creative ability of a team can be improved through diversity, this carries the potential to increase intra-team conflict, originating from the differences in thinking patterns and approaches of the different functions and disciplines (Cronin & Weingart, 2007). So it is essential to cover these types of issues in the teaching of product design and development.

Product Design and Development as an Experiential Learning Activity

Product design and development is an inherently creative act: by definition, radical products chart new territory. Most existing product development process models, such as stage-gate or spiral models, involve frequent information updates, and thus need to be flexible and adaptable (Cooper, 1994, 2008), particularly during the early fuzzy front-end phase (Cagan & Vogel, 2002). In other words, while the direction in which to proceed might be clear to the development team, the exact outcome of the subsequent steps is typically not known until feedback information arrives. This situation makes experimentation and prototyping particularly relevant (Thomke, 2003). In fact, Barczak, Griffin and Kahn (2009) find that high-performing firms make extensive use of experimentation. 'Fail often to succeed sooner' is reportedly one of the mottos of the successful product design firm IDEO (Kelley, 2001). In particular, early iterations can accelerate the learning process. In many product development projects, active and early search for problems, and their subsequent solution, tends to improve the project performance (Thomke & Fujimoto, 2000; Sheremata, 2002). More generally, the way in which experiential learning takes place in a product development project has a major influence on the project's performance.

Furthermore, NPD personnel with extensive experience recognize that much of what they have learnt is connected with tacit knowledge (Goffin and Koners, 2009). Since managing product design and development involves tacit knowledge and experience, the implication is that teaching of the subject needs to be based on an experiential approach.

Course List Construction and Data Collection

Data Sample

The starting point for constructing a useful list of current interdisciplinary courses in product design and development in the United States was a list of courses recently compiled by the Corporate Design Foundation (CDF) (2007). The CDF list contained nine product design and development courses that involved multiple disciplines. The next step was to obtain the contact information of the instructors currently in charge of running these nine courses. Following e-mail exchanges and telephone interviews with all of the instructors, each interviewee was asked to recommend other courses fitting the interdisciplinary target profile, and the people developing and teaching these courses. Through this snowball technique a total of 18 interdisciplinary courses were identified. Two of the 18 institutions identified failed to provide the requested information despite repeated requests; hence the final sample consisted of 16 institutions of higher education.[1] Although this study originally targeted individual courses as the unit of analysis, during the interviews it was discovered that two universities (CMU and Northwestern University) had established entire degree programmes around product development, and one (Stanford) formed a Design School as an umbrella for a series of design and product development courses. As a result, the final list includes 14 individual courses and three programmes (Table 1). The individual courses range in length from one to two semesters, are populated by undergraduate or graduate students or both, and use a variety of institutional set-ups such as cross-listing, non-departmental electives, or separate courses for different students in their respective home departments. All courses were established during the past 20 years, with CMU being the first in 1989.

The two degree programmes and Stanford's D-school are focused on graduate students, and offer multiple courses. One degree granting programme, at CMU, requires four pre-set courses (one of which is the Integrated Product Development course at CMU which also appears on the list of individual courses) and four electives, all to be taken in a one-year period. The typical class size in this programme is 30 students. The second degree programme, at Northwestern University, consists of 22 separate courses over a two-year period, with a typical class size of 36 students. In both cases, the programmes are spearheaded by the engineering schools of the respective universities. Finally, in Stanford's D-School, which does not grant degrees, the courses on offer vary from semester to semester, depending on the availability of faculty who come from one of Stanford's seven existing schools. The class size in these courses ranges from 12 to 16 students in small courses to 60–70 students for larger classes.

Data Collection Method

The main vehicle for the data collection process were interviews, some conducted face-to-face, most by phone, ranging from 30 minutes to 90 minutes each, with an average length of about an hour. At each institution at least one key instructor was interviewed, in some cases two or three. In total, 20 interviews were conducted, and the interview data was supplemented with information from e-mail exchanges, websites, syllabi, press releases and journal articles about these courses. I do not claim the sample to be comprehensive, but it does provide a snapshot on the way innovation is taught through interdisciplinary product design and development courses and programmes at 16 leading US schools at the beginning of the 21st century.[2] All of the data were collected in 2007–2008.

Findings

I group the discussion of course and programme characteristics below into three areas: interdisciplinary collaboration, experiential learning and performance assessment (see Table 1).

Interdisciplinary Collaboration

The aspect of interdisciplinary collaboration is relevant in the courses investigated for this study on three levels: course set-up, students and instructors. Concerning the course set-up, at the highest level, the academic disciplines typically involved in teaching these courses are business, engineering and design. Taking a more detailed look, however, reveals substantial differences between the disciplines involved in particular settings. For example, the undergraduate course in product development at Boston University (BU) is really a capstone-type course that runs in conjunction with four 'disciplinary' (or 'core') courses in Finance, Operations, Marketing and IT. Thus, at BU the different disciplines involved are all sub-disciplines of management. On the other hand, the undergraduate course involving students from Babson College, Olin College of Engineering, and Rhode Island School of Design brings together the disciplines business, engineering and industrial design. Some courses combine only two of the three disciplines, for example, business and engineering but not design (e.g., University of Minnesota, University of Pennsylvania).

In business schools, the typical sub-disciplines involved in teaching product design and development are marketing, operations and sometimes organizational behaviour. Within engineering, the sub-discipline most often represented is mechanical engineering, although there are some exceptions (e.g., industrial engineering at Michigan, textile and biomedical engineering at North Carolina State University (NCSU), or computer engineering at Virginia Tech (VT)). Within design schools, the typical sub-discipline is industrial design, although some variations exist here as well (e.g., graphic design at NCSU and Arizona State University (ASU), fashion design at Parsons). Finally, while most of the courses in the sample recruit students from one or more of the disciplines business, engineering and design, some of the courses also include students from other disciplines such as medicine (e.g., University of Minnesota) or law (e.g., Harvard Business School (HBS)).

On the student level, the interdisciplinary collaboration is most apparent in the teams that work on term-long team projects. Team size ranges across the courses from four to ten students, with four to six as a typical team size. The way in which the teams are composed tends to start with the programmes in which the students are enrolled, i.e., their home departments, but other factors are also taken into consideration. For example, in some courses students can self-select into projects by personal interests as long as the high-level interdisciplinary team composition is maintained (e.g., MIT-RISD, Babson-Olin-RISD). In other courses the faculty declares a set of different roles that have to be occupied in each team (e.g., technology/feasibility, viability/business, human values/empathy, and design thinking, at Stanford) and each student selects a role for him/herself irrespective of home discipline. These examples also show that the degree to which students can influence which team they ultimately join varies across the course sample. In some cases it also varies from year to year as some instructors continue to experiment while others have settled on a way to create the teams in their courses.

On the instructor level most of the courses in this study also involve interdisciplinary collaboration. The majority of the courses are taught by a team of instructors. Depending on the number of disciplines involved and the class size, the size of the faculty team shows a wide range. For example, the course at the University of Michigan, which enrols typically 32 students, is taught by two faculty members, one from business and one from engineering, whereas the course at Boston University which enrols 300–400 students each autumn (and 200 in the spring) involves up to 32 faculty members.

One aspect that appears to be extremely critical for the success of these courses, and especially for the smaller ones that have less of an institutional frame built around them, is the way in which the faculty finds ways to collaborate to solve the invariably unforeseen problems, as the following quotes from my interviews with faculty indicate:

> 'We make things up as we go along.'
> 'I trust my co-instructor to be there when things get tough.'
> 'What it takes is committed and aligned faculty.'
> 'Faculty chemistry is absolutely essential!'

More generally, almost all instructors consider a high level of mutual trust as critical for the success of these courses and programmes, as participating instructors have to be willing to cede some control over their course, and have to be comfortable in a teaching mode that is often foreign to their own discipline.

Experiential Learning

The major vehicle to allow students to experience design and development processes for themselves is their team project. This focus on 'doing' often drives the teaching mode employed in these courses. Historically, the three different disciplines of business, engineering and design have exhibited very different teaching modes. Business schools often employ a case study format in which students prepare and discuss a business challenge within the context of a realistic case situation. The dominant teaching mode in engineering schools has been, until very recently, the lecture format, often accompanied by labs, study groups and recitations led by graduate students. Design schools, as a discipline more rooted in art than in science, have developed studios as a prevalent teaching mode, a mode in which faculty supervises, discusses and critiques students' work on an ongoing basis.

Because of the high degree of uncertainty inherent in product development, active problem solving plays a significant role in these courses. To this end, most courses employ studio-style work sessions and workshops, in addition to lectures and, in some courses, traditional business school case discussions (e.g., HBS). Students engage in this mode of active problem solving in various project phases, from user studies to technical prototyping. For example, most courses and programmes in the sample start with a phase of careful user study, using observation, interviews and participation as means to develop both a deep understanding of the user's needs and empathy for their situation. This emphasis on the experience of collecting and interpreting primary data favours a teaching mode that more often resembles coaching than lecturing.

The value that experiential learning can provide is also the reason for prototyping playing an important role in almost all of the courses and programmes. Most courses require the development and fabrication of 'looks-like' and/or 'works-like' prototypes as part of the course deliverables; and even in those courses in which works-like prototypes are not explicitly required (Parsons and VT) or are excluded from grading (HBS), student teams often produce various prototypes. In addition to enabling faster and better decision making, prototypes are particularly valuable in interdisciplinary settings as they 'serve an important boundary-spanning role by helping team members communicate better' as recognized by Dan Droz, one of the creators of the first interdisciplinary product development courses at CMU (Droz, 1992, p. 35). This is particularly true for teams that comprise members with different disciplinary backgrounds.

One aspect that is critical for the success of the students' learning experience in their team projects is the design of the projects. Interviewees stressed two elements that they try to balance carefully: degree of project definition and project scope. The definition of a good project needs to be sufficiently open-ended to allow students to explore new ideas; a project definition that is too narrow often only leads the team down a path to a known solution. At the same time, the difficult task concerning the project scope is to identify projects that represent challenging targets for the students but are still doable given the skills, time and equipment available to them. A good indicator for a healthy balance is when students are excited about their project: enthusiastic about the opportunity to create something new, and simultaneously optimistic that they can complete the project in the allotted time. Just like the product development process itself, this balancing act is often an iterative process. For example, at the start of the course the students might be given a broad opportunity space in which they themselves identify a large number of opportunities, and subsequent selection then leads to the actual definition of projects with appropriate scope.

Performance Assessment

The measurement of performance in higher education has always had two elements:

Table 1. Interdisciplinary Product Design and Development Courses (14) and Programmes (3) at Leading US Schools

No.	School(s)	Course Name	Course/Program Characteristics				Interdisciplinary Collaboration				Experiential Learning				Student Performance Assessment
			First taught	Course duration	Typical class size	Student level	Business	Design	Engineering	Other	Lectures	Workshops	Typical Team Size	Prototypes	
1	Arizona State University	Innovation Space	2003	2	36	UG	X	X	X		X	X	4	X	Final prototype(s) and reports
2	Babson College/Olin College of Engineering/Rhode Island School of Design	Product Design and Development	2008	1	48	UG	X	X	X		X	X	6	X	Final prototype(s), presentation, and reports; peer evaluations
3	Boston University	Cross-Functional Core	1990	1	300–400	UG	X				X		7–8	X	Final prototype(s), presentation, and reports
4	Carnegie Mellon University	Integrated Product Development	1989	1	30	UG/G	X	X	X	(X)	X	X	6	X	Final prototype(s), presentation, and reports
5	Harvard Business School	Managing Product Development	1997	1	60–70	G	X			X	X		6–8	(X)	Final product report; product fair is not graded
6	Massachusetts Institute of Technology/Rhode Island School of Design	Product Design and Development	1990	1	70	G	X	X	X		X	X	6–7	X	Final prototype(s), presentation, and reports
7	North Carolina State University	Product Innovation Lab	1996	1	75–90	Grad	X	X	X		X	X	6	X	Final prototype(s), presentation, and reports
8	Parsons New School of Design/Columbia University	Luxury Goods Studio	2003	1	60–70	UG/G	X	X			?	X	7–10		Final presentation and reports

9	University of California at Berkeley/California College of Arts	Managing New Product Development	1995	2	30–40	G	X	(X)	X		X	X	4–6	X	Final prototype(s), presentation, and reports
10	University of Illinois at Chicago	Interdisciplinary Product Development	2002	2	40–50	UG/G	X	X	X		X	X	6–7	X	Final prototype(s), presentation, and reports; peer evaluations
11	University of Michigan	Integrated Product Development	1995	1	32	UG/G	X	X	X		X	X	4	X	Final prototype(s), competition, and reports
12	University of Minnesota	New Product Design and Business Development	1994	2	40	G	X		X	X	X	X	5–7	X	Final prototype(s), presentation, and reports
13	University of Pennsylvania	Product Design	2001	1	60	UG	X		X		X	X	4	X	Final prototype(s), presentation, and reports
14	Virginia Tech University	Wearable Computing/ Independent Study	2004	1	20–25	UG	(X)	X	X		X	X	4–6		Final presentation and reports
	School(s)	**Program/ School Name**													
1	Carnegie Mellon University	Masters in Product Development	2000	2	30	G	(X)	X	X		X	X	6	X	Final prototype(s), presentation, and reports
2	Northwestern University	Masters in Product Development	2001	4	36	G	X		X		X	X	6	X	Final prototype(s), presentation, and reports
3	Stanford University	D-School	2003	1–2	12–16 60–70	G	X	X	X		X	X	4	X	Final prototype(s), presentation, and reports

Key: UG = Undergraduate, G = Graduate; X = Yes, (X) = Sometimes; Course duration measured in semesters (typically 13–14 week periods) – with some exceptions (e.g., Stanford operates on a quarter system).

performance of the students on one hand, and performance of the instructor(s), and the course as a whole, on the other. The systems to measure student performance are very homogeneous across the courses in this sample. They include intermediate presentations and reports from the teams as their projects progress, and in many cases also final presentations, reports and submission of a prototype. Often peer- and self-evaluations are used. A unique form of student performance measurement represents a competition in a simulated market (University of Michigan). Perhaps reflecting the emphasis on experiential hands-on work, in none of the courses is student performance measured through written examinations.

The performance of instructors is typically measured through teaching evaluations that students fill out at the end of the course. On the course level, the way in which the 'course value' is demonstrated varies across the courses in this sample: it ranges from the project results, to the students' employability, to press recognition. For example, in some instances innovations from student projects have been patented by the sponsoring company (e.g., CMU); or participating students have used their ideas to launch new ventures (e.g., ASU). In other cases, students reported that the course had turned them into more interesting job candidates; or the course, and perhaps its concluding design fair, were covered in the press, often regional, sometimes national. Once successfully established, some of the courses have even become marketing tools themselves as some of the interviewees reported:

> 'It's the kind of thing development [offices] loves to put in front of donors.'
> 'Our development office wanted to get something out of it and signed a sponsor.'

Discussion

When asked about his motivation for creating an interdisciplinary programme in product design and development, one of the interviewees, George Kembel of Stanford University, replied: 'Universities typically produce experts, but we need to shape a new kind of innovator'. In its own way, each of the 14 courses and three programmes investigated for this study is a similar response to the increasing importance of innovation and collaboration in today's markets. Their common elements are interdisciplinary teams that work on term-long projects involving, in most cases, real prototypes. The teaching mode appears to be moving further away from traditional classroom teaching towards a mode that is more explorative in nature and collaborative in style – not only within the teams, but also between students and faculty.

Although the measures used vary across the sample, the majority of these courses are considered successful. Collectively, they certainly have contributed to building a legitimacy for this type of interdisciplinary educational offering. One of the current major questions is the sustainability of these courses and programmes with respect to their financial and institutional support. With their requirement for faculty members from different disciplines (to teach and support project teams), for access to materials, tools and workshops (to produce prototypes), and, ideally, for dedicated work space for the teams, these courses are resource intensive and do not necessarily fit nicely within existing school structures. The instructors interviewed for this study have creatively developed a variety of mechanisms to garner support for their courses. On the financial side, some faculty members have organized for outside companies to sponsor individual projects; in other cases sponsors fund entire courses. Some have grown their course into a degree programme that generates revenues from tuition (e.g., Northwestern). Yet others have secured funds from outside companies to acquire dedicated space (e.g., University of Illinois at Chicago, NCSU, ASU). Where to house these courses and programmes has been another challenge, in particular for those courses that engage students and faculty not only across different departments and schools within a university, but also across separate institutions (e.g., University of California at Berkeley–California College of Arts, Babson–Olin–RISD, Parson–Columbia University). An example of an entirely new structure is the D-School at Stanford University, which forms a separate entity in addition to the existing schools within the university. How such strategies for funding, promoting and sustaining interdisciplinary courses develop in the coming years is a major future research question.

A second major research question, and it is closely related to the first, is how to better measure the impact of these courses on the learning and development of its students, and its faculty for that matter. While this is a question with which all educational institutions have to wrestle, it is of particular importance for non-traditional educational designs using interdisciplinary and experiential approaches to teaching product design and development.

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Notes

1. Most of the courses and programmes investigated here are offered within a single educational institution (e.g., large university); however, in some cases several institutions jointly offer the PDD course. Counting only the 'lead' schools, the number of institutions is 16, counting all schools involved the number is 20 (see Table 1).
2. Note that the sample exhibits a survivor bias. There might be additional courses and programmes which have been started during the past 20 years but did not survive.

References

Amabile, T.M. (1997) Motivating Creativity in Organizations: On Doing What you Love and Loving What you Do. *California Management Review*, 40, 39–58.

Barczak, G., Griffin, A. and Kahn, K.B. (2009) Trends and Drivers of Success in NPD Practices: Results of the 2003 PDMA Best Practices Study. *Journal of Product Innovation Management*, 26, 3–23.

Beard, C. and Wilson, J.P. (2006) *Experiential Learning – A Best Practice Handbook for Educators and Trainers*. Kogan Page, London.

Beckman, S. and Barry, M. (2007) Innovation as a Learning Process: Embedded Design Thinking. *California Management Review*, 50, 25–56.

Brown, T. (2008) Design Thinking. *Harvard Business Review*, 86, 85–92.

Cagan, J. and Vogel, C.M. (2002) *Creating Breakthrough Products – Innovation from Product Planning to Program Approval*. Pearson Education, Upper Saddle River, NJ.

Cagan, J., Vogel, C.M. and Weingart, L.R. (2003) Developing a New Breed of Engineer – Integrated Product Development at Carnegie Mellon University. ASME Curriculum Innovation Award Winner, American Society of Mechanical Engineers.

Cardozo, R.N., Durfee, W.K., Ardichvili, A., Adams, C., Erdman, A.G., Hoey, M., Iaizzo, P.A., Mallick, D.N., Bar-Cohen, A., Beachy, R. and Johnson, A. (2002) Experiential Education in New Product Design and Business Development. *Journal of Product Innovation Management*, 19, 4–17.

Cooper, R.G. (1994) 3rd Generation New Product Processes. *Journal of Product Innovation Management*, 11, 3–14.

Cooper, R.G. (2008) Perspective: The Stage-Gate (R) Idea-to-Launch Process – Update, What's New, and NexGen Systems. *Journal of Product Innovation Management*, 25, 213–32.

Corporate Design Foundation (2007) *Multidisciplinary Education* [WWW document]. URL http://www.cdf.org/education/multidisciplinary.html [accessed on 5 November 2007].

Cronin, M.A. and Weingart, L.R. (2007) Representational Gaps, Information Processing, and Conflict in Functionally Diverse Teams. *Academy of Management Review*, 32, 761–73.

DeCusatis, C. (2008) Creating, Growing and Sustaining Efficient Innovation Teams. *Creativity and Innovation Management*, 17, 155–64.

Droz, D.M. (1992) Prototyping: A Key to Managing Product Development. *Journal of Business Strategy*, May/June, 34–9.

Dunne, D. and Martin, R. (2006) Design Thinking and How It Will Change Management Education: An Interview and Discussion. *Academy of Management Learning & Education*, 5, 512–23.

Engardio, P. (2006) The Future of Outsourcing. *Business Week*, 30 January.

Eppinger, S.D. and Kressy, M.S. (2002) Interdisciplinary Product Development Education at MIT and RISD. *Design Management Journal*, 13, 58–61.

Florida, R. (2003) *The Rise of the Creative Class: And How It's Transforming Work, Leisure, Community and Everyday Life*. Basic Books, New York.

Goffin, K. (1998) Operations Management Teaching on European MBA Programmes. *International Journal of Operations & Production Management*, 18, 424–51.

Goffin, K. and Koners, U. (2009) Tacit Knowledge, Lessons Learnt, and New Product Development. *Journal of Product Innovation Management*, in press.

Hauser, J.R., Tellis, G.J. and Griffin, A. (2006) Research on Innovation: A Review and Agenda for Marketing Science. *Marketing Science*, 25, 687–717.

Hustad, T.P. (1977) Approaches to the Teaching of Product Development and Management. Product Development Management Association: 113.

Kelley, T. (2001) *The Art of Innovation: Lessons in Creativity from IDEO, America's Leading Design Firm*. Currency Books, New York.

Klandt, H. (2004) Entrepreneurship Education and Research in German-Speaking Europe. *Academy of Management Learning & Education*, 3, 293–301.

Krishnan, V. and Ulrich, K.T. (2001) Product Development Decisions: A Review of the Literature. *Management Science*, 47, 1–21.

Lawrence, P. (1994) *Teaching Collaborative Product Development*. Corporate Design Foundation, Boston, MA.

Lovejoy, W.S. and Srinivasan, V. (2002) Ten Years of Experience Teaching a Multi-Disciplinary Product Development Course. *Journal of Product Innovation Management*, 19, 32–45.
McGregor, J. (2006) The World's Most Innovative Companies. *Business Week*, 24 April, 62–76.
McGregor, J. (2007) 25 Most Innovative Companies. *Business Week*, 14 May, 52–64.
Roth, A.V. and Menor, L.J. (2003) Insights into Service Operations Management: A Research Agenda. *Production and Operations Management*, 12, 145–64.
Sheremata, W.A. (2002) Finding and Solving Problems in Software New Product Development. *Journal of Product Innovation Management*, 19, 144–58.
Silvester, K.J., Durgee, J.F., McDermott, C.M. and Veryzer, R.W. (2002) Integrated Market-Immersion Approach to Teaching New Product Development in Technologically-Oriented Teams. *Journal of Product Innovation Management*, 19, 18–31.
Smith, P.G. and Reinertsen, D.G. (1998) *Developing Products in Half the Time – New Rules, New Tools*, John Wiley & Sons, New York.
Thomke, S.H. (2003) *Experimentation Matters – Unlocking the Potential of New Technologies for Innovation*. Harvard Business School Press, Boston, MA.
Thomke, S.H. and Fujimoto, T. (2000) The Effect of 'Front-Loading' Problem-Solving on Product Development Performance. *Journal of Product Innovation Management*, 17, 128–42.
Ulrich, K.T. and Eppinger, S.D. (1992) Educating Product Development Leaders. *Design Management Journal*, 3, 47–54.
Xu, F., McDonnell, G. and Nash, W.R. (2005) A Survey of Creativity Courses at Universities at Principal Countries. *Journal of Creative Behavior*, 39, 75–88.

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