California Innovation Corridor

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Pilot Program for Professional and Graduate Student Internship to Explore Innovation and Entrepreneur Environment

WIRED California Innovation Corridor Task 1.5

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Revised January 8, 2009

California Innovation Corridor

Wired TALENT DRIVING PROSPERITY

UCR Bourns College of Engineering

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Acknowledgments

The Honorable Andrea Seastrand
Executive Director
California Space Authority

Governed by a statewide board of directors, the California Space Authority (CSA) is a nonprofit organization representing the interests of California's diverse space enterprise community to facilitate vibrant space enterprise throughout California.

CSA was the first entity of its kind to develop a comprehensive, statewide Space Enterprise Strategic Plan that engages stakeholders from across the state to address critical issues affecting space enterprise development. In late 2005, the U.S. Department of Labor (DOL) announced a powerful initiative called Workforce Innovation in Regional Economic Development (WIRED) that closely aligned with the strategic objectives and findings of the California Space Enterprise Strategic Plan 2004-2006.

In January 2006, the State of California through the California Labor and Workforce Development Agency (CLWD) submitted the CSA-led WIRED proposal to the DOL. In February of that year, the California Innovation Corridor was spawned when the State of California, with CSA as the program lead, became one of 13 first-generation WIRED regions nationwide selected to assist the federal government in addressing the priorities outlined in the American Competitiveness Initiative. The California Innovation Corridor was originally comprised of more than 60 private and public sector partners spanning 13 counties to "optimize the Corridor for innovation and 21st Century workforce competitiveness."

CSA and its partners are achieving this objective through the implementation of 25 projects that fall under one of three strategic goals: innovation support, industrial rejuvenation, and talent development. This report is a major component of our integrated innovation and talent development efforts designed to create a globally competitive workforce capable of driving innovation through the 21st century. CSA extends its appreciation to the hundreds of stakeholders representing the government, industry, academia, economic and workforce development entities, who worked tirelessly toward the success of the California Innovation Corridor initiative.

Sincerely,

The Honorable Andrea Seastrand

Executive Director

California Space Authority

Christine Purcell, SPHR
Manager, Industry Workforce and Technology Development
California Space Authority

CSA would like to specifically thank Reza Abbaschian, Dean, College of Engineering, Bourns College of Engineering (BCOE), Mitch Boretz, BCOE, Dave Stewart, Dean, Anderson Graduate School of Management (AGSM), and Christine Pence, PhD., Director, Workforce Innovation Programs, BCOE and AGSM. We also wish to thank all of the stakeholders and participants in the Interdisciplinary Innovation Study – students, faculty and companies.

Education and Workforce Development (EWD) is one of the strategic objectives of the California Space Enterprise Strategic Plan 2004-2006, mentioned by Andrea Seastrand, and remains a key objective of the 2007-2010 plan, identifying needs for STEM (Science, Engineering, Technology and Math) and interdisciplinary education and workforce development, as well as innovation to sustain U. S. global competitiveness supporting national and economic security.

This Interdisciplinary Innovation Study, part of CSA's implementation of the U.S. Department of Labor (DOL) Workforce Innovation in Regional Economic Development (WIRED) California Innovation Corridor (CIC) program, aligned with the strategic objective to characterize and foster innovation, along with STEM education and workforce development efforts.

This project developed a model to study innovation and its drivers, incorporated the project into the UC Riverside MBA program creating teams of interdisciplinary PhD. science and engineering candidates and MBA students, allowing all to understand the new product development and introduction process. Teams presented to angel and venture capitalists and one team was invited to formally apply for funding, We hope to be able to continue the work, to further populate the model and create curriculum to address innovation and entrepreneurship at the graduate level and driving down to the undergrad and K12 level.

Some key findings were that interdisciplinary skills are important, and that early collaboration with the market and customers, often with shared investment, are key to innovation success.

Similar findings concerning early collaboration, interdisciplinary skills sets and evolving new business models were found in other WIRED CIC projects including:

- 21st Century Worker Profiles focused on advanced manufacturing technicians, management and executive levels of the biotechnology and life sciences industry, including discrete, process and nano companies. This study indicated that there are ad hoc university programs addressing integrated technical and business knowledge, but they are few, with little institutionalization of these programs.

- The Smart Supplier Transformation project focused on characterizing the current California supplier base and identification of common requirements for successful 21st century global supplier network.
- 21st Century Skills Analysis data driven and aligned with the Economic Strategy Panel Industry Cluster analysis, focused on high tech high wage industries and occupation requirements.

CSA thanks the participants and we hope to be able to continue this work to identify and communicate key innovation enablers throughout the workforce and education development system.

Sincerely,

Christine Purcell, SPHR

Manager, Industry Workforce and Technology Development
California Space Authority

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This project has been funded by the California Space Authority, through the California Labor and Workforce Development Agency, as part of the California Innovation Corridor "Workforce Innovation in Regional Economic Development (WIRED)" grant from the Employment Training Agency of the U.S. Department of Labor.

The conclusions and recommendations in this report are those of the authors and do not necessarily reflect the opinions of the California Space Authority or U.S. Department of Labor.

This project involved a large number of UCR faculty members and graduate students of the Bourns College of Engineering and A. Gary Anderson Graduate School of Management.

Faculty contributors include Guillermo Aguilar, Bahman Anvari, Gerardo Beni, Michalis Faloutsos, Qing Jiang, Ping Liang, Jiayu Liao, Walid Najjar, Tom Payne, Marko Princevac, Victor G.J. Rodgers, Jerome S. Schultz, Tom Stahovich, Kambiz Vafai, Sundararajan Venkatadriagaram, Junlan Wang, Yushan Yan, and Victor Zordan.

Student contributors were Anirban Banerjee, Rajwant Bedi, Joe Chan, John Cortes, Justin Cram, Christine Dela Cruz, Yu-Hsuan Fang, Yuying Gao, Pei-Yi Hsiao, Parisa Hakim Javadi, Kurt Jensen, Dessy John, Mehdi Kabbaj, Petcharin Karnchanachari, Mehrzad Khakpour, Matthieu Le Coffre, Po-Yi Lee, Bo Liu, Shadi Mahjoob, Phillip Miller, Abhishek Mitra, Roland Mouterde, Muhammad Ibrahim Khan, Oliver Pacifico, Daniel Pio, A.J. Reese, Geoffrey Rowe, Ryan Rusich, Maryam Shafahi, Mona Shams, Xiulin Shen, Danny Solarz, Audun Utengen, Prashanthi Vandrangi, Henry Vu, Jun Wang, Hui-Lan Wu, Shuo Xie, Zhi Xu, Xin Xue, Jamie Yee, and Sebastian Zeiss.

We gratefully acknowledge the many people at the companies we interviewed for their willingness to share their time, their ideas, and their philosophies with us. As we agreed from the start, the names of these companies are not being disclosed.

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1. Summary

The mission of Task 1.5 was to build an understanding of how California companies encourage innovation and profit from it, and how academic institutions can better-prepare graduates to succeed in an innovation-driven environment. The role of the University of California, Riverside, in Task 1.5 was to develop an action research model by which student-faculty teams were to conduct multiple site visits with a variety of companies in the California Innovation Corridor to learn about their approaches to innovation. With this information, UCR was to determine important elements of innovation and identify ways of building them into the educational experience, particularly for graduate students in UCR's Bourns College of Engineering (BCOE). The task also called for UCR to disseminate results through workshops.

UCR's research identified skill sets that innovative California companies consider to be important in engineering and business employees. Broadly, key needs, particularly for technical employees, are:

- Good technical research skills.
- The ability to communicate effectively, within the organization, with upper levels of management, with peers, with regulators, and with the public.
- Managerial skills, including the ability to delegate work, organize teams, and follow up.
- Knowledge about the regulatory and economic environment in which the organization works.
- A good grasp of ethics.
- The ability to work in teams.

Section 5 of this report discusses these needs.

UCR also identified numerous means to build these tasks into the engineering educational experience. Because the course load for engineering students is already substantial, we emphasized opportunities to build skills without changing – or, in particular, adding – curriculum requirements. Concepts that merit further exploration at UCR and other collegiate programs include the following (Section 6 expands on these ideas):

- Integrating innovation into new undergraduate breadth requirements.
- Master of Engineering program.
- Expanding the Teaching Assistant Development Program.
- Expanding programs required under the America COMPETES Act.
- Weekend business "boot camp" for engineering students.
- Broadening weekly graduate seminar series.
- Technical writing course.

- Continue the site visits.
- Internships.

The site visits indicated that corporate R&D activities contribute incremental improvements to existing product lines but are less involved in developing disruptive innovation. Many of the interviewees turned to other firms in their networks for this kind of developmental research, but few were involved directly with academic institutional research labs for either short-term or long-term R&D.

While much of the workforce training happens on the job, it appears that hiring criteria are designed to attract candidates with appropriate qualifications and training who would be operational immediately. Again, the interviews found few links with higher level educational institutions to assist with determining what kind of entering operational skill sets would be considered essential for priority hiring. Whatever links do exist are not with the core academic units such as Engineering and Business.

UCR conducted an on-line survey to validate the data collected in the 23 site visits. The survey collected 106 on-line responses; in general they corroborated what we learned from the site visits. We wish to emphasize, however, that the results have not been validated against more statistically rigorous studies of U.S. companies, and we caution against treating the results as *statistically* valid.

Important to the overall project and the manner in which it was conducted is the unique opportunity this study provided for students from very different disciplines to work together on a quality field research project. The Engineering Ph.D. candidates and the Business MBA candidates brought different insights and perspectives to the general understanding of innovation, business culture, and research design. The value of the formal and informal exchange which resulted during the course of the project already has been reported by companies which have hired the recent project graduates.

2. Project Overview

A. Objective of Task 1.5 and Performance Metrics

The objective of Task 1.5 was to facilitate transformation of the industrial and academic innovation enterprise by building an understanding of effective practices for how innovation is encouraged and commercialized. The California Space Authority established a series of goals and metrics for measuring the extent to which the objective of Task 1.5 was being realized. Table 2-1 lists the stated goals and summarizes the UCR deliverables and metrics pertinent to each.

Table 2-1. Task 1.5 goals and deliverables/outcomes, as set forth by the California Space Authority (2007-2008).

Project Goals*	Deliverable/Outcome
Action Research model to engage professors and students in exploration of innovation/ entrepreneurship with goal of transforming academic understanding.	The approach to the task has been modified to involve a larger number of shorter visits. This has been well documented during the course of the project. As agreed upon from the outset, we will not report the names of these companies to avoid disclosure of anything that might impair competitive advantages or approaches.
Literature review of best practices in technology transfer.	An annotated bibliography has been under development throughout the project. This has been delivered to the California Space Authority for posting on the Innovate California web site, and it is included here as Appendix 1.
Multi-day site visits, tours, consultations, and interviews with businesses.	Twenty-three site visits have been conducted.
Identification of key elements of how innovation is fostered and commercialized in real world corporations.	UCR developed a standardized template for the site visit interviews to enable comparison of answers from different companies. The site visit teams did not merely read from the questionnaire; they conducted interviews. After each visit, every team member filled in the questionnaire based on his or her notes. This resulted in multiple questionnaires per visit. The analytical team them sorted the questionnaires to identify key elements of how innovation is fostered and commercialized.
Summary reports of the site visits.	See previous item.
Student/faculty practicum with presentation of key learning.	We have conducted student-to-student sessions in which business students work with engineering students on presentation skills (written and oral). We have had sessions with faculty to collect lessons learned and ideas about how to incorporate innovative/entrepreneurial thinking into the graduate experience.
Reporting/dissemination of findings.	A preliminary, high-level review of the project was presented at the TechHorizons conference in May 2008.

This task was part of an extensive program of activities supported under the WIRED California Innovation Corridor project (Table 2-2). UCR participated informally in various aspects of other tasks, notably the talent develop activities of Task 3 and some of the supply chain and logistics aspects of Task 2.

Table 2-2. Task 1.5 in the context of the California Innovation Corridor mission.

Innovation Support – *"Create new companies and high-skill, high-wage jobs by designing a replicable and sustainable "innovation support architecture" to increase innovation and entrepreneurship"*

- Creation of an Economic Development Toolkit
- Develop 21st Century Job Profiles to define future workforce skills and needs
- Compilation of an Innovation Asset Inventory to foster innovation and entrepreneurship
- Support of entrepreneurial companies, including SBIR Phase II awardees, to identify best practices that lead to commercialization
- A pilot program set to identify and replicate an existing successful model of technology transfer from a university to the business community
- Identification of a new model for student payload rideshare on military space lift
- Establish a WIB toolkit for support of entrepreneurial companies

Industrial Rejuvenation – *"Improve the international competitiveness of the region's supply chain by developing and executing a "Smart Supplier Strategy" that supports manufacturers, small businesses and entrepreneurs in adapting to the global manufacturing transformation"*

- Identification of high priority supplier training needs through surveys, forums and industry input
- Characterization of "Smart Supplier" competitiveness skills
- Build a "Smart Supplier" resource for providers within the Corridor
- Development of an industry-driven community college Manufacturing Technician Training Program

Talent Development – *"Accelerate development of a highly skilled 21st Century talent pool by creating pilot projects and activities capable of supporting a continuum of math, science and engineering education (K-U), and lifelong learning relevant to the 21st Century worker."*

- Compilation of a *Corporation Workforce Skills Analysis*
- Unifying a Space Employer/University Consortium
- Advancing space related experiential university internships and mentoring programs
- Develop and execute an outreach of systems engineering training programs throughout the Corridor
- Organize the development of a statewide STEM education collaborative action plan
- Creation and implementation of science and math middle and high school teachers institutes
- Originate an industry-driven training program to retrain dislocated software specialists for space related computer science technician work
- Orientation of university and graduate advisors to innovation-oriented acumen through the establishment of an industry mentorship link
- Advancing the Troops To Teachers recruitment and accelerated credentialing of math/science teachers
- Establish a model university and high school mentoring program
- Foster a community college industrial technology-based degree in Mechatronics
- Produce real-world curriculum for educator conferences focused on STEM education and space science
- Develop a virtual web-based participatory "California Space Education Center" using interactive and community building Internet technology
- Building a Learning Collaboratory of training and best practices on innovative approaches to partnerships in support of an innovation ecosystem

B. Evolution of the Task Plan

The original plan for Task 1.5 called for two to three company visits per year, each lasting 6-10 weeks and involving multiple professors and graduate students. This proved to be impractical: Few companies were willing to accommodate such large groups for such long periods, and professors and graduate students were reluctant to relocate and disengage from their teaching and research for extended periods. With approval of the California Space Authority, the approach to Task 1.5 was revised to involve shorter visits, of half a day to a day each, with a larger number of companies.

Benefits of this approach included the ability to involve more professors and students in site visits, and the ability to compare and contrast different companies' approaches by the use of a standardized format for compiling and analyzing the companies' answers to our questions. Section 4 discusses the selection of companies and our approach to collecting and analyzing information. Eighteen engineering faculty members and forty-two graduate students from Engineering and Business participated in some phase of the overall project. Twenty-three site visits were conducted from March 2007 through June 2008 using cross-disciplinary teams of these students and faculty members. The typical team consisted of at least one engineering faculty member, two engineering graduate students and one to two business school graduate students.

Originally, the task plan called for each site visit team to include participants from UCR and from Stanford University. For numerous logistical reasons, eventually it was agreed that Stanford would not participate in the site visits. This report discusses only UCR's activities in Task 1.5.

3. Literature Review

A. Definitions of Innovation

Before we could go out in search of innovation, we needed a working definition of the term. This definition had to work in the context of the project, which the California Space Authority's Christine Purcell articulated at the 2007 TechHorizons conference at UC Riverside (Table 3-1).

Table 3-1. Context for defining innovation (from presentation by Christine Purcell and Judy Turner, California Space Authority, at UCR, May 16, 2007).

• **Established Need** -- Entrepreneurship seriously under potential. -- Wealth of world-class innovation assets. -- No area within the Corridor in the top 25 of Regional Entrepreneur Index. • **Staggering Manufacturing Job Loss** -- Manufacturing still the largest in the U.S., but job loss between 1990 and 2004 = 438,500 jobs. -- Jobs retained still at risk due to globalization. • **Inadequate Technical Workforce to Meet Needs** -- Graying of scientists, engineers. -- Universities not attracting enough technical students.

A report commissioned by the U.S. Small Business Administration identified keys to regional economic growth as entrepreneurship (new companies and growth in existing companies) and innovation (as evidenced, but not defined, by the number of patents, the amount of research and development activity, and the number of high-tech companies in a given region) (SBA, 2005).

In that context, we found several salient definitions of innovation:

- **The National Council on Competitiveness:**

Innovation is "the intersection of invention and insight, leading to the creation of social and economic value." *Innovate America: National Innovation Initiative Report*. ISBN 1-889866-20-2 (2004)

- **Andrew and Sirkin (2006):**

Innovation is "the entire process of developing ideas <u>with the goal of achieving payback</u>." The "four S's" of the business process of innovation are start-up, speed, scale, and support costs; controlling them controls the impact of innovation. *Payback: Reaping the Rewards of Innovation.*

- **The National Science Foundation Innovation & Discovery Workshop:**

"Creativity involves the introduction of new variables, significant leaps, and novel connections. A subset of creativity, innovation, involves the creation of a new idea but also involves its implementation, adoption, and transfer. Innovation and discovery transform insight and technology into novel products, processes, and services that create value for stakeholders and society. Innovations and discoveries are the tangible outcomes. Creativity is needed to produce these outcomes. Innovation and discovery processes should be formal processes that harness creativity to those ends." *Final Report from the NSF Innovation and Discovery Workshop: The Scientific Basis of Individual and Team Innovation and Discovery,* NSF Report 07-25 (2007)

- **Peter F. Drucker**

Innovation is "change that creates a new dimension of performance."

- **Christine Cope Pence (the working definition for this project)**

Innovation is the vortex of successful business where strategic capability, competence, process, and design converge to provide significant, measurable, long term value to validated stakeholders.

We also explored the European Community Innovation Survey (CIS) definitions and methodology. The CIS does extensive surveying of European companies regarding innovation. Although the scope of our site visits and surveying would be much less, we thought it could be useful to be able to compare our findings in California with the results from European studies. Ultimately, however, the CIS framework turned out to be too extensive and cumbersome for us to apply. Table 3-2 shows key elements of the CIS.

Table 3-2. Key aspects of the European Community Innovation Survey.

• Sufficient and high-quality human resources. • A strong public research base with strong links to industry. • Entrepreneurship for and through R&D. • Effective adaptation and use of intellectual property rights systems. • Research- and innovative-friendly regulators. • A competitive environment and supportive competition rules. • Supportive financial markets covering the various stage of development of high-tech and other innovative companies. • Macro-economic stability and favorable fiscal conditions.

B. Literature Review

In order to develop the innovation model (see Figure 4-1 in Section 4), a review of existing research was conducted on several key topics including innovation, technology development and transfer, regional clustering, regional innovation metrics, innovation management and innovation frameworks.

Several academic journals were identified as being important sources of research information including:

1. *Creativity and Innovation Management*
   http://www3.interscience.wiley.com/journal/117967113/home
2. *IEEE Transactions on Engineering Management*
   IEEE Engineering Management Society
   http://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=17
3. *International Journal of Innovation Management*
   http://www.worldscinet.com/cgi-bin/details.cgi?id=voliss:ijim_0702&type=toc
4. *Journal of Engineering & Technology Management*
   http://www.elsevier.com/wps/find/journaldescription.cws_home/505648/description#description
5. *Journal of Operations Management*
   http://www.sciencedirect.com/science/journal/02726963
6. *Journal of Product Innovation Management*
   http://www3.interscience.wiley.com/journal/118487224/home
7. *Journal of Technology Transfer*
   http://springerlink.metapress.com/content/104998/
8. *R&D Management*
   http://www3.interscience.wiley.com/journal/118510592/home
9. *Research Policy*
   http://www.sciencedirect.com/science/journal/00487333
10. *Technology Analysis and Strategic Management*
    http://www.informaworld.com/smpp/title~content=t713447357~db=all

Two key reports which were central to the determination of appropriate innovation metrics were:

1. Camp, S.M. (2005). The innovation-entrepreneurship NEXUS a national assessment of entrepreneurship and regional economic growth and development. Washington, D.C.: SBA Office of Advocacy. http://purl.access.gpo.gov/GPO/LPS95743.
2. Atkinson, R.D., and Correa, D.K. (2007). The 2007 state new economy index: Benchmarking economic transformation in the states. *The Information Technology and Innovation Foundation*. Retrieved April 6, 2007 from http://www.itif.org/index.php?id=30

In the first study, measurement drivers of regional growth (entrepreneurship and innovation) indicated that no sub-region within the California Innovation Corridor's thirteen counties was ranked within the top twenty-five most entrepreneurial regions of the country. These regional measurements included number of new firms, number of growing firms, number of patents, amount invested in R&D, and number of high-tech industries. In the second study, twenty-six factors were identified which were indicators of state economies which were prepared for economic success. These measures evaluated each state economy according to knowledge jobs, globalization, economic dynamism, transformation to a digital economy, and technological innovation capacity. It concluded that California had dropped three places from number two in 1999 to number five in 2007.

Regional industrial clustering has been of interest to researchers who assist with policy making, and to government leaders (Council on Competitiveness, 2005; Ketels, 2003). Ketels presents a good framework for determining and evaluating cluster development and provides substantial understanding of the economic effects of good regional alliances.

As our project focuses on firm-level innovation, we chose to look at the innovation process as a systems analysis and thus depended upon research related to firm level strategy. Schilling (2007) provides a good overview of the important factors we needed to consider in determining our firm-level model of innovation. Also, Dorf and Byers (2006) was useful for identifying the appropriate factors we needed to evaluate across the firm. Our first qualitative interview template evolved from an analysis of these two books plus David (2006), and Murray (2000).

Lastly, we found several articles of interest as that of Muller et al. (2005), which investigated internal innovation metrics such. At an OCTANe (Orange County Technology Action Network) meeting, we had the opportunity to hear Shelton speak on his innovation consulting (Davila et al., 2006). This practitioners' approach to the subject helped us to look at innovation within the firm more broadly than just from the research lab/product perspective.

4. Research Approach

A. Determining the Important Elements of Innovation

By defining innovation as "the vortex of successful business where strategic capability, competence, process, and design converge to provide significant, measurable, long-term value to validated stakeholders," we set the framework for identifying and evaluating innovation within our target market of technologically oriented California based businesses. The initial literature review led us to the conclusion that we needed to model firm innovation in terms of both product and process, if we were to understand what factors might encourage innovation. Looking at innovation from a systems thinking perspective, we identified five major subsets process systems within the firm which interacted with each other around innovation product and process:

1. Idea Generation process (company culture, encouragement, reward system).
2. Decision Making process.
3. Financing and Budgeting process.
4. Innovation Development process (including IP protection).
5. Production and Outsourcing processes.

Figure 4-1 illustrates the decision relationships amongst the product and process systems.

B. Selection of Companies for Interview

Figure 4-2 shows the California Innovation Corridor, the region that the WIRED project focused on. Within this region, UCR contacted companies involved in a number of technology-based industries: semiconductors, communications, databases entertainment, industrial manufacturing, aerospace, and biotechnology. We had envisioned targeting clusters of companies in industries to get a perspective on the variations in approaches within a single industry, and among large and small companies. However, logistical considerations made it difficult to target sufficient numbers of companies in any given industry.

By agreement with the site visit companies (and with the assent of the California Space Authority), UCR promised anonymity to the companies that were visited. This was intended to make the companies more willing to talk openly about their approaches; they would not have to worry about competitors being able to identify key practices or elements of their competitive strategies. Only one company asked for us to enter into a non-disclosure agreement before the site visit. We asked all participating companies to think of the site visit team like a news reporter: Don't say things that you wouldn't want to see in print.

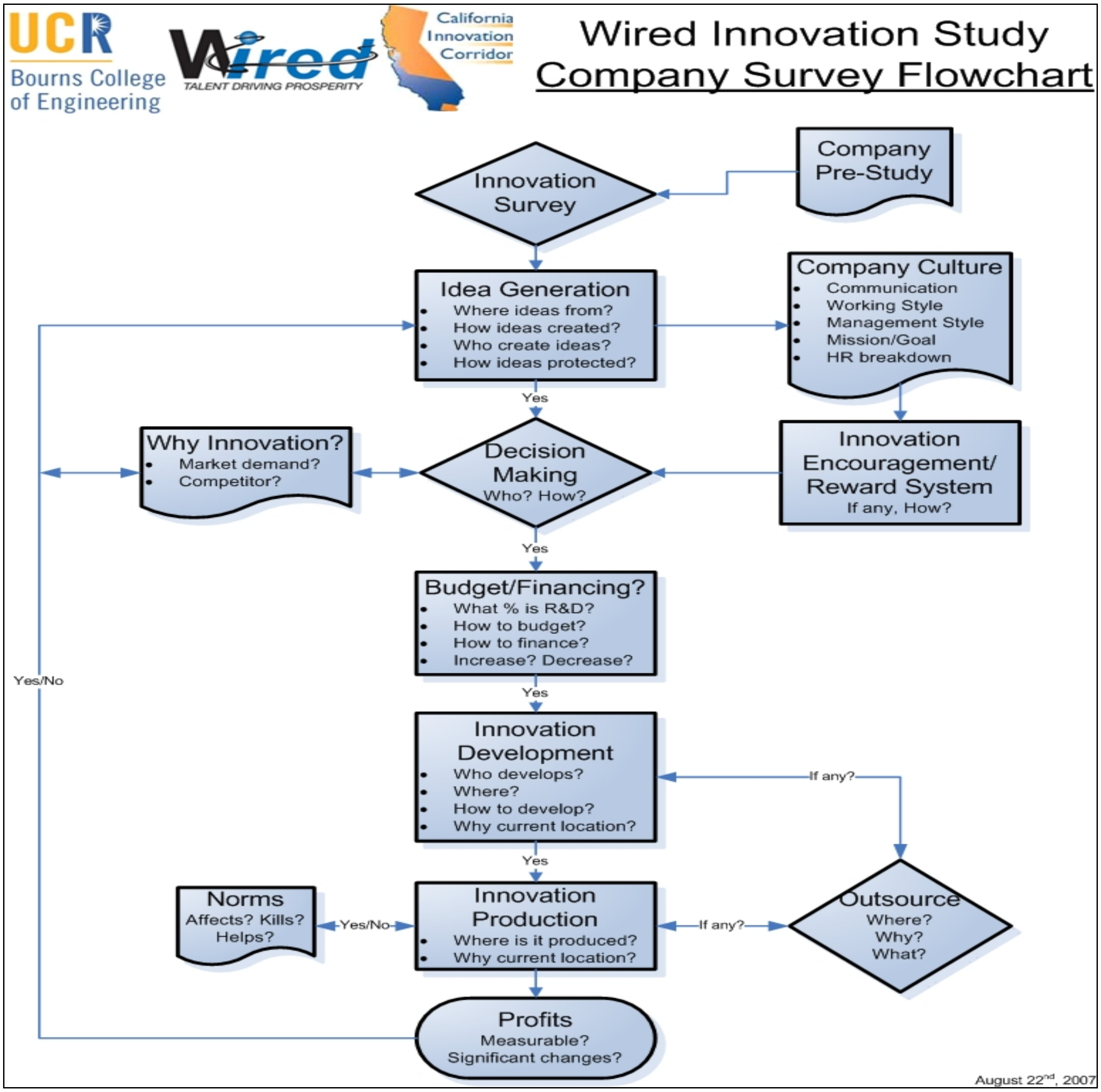

Figure 4-1. The WIRED innovation study company survey flow chart.

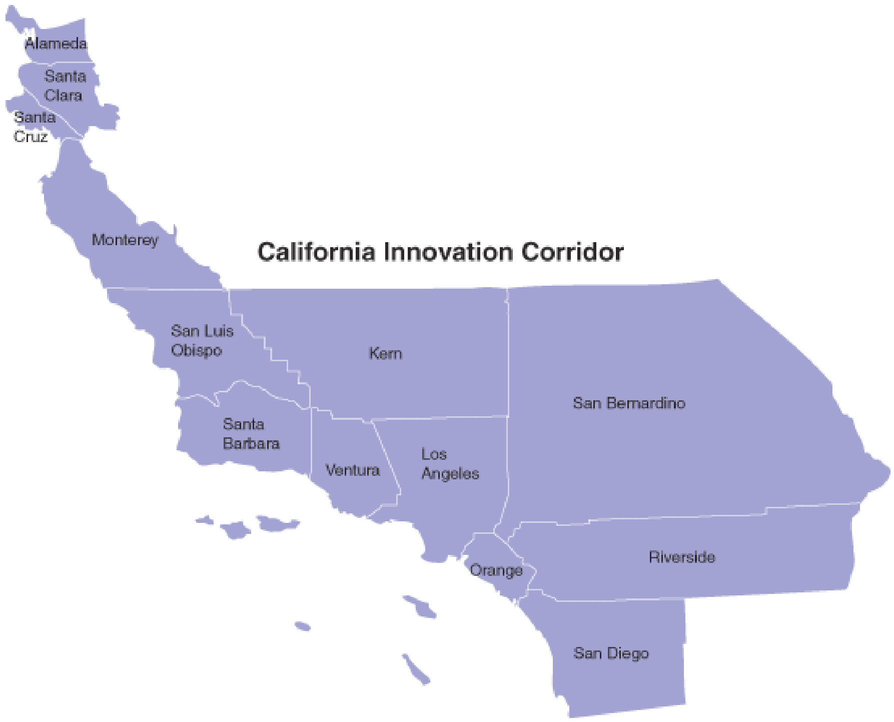

Figure 4-2. Map of the California Innovation Corridor.

Physically, five of the twenty-three site visits were conducted in businesses based in the Bay Area in Northern California while the remaining eighteen were spread across Southern California in Los Angeles Orange Counties, the Inland Empire, and the wider San Diego County area. As illustrated in Figure 4-3, companies visited represented all sizes from smaller start up businesses to very large established businesses.

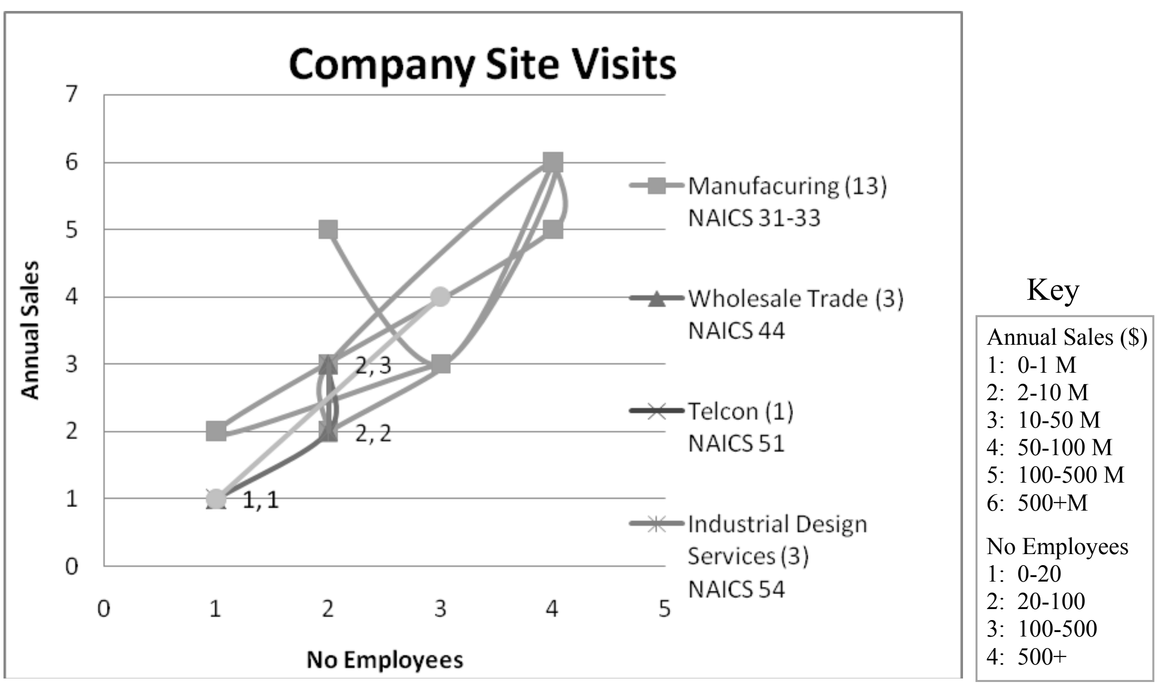

Figure 4-3. Company site visit demographics.

Prior to the site visits, preliminary background information was collected and stored for further evaluation. This information later was coded and integrated with the results from the qualitative interviews (Appendices 2 and 3). Figure 5-3 illustrates the relationship between the pre-interview background information collected.

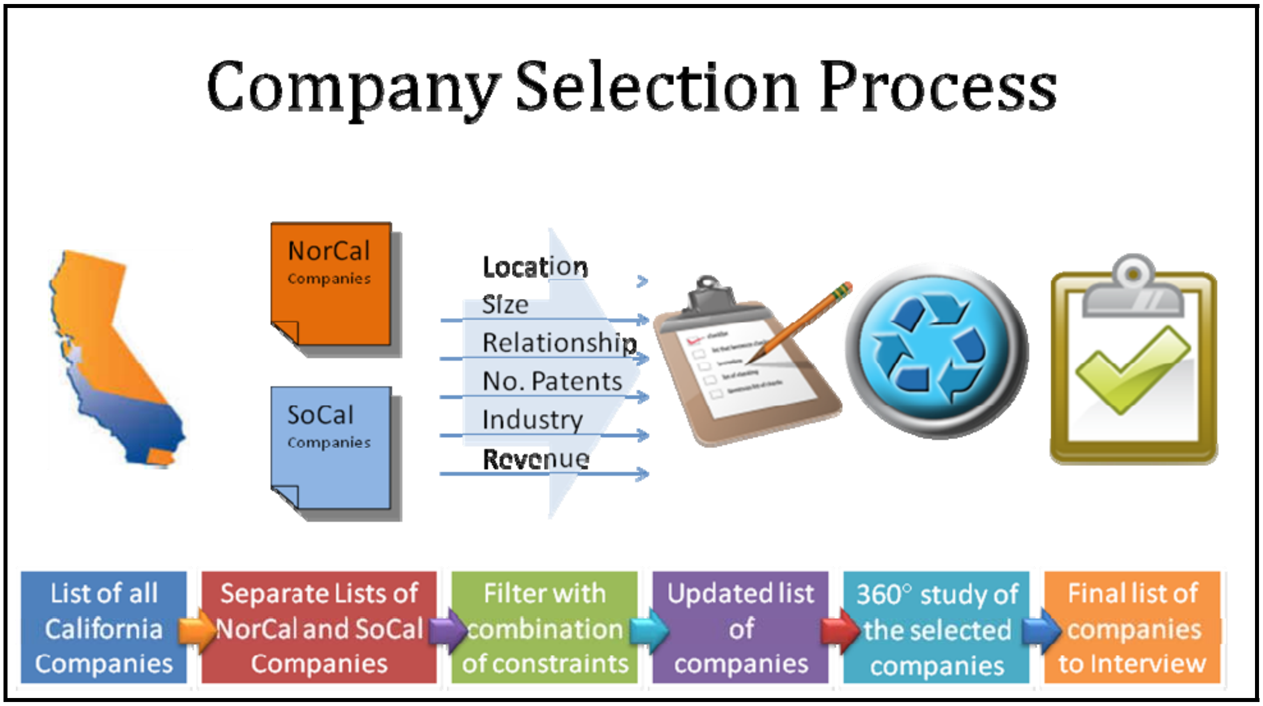

Figure 4-4. Site visit company selection process.

C. Questionnaire

The initial questionnaire was designed as a qualitative interview research instrument to help guide the discussions in directions which corresponded to our model of the firm and its product/process innovation system. As everyone seems to have an opinion about innovation, its definition, its inhibitors, its enablers and its current status in the firm and economy, we wanted to get specific answers from these site visits which would permit us to make our own judgments based upon our modeling rather than just the recording of general "cocktail hour" comments.

The objective of the qualitative interviews was to collect information on the business and its decision making processes. Five processes were identified as being central to decision making:

- Company Culture and Reward process
- Market and Financial process
- Manufacturing and Production process
- Human Resource process
- Innovative process

Figure 4-5. Qualitative questionnaire information framework.

As illustrated in Figure 4-5, the interview objective was to understand the company from a systems perspective. We investigated internal and external stakeholder relationships and their potential relationship to the firm's approach to innovation.

The WIRED Innovation Study Interviews Questionnaire template (Appendix 3) was designed to guide the qualitative interviewers in their on-site interviews. The questionnaire was not distributed to the interviewees, but rather served as a guide to assist the goal of achieving a maximum of exchange in a short period of interview face time. In total, forty-nine questions reflect the pre-programmed expected response alternatives. This permitted rapid tabulation of interview data-comments in that many of the possible response alternatives had been pre-identified.

D. Qualitative Interviews

Teams consisting of at least two Ph.D. Engineering candidates, one MBA candidate, and one Engineering faculty member were pre-assigned the task of conducting the on-site qualitative interview at the company's California based location. These multidisciplinary teams prepared their site visits first by reviewing the pre-survey template results and then by determining ahead of time the areas of responsibility for collecting and recording data. This permitted the maximum accumulation of interviewee potential responses as each interviewer was prepared to cover a specific set of directed questions. Additionally, this approach permitted the interviewers to meet one another and to discuss a priori the company and expectations from the visit. As the different disciplines represented had different educational knowledge, the cross fertilization of the team with these respective disciplines assured as best possible a positive experience in terms of data collection from the interview. Though maximum efforts were made to have at least three company representatives available for the interview (one from a strategic management area, one from marketing, and one from research and/or production), in the end, each interview was a unique experience and rarely were the experiences the same from company to company.

E. Recording Results

Upon completion of the interview, each participant prepared a two-page document of lessons learned: personal lessons, questionnaire improvement suggestions; additions/improvements of conclusions regarding innovation. Additionally, the team completed the Questionnaire Template (Appendix 3) which then was coded for data entry into our WIRED Project database in the SPSS (Statistical Package for Social Sciences). A Microsoft Access database also was populated with the completed pre-survey template data and additional NAICS information (North American Industry Classification System).

Regularly scheduled WIRED Project team meetings permitted the exchange of individual site visit learning and opened the discussion regarding eventual improvements in both the model and the questionnaire used to elicit data collection. The two-page documents of lessons learned were evaluated by one of the MBA candidates, a practicing human resource manager, to identify common threads useful for improving the current academic experience in light of industry expectations (Appendix 4).

F. Online Questionnaire

As the site visit analyses progressed, it became clear that the model needed slight adjustments and that further data collection was necessary in order to perfect the model. As additional site visits were difficult to coordinate in the limited time remaining on the project, it was felt that even preliminary information from an online questionnaire would be useful to the evaluation of the site visit data. A revised questionnaire was prepared and placed online 11 July 2008 with the last recorded data entry before closure on 18 September 2008 (Appendix 5). This online survey provided additional company feedback from 106 companies separate from those we had interviewed. Respondents represented those to whom we had sent targeted requests as well as those who had been contacted by other WIRED partners. Again, the respondent pool was small, but it added additional data to help us understand our preliminary site visit results.

5. Research Findings

A. Significant Elements of Innovation in California Companies

Returning to our Innovation Model as described in Section 4, five processes were identified as being central to decision making:

- Company Culture and Reward process.
- Market and Financial process.
- Manufacturing and Production process.
- Human Resource process.
- Innovative process.

After running correlation tests on nineteen of the qualitative interviews (four site visit results were rejected due to inadequate information), we made the following observations:

Company Culture and Reward process:

The reward system is an effective parameter for innovation. It primarily comes in the form of monetary reward and/or promotion for the team/group achievements.

- Rewards for innovation through promotion and monetary incentives encourage more innovative products which assist in differentiating the company from its competitors.
- Encouraging employees by formal rewards, such as monetary reward and promotion, affects robust intellectual property (e.g. patents), in a positive manner, which in turn aids in maintaining competitive industrial advantage.
- Innovative products and robust intellectual property, e.g. patents, directly contribute to a company's profitability and cost effectiveness. This further differentiates the company from the competitors.
- Rewards for learning enhance the innovative environment, spurring fresh ideas and market leading products differentiating the company from its competitors.
- Generally, the board of advisors makes the final decision on innovation projects, with the major considerations being project performance, and resultant profitability.

The Market and Financial process:

The market/customer determines the need for new products. The financial health of the company affects its ability to fund R&D efforts as well as to meet stakeholder demands.

- Annual operating budget allocations for R&D favor departments that play dominate roles in the development of the companies' products.
- The increase or decrease in annual allotments is directly tied to the products being created, and their subsequent performance.

The Manufacturing and Production process:

Hiring and outsourcing decisions are determinants of innovation.

- Companies develop their R&D by outsourcing or collaboration with research institutes, universities or other companies.
- The main reason for outsourcing outside California is labor compensation, investment opportunities (in the form of tax incentives) and collaboration with experts.
- Quality norms (industry standards which define ranges of tolerability) are used mostly because of consumer expectations. Norms neither hinder nor bolster the innovation process.
- The desired outcome of R&D could be a new product, new process or improvement on existing process. The criteria to measure the innovation of the process are financial profitability and sales growth.
- Mostly, the reason for the companies not to outsource is it could be too costly or time consuming.
- The most common type of outsourcing is done for manufacturing in which cheap labor costs can be procured from other countries.

The Human Resource process:

Hiring decisions affect the innovation process.

- Hiring decisions are initiated by people in the HR department and people in the company who are qualified with an MBA in HR.
- Hiring decisions are predominantly made by the departments in need, be it HR or R&D.
- The key people involved in innovative efforts in R&D are qualified with a Ph.D., M.S., or B.S. in engineering/sciences.
- Engineers/Scientists are hired based on either the R&D or the HR recommendations.
- People who work as engineers either have a Ph.D., M.S., or B.S. in engineering/ sciences.
- People who work as scientists have Ph.D.s in engineering/sciences.
- Managers are hired based on the recommendations of the company's executives. People who work as managers usually have a B.S. or M.S. in business/sciences.
- The finance department provides the budget required to hire the engineers/ managers/ scientists. Hiring may undergo a freeze when the company's finances are low.

The Innovative process:

Decisions affect the innovative process including R&D, market positioning, and intellectual property management.

- The decisions made by the director of R&D will be based on the desired outcomes of the R&D process, which include improvement of existing products and creation of new products in which new products are protected through patents acquired with the approval of the director of R&D.
- Competitive edge is maintained by having robust intellectual property.
- If a product is robust, norms are not required to validate it, but norms will not negatively affect innovation. The norms are placed so that competitive edge can be obtained.
- A company which obtains intellectual property usually will try to have an exit strategy of 10 or more years to maximize the utilization of that intellectual property; norms would not get in the way of the maximum utilization of intellectual property.
- Companies that develop R&D internally focus on creating new products or processes and or improving existing ones based on consumer expectations to gain competitive advantage. Generally R&D does not use any standard norms, but if norms are used they would not negatively affect innovation. R&D is protected using patents, trademarks, and trade secrets.
- When companies develop R&D by external collaboration with another firm or consortia, improvement of existing processes is the focus, and patents are used to protect IP.
- When companies develop R&D by collaborating with university labs, they tend to focus on creating new products and improving existing products to gain competitive advantage, and IP is protected by patents.
- From an engineer's perspective or from a manager's perspective, the goals of developing R&D are the same: improvement of current products/processes, production of new products/processes, and protecting of IP. Norms are not seen as a negative influence on innovation.

Turning now to the online survey, the following preliminary observations seem to contribute further to the conclusions obtained from the site visits:

Company Culture and Reward process:

- Companies value life-long learning programs. They are willing to pay for them and to provide time off to participate in them.
- Critical thinking skills are essential for company innovation including the ability and willingness to ask questions. These skills are rewarded monetarily.
- Ideas are shared and communicated throughout the organization.

- Organizations have formal commitments to include customer views in the decision making process.

Market and Financial process:

- Projects are chosen primarily based upon customer demand.
- New hires are recommended by the department that has the need.
- Customer demand drives project selection.
- The company's primary competitive advantage lies in the technology and the managerial expertise.
- Customer demand drives innovation.
- Two key differentiators among competitors are *quality and service.*
- Companies choose to be the leader of innovation relative to their competitors.
- Most companies estimate that they spend more than their competitors on innovation.
- There is no relationship between capitalization and innovation.
- Companies characterize themselves as ones which identify customer needs first, focus on incremental improvements to take second mover advantage, and lastly develop new, radical technologies from internal R%D.

Manufacturing and Production process:

- 0-5% of the total budget is spent on R&D.
- Generally all companies allocate 5% or less of their total budget to R&D.
- Spending on R&D in the past 3 years in these companies has changed both in terms of location and amount.
- Norms are important and especially ISO and 6 Sigma.
- Norms are necessary because of government contracts and regulations, customer demand, and overall cost efficiency.
- Norms do drive innovation.
- The benefits of innovation are measured by customer satisfaction and changes in revenue.
- Companies outsource outside of California to reduce labor compensation and as a way to penetrate new markets.
- Companies are concerned about outsourcers being too far away geographically.
- Companies are concerned about safeguarding intellectual property when collaborating with overseas companies.

Innovative process:

- Companies that answered this survey generally had been in business for more than 20 years
- In general, outright sale is the preferred exit strategy of the companies studied, with the time horizon being 4-6 years.
- R&D is driven by top management and then by engineering

- Most R&D is internal to the particular company, with external collaboration with other first and consortiums next in popularity.
- Only 12% of the companies interviewed said that they actively collaborate with Universities research labs.
- Primary collaboration partners are within the USA. Of them, 50% are in California.
- External collaborators are used primarily for specialized expertise.
- Innovations which are not commercialized are revisited regularly for potential application.
- Innovation is protected by patents and trade secrets.

Human Resource process:

- Companies stay in California because of the level of availability of highly educated professionals.
- Language barriers affect companies' decisions with regards to outsourcing.
- California businesses hire primarily from the local region with the exception of employees with advanced degrees, for which they prefer to hire within the United States and locally if possible.

B. Analysis of Results for Educational Improvement

Based on the site visits and survey, businesses indicate that the skill sets they demand include the following:

- Functional business knowledge, including basic principles of management, budgeting and financial analysis, systems analysis, project management, marketing, law as pertains to intellectual property and contracts.
- General political/social/economic awareness of global issues.
- Written and oral communication skills, negotiation skills and organizational skills.

In all cases, field experience is valued.

Additionally, our findings show that industry is reaching externally for its R&D function. Companies hire from the pool of universities with which they have relations. Industry turns to these same universities for collaborative work. California is appealing because of the qualified talent pool available here. Industry maintains its competitive edge because of the quality of innovation, technology and managerial expertise.

Most relevant to the purpose of Task 1.5 is an analysis of what attributes California companies look for when hiring technical workers. The "bright lines" running through the site visit interviews were:

- Good technical research skills.

- The ability to communicate effectively, within the organization, with upper levels of management, with peers, with regulators, and with the public.
- Managerial skills, including the ability to delegate work, organize teams, and follow up.
- Knowledge about the regulatory and economic environment in which the organization works.
- A good grasp of ethics.
- Ability to work in teams.

These findings correspond well with the results of a study by Fisher et al. (2006), which summarized the priorities as:

- Project management.
- Communication and team skills.
- Quality management practices.
- Ethics.
- Economics and financial issues.

We can also think in the context of selected ABET criteria. ABET is the accrediting body for college engineering programs in the United States. ABET identifies a number of "outcomes" – skills that every engineering student should have on graduation day. These include:

- An ability to function on multi-disciplinary teams.
- An understanding of professional and ethical responsibility.
- An ability to communicate effectively.
- The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
- Recognition of the need for, and an ability to engage in, life-long learning.
- Knowledge of contemporary issues.

The results of our study, therefore, align well with what others have found, and with what the broader engineering community looks for from the educational system. With the ABET requirements in particular, virtually every college engineering program in America addresses these needs to some extent, and measures the extent to which students are absorbing what is being offered. However, it was clear from our discussions, and from the reactions of engineering graduate students to what they were hearing from business professionals, that more is needed. Section 6 discusses UCR's conceptual plan for enhancing the engineering educational experience so it is more responsive to the needs that we found.

6. Education Approach

A. Active Learning and Cross-Disciplinary Projects

The WIRED research task provided a unique opportunity for students from cross-functional disciplines to interact around an important field research project with broad implications for their future career development. Whether in academic research or industry, it appears that desired personnel are those who have technical and managerial skill sets. As our results indicated that industry prefers to hire locally, this opportunity to study local industry was timely for many of the graduating participants of the WIRED project. For the industrial participants, this was a fortuitous opportunity to meet future employment candidates under circumstances where their communication and analytical skills could be evaluated without financial obligation.

Visualizing workplace issues through live case studies was an effective means to communicate the need for cross disciplinary skill sets. By bringing the two student groups together around this project, they used the opportunity to share their specific knowledge for the good of the overall research project. The key was that this was a real field research project with objectives of mutual interest. In spite of the academic pressure to complete class-related tasks, students found the time to dedicate toward this project including ancillary field trips, workshops, not for credit class projects, seminars and conferences. Their participation in this project added an important line item to their résumés which they were quick to appreciate.

B. Actual Projects

Several active learning projects were implemented (Figure 6-1). These led to the completion of the overarching WIRED research project.

- In the spring of 2007, Engineering graduate students joined the MBA students in a formal business class to study innovation and business planning. Through the vehicle of this class, the initial WIRED project student teams were formed; the initial innovation model and initial qualitative survey were developed and tested; the initial annotated bibliography was established; a formal presentation was given at the UCR TechHorizons conference[*]; an innovative business plan was developed and presented for an on campus technology transfer consulting business.

- In the spring of 2008, this same class again was offered with new MBA participants and many returning Engineering participants. Two real businesses were created based upon engineering lab research results. Students entered an intercollegiate inventor competition, having developed and filed a priori the patent materials for their inventions. They then proceeded to create the business and business plan which they presented to the business community at large at a formal screening. One of the businesses has now gone on to be funded by the angel investment community and has obtained an NSF SBIR award.

[*] TechHorizons is an annual conference of the UCR Bourns College of Engineering designed to engage industry with UCR faculty and students on advanced technologies.

- In the winter and early spring of 2008, the WIRED students prepared and conducted three student to student workshops focused on business presentation skills and poster design. They designed and ran the UCR Tech Horizon Poster Contest in which 41 participants presented their business applications in poster and verbal presentation over the two-day conference resulting in monetary rewards for four of the poster candidates. (Appendix 6).

Figure 6-1. Engineering students participated in MBA courses (top) and worked in interdisciplinary teams. They trained in speaking and presenting skills in preparation for UCR's annual TechHorizons conference, in which they had to present the potential market impacts of engineering research (center right and bottom).

C. Field Trips

Students participated in academic and industry forums in which various aspects of innovation issues were discussed. These field trips included conferences sponsored by OCTANe (a Southern California organization which facilitates innovation development through networking activities), Caltech/MIT Enterprise Forum (a joint venture of Caltech Industrial Relations Center, Alumni Association and the MIT Alumni Association which hosts monthly networking forums on key entrepreneurial issues), Medical Design & Manufacturing West Conference, the Third Annual Biomedical Form, TECH 100 Conference, and The West Coast Oil & Gas Industry Conference. Students wrote up their learning experiences from each field trip and discussed them in formal classroom and WIRED team meetings.

D. College Wide Workshop Conclusions

In the fall of 2008, WIRED personnel conducted two workshops with faculty and graduate students from the Bourns College of Engineering (BCOE). The meetings consisted of a brief overview of the findings presented in Section 5 of this report, and a discussion of the things we can do in response. To the greatest extent possible, we avoided solutions that rely on curriculum changes, since the undergraduate and graduate engineering curriculum already is heavily loaded, and curriculum changes generally require long and expensive processes to implement.

The workshops produced the following suggestions:

- **Integrating innovation into new undergraduate breadth requirements.**
  UCR is undertaking an overhaul of the breadth requirements for undergraduates – the required courses outside of a student's major. The new approach gives students the opportunity to choose themes, such as sustainability, that will permeate their breadth courses. In this context, we can assure greater inclusion of "real-world" topics, such as ethics.

- **Master of Engineering.**
  BCOE is developing a Master of Engineering (M.Eng) degree designed for mid-career professionals who wish to earn an advanced degree. Unlike a Master of Science degree, M.Eng will be broadly focused to include business and societal topics. We envision offering much of the M.Eng curriculum on-line, which will make it possible for traditional M.S. and Ph.D. students to review lectures and other materials on the topics that California companies seek.

- **Certificate Programs in the Business of Engineering and Science**
  Several units on campus are in differing stages of producing certificate programs designed to incorporate targeted business awareness into existing academic STEM field studies.

- **Expanding the Teaching Assistant Development Program**
  The Teaching Assistant Development Program (TADP) at UCR was created in 1988 through a grant from the U.S. Department of Education's Fund for the Improvement of Post-Secondary Education. The program began as a broad, interdisciplinary program, and now uses disciplinary clusters to facilitate TA training. The program fulfils the California state mandate that all persons in charge of student education in the classroom be properly trained. Training topics include diversity and sensitivity, dealing with sexual harassment, proper classroom teaching techniques, UC and UCR campus policies, academic dishonesty and student conduct policies. The program consists mainly of a series of seminars lasting one academic quarter. Senior graduate students and faculty also attend classes taught by newer graduate students to review their performance.

  We envision that we can build on this mandatory framework with several optional modules. In principle, UCR could offer a series of "brown bag" workshops once a week, or perhaps once every two weeks, to anyone interested in attending – faculty, students, and staff. Topics can include written communication, oral presentation skills, research ethics, business ethics, budgeting, time management, and business principles for engineers. This flexible, informal program can be repeated every year and modified to take advantage of visiting speakers and new needs.

- **Expanding programs required under the America COMPETES Act**
  The America COMPETES Act of 2007 (PL 110-69, signed August 9, 2007) requires that any organization employing postdoctoral researchers under funding from the National Science Foundation to provide mentoring to those researchers. Examples of mentoring activities mentioned in the law (Section 7008) include career counseling, training in preparing grant applications, guidance on ways to improve teaching skills, and training in research ethics. The aim is to develop postdoctoral researchers' skills so they can become independent researchers. This means that UCR and every other academic institution with NSF-supported postdoctoral researchers will have to develop formal or informal training mechanisms. As these evolve at UCR, we will be mindful of the skill sets that California companies want. Over the long run, perhaps the expanded TADP and the postdoctoral training program will converge into a broad-based program that addresses the themes shown in Section 5.

- **Weekend business "boot camp" for engineering students**
  The idea of having "boot camps" on business topics, either for one or several Saturdays was not popular. Students indicated that they would be unlikely to attend unless these sessions were mandatory. However, one student suggested that these courses could be offered in lieu of regular courses during one week each academic year. This would emphasize the special importance of the material. Perhaps Engineering Week would be the right time for such an event.

- **Broadening weekly graduate seminar series**
  Every department in the Bourns College of Engineering conducts a seminar series, in which researchers from other institutions and organizations visit and present their current

research findings. Graduate students must attend these sessions. It is feasible to expand the scope of these lectures to include topics such as business and ethics.

- **Technical writing course**
  Two departments in the Bourns College of Engineering, Computer Science and Engineering and Electrical Engineering, require undergraduates to take ENGR 180, a course in technical communication. Other departments are considering this course, and there is some support for making this a requirement for graduate students as well. Nationally, far more than half of all Ph.D. students in engineering come from overseas, and are not native English speakers. Although they pass the Test of English as a Foreign Language, it is widely agreed that their writing and speaking skills need improvement. A required course in written and spoken technical communication could be a valuable addition.

  Informally, technical communication skills could be improved through a program that the WIRED project piloted. The Bourns College of Engineering conducts an annual "industry day" style workshop to highlight the research taking place here and potential collaborations with industry. In 2008, engineering and business graduate students held two workshops to build the engineering students' skills in preparing and presenting posters on their work. Engineering students brought their posters, or drafts of their presentations, and delivered them to the group. The students then critiqued the presenter and made constructive comments on how to improve the material. The focus was on emphasizing the potential impact and benefits of the research, rather than on methodology and technical minutiae. These workshops could become annual events.

  Similarly, one student suggested informal "mixers" for faculty and graduate students, in which graduate students are given the opportunity to talk about their research and build conversational skills.

- **Continue the site visits**
  The site visits were a means to an end in the WIRED project, but they could be an end in themselves. Half-day visits to companies are positive experiences for the participating students, the faculty members, and the company representatives. Students must learn about the companies before they visit, and in the process they must pick up some business vocabulary. During the visit, they can ask questions that relate business principles and practices to their research, so they can broaden their perspectives on how ideas migrate from the laboratory to the market. Business people, for their part, learn about new research under way at the University, and they get an early look at prospective new hires. The students also begin building professional networks as a result of the interactions.

- **Internships**
  Internships are widely believed to be valuable experiences for undergraduates and graduates. One or two summers of industry or agency experience, or perhaps one or two quarters during a student's academic career, provide valuable applied experience. In particular, the students learn about business processes, quality management, competitive

considerations, budgeting, scheduling, and other aspects of the engineering and innovation processes in the real world. The consensus is that interns are more marketable upon graduation, too, by virtue of their industry experience.

- **The business card effect**
  At the April 2008 WIRED meeting, we reported on the "business card effect." Students who participated in the site visits were given business cards – they found it awkward to ask for business cards at meetings without having their own to give out in return. Supply of cards begets demand for opportunities to hand out business cards. Many of the WIRED students attended meetings of OCTANe and the Caltech Enterprise Forum because these were opportunities to learn about business topics, meet prospective colleagues, and, of course, exchange business cards.

7. Next Steps

A. Publishing Current Results

Several research articles are expected to result from this study and will be presented to the appropriate journals. Current working papers include:

- Modeling innovation metrics for wealth generation.
- Innovation metrics and the supply chain.
- Engineering cooperative education lessons learned from the WIRED project.

B. Further Research in Innovation

The WIRED Task 1.5 study has resulted in a first modeling of innovation culture characteristics within California based technology companies. Further analysis of the online questionnaire is required to understand fully the implications this might have on this first model. Additional empirical work is required in order to develop a definitive model and to test its validity in the marketplace. A larger and more targeted sampling population is needed for this next step. As this model is validated for California based companies, a cross-border analysis should be conducted with neighboring states and countries. Numerous studies exist in the European sphere which should be evaluated in light of the California market as they could lead to additional variables of interest. An exploratory research project in this cross border vein could be conducted with certain Asian countries which are involved in outsourcing activities with California based businesses.

Lastly, it is recommended that further cross-disciplinary active learning projects involving innovation processes should be developed and institutionalized at the bachelor’s, master’s, and doctoral levels in order to increase a broader understanding of the implications of sound innovation programs and processes for competitive sustainability.

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Appendices

Appendix 1. Annotated Bibliography

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Andrew, J.P., Sirkin, H., & Butman, J. (2007). *Payback: Reaping the Rewards of Innovation.* Boston: Harvard Business School Press.

Authors James Andrew and Harold Sirkin, senior partners in The Boston Consulting Group, describe an approach to managing innovation based on the concept of a cash curve, which tracks investment against time.

Berkun, S. (2007). *The Myths of Innovation.* Sebastopol, CA: O'Reilly Media, Inc.

How do you know whether a hot technology will succeed or fail? Or where the next big idea will come from? The best answers come not from the popular myths we tell about innovation, but instead from time-tested truths that explain how we've made it this far. This book shows the way.

Bernstein, J.I., & Nadiri, M.I. (1989). *Research and Development and Intra-Industry Spillovers: An Empirical Application of Dynamic Duality*. Preprint / NBER, 1283. Cambridge, MA: National Bureau of Economic Research.

Boyer, K., Frohlich, M.T., & Hult, T.M. (2004). *Extending the Supply Chain: How Cutting-Edge Companies Bridge the Critical Last Mile into Customers' Homes*. New York: AMACOM Div American Management Association.

Brenner, T., & Greif, S. (2003). *The Dependence of Innovativeness on the Local Firm Population: An Empirical Study of German Patents*. Papers on economics and evolution, 0306. Jena: Max-Planck-Inst. for Research into Economic Systems.

In many studies, local clusters are repeatedly related to a high level of innovativeness; however, this article discusses four industries within the German market about the impact of location and innovativeness. The article concludes that innovativeness does indeed depend on other firms in the same region but also depends on the idea of studying the industry as a whole.

Burgelman, R.A., Christensen, C., & Wheelwright, S.C. (2003). *Strategic Management of Technology and Innovation (4th ed.)* Boston: McGraw Hill Higher Education.

This text covers the latest research by using a combination of text, readings, and cases. Based on reviewer response to a survey, the authors have updated many of the cases and instructors found outdated or lacking.

Carlson, C.R., & Wilmot, W.W. (2006). *Innovation: The Five Disciplines for Creating what Customers Want.* New York: Crown Business.

The book cites dozens of examples of innovative ideas brought to fruition by innovators from Thomas Edison to Steve Jobs. It outlines the critical decision-making process required to think innovatively and offered a well-reasoned approach to innovation.

Chesbrough, H.W. (2006). *Open Business Models: How to Thrive in the New Innovation Landscape.* Boston, MA: Harvard Business School Press.

The author demonstrated in this book that because useful knowledge is no longer concentrated in a few large organizations, business leaders must adopt a new, "open" model of innovation. Using this model, companies look outside their boundaries for ideas and intellectual property (IP) they can bring in, as well as license their unutilized home-grown IP to other organizations.

Chesbrough, H.W. (2003). *Open Innovation: The New Imperative for Creating and Profiting from Technology.* Boston, MA: Harvard Business School Press.

The path-breaking analysis in this book is based on extensive field research, academic study, and the author's own longtime experience working in Silicon Valley. Through rich descriptions of the innovation processes, Open Innovation shows how companies can use their business model to identify a more enlightened role for R&D in a world of abundant information, better manage and access intellectual property, advance their current business, and grow their future business.

David, F.R. (2006). *Strategic Management*. Upper Saddle River, NJ: Pearson Education.

Davila, T., Epstein, M.J., & Shelton, R.D. (2006). *Making Innovation Work: How to Manage It, Measure It, and Profit from It*. Upper Saddle River, N.J.: Wharton School Pub.

This book challenges the prevalent misconceptions and lays out the tools and processes necessary for an organization to harness and execute innovation.

Dorf, R. C., & Byers, T. (2006). *Technology Ventures: From Idea to Enterprise*. New York, NY: McGraw-Hill Higher Education.

Technology Ventures examines a global phenomenon known as "technology entrepreneurship." Entrepreneurship represents a vital source of change in all facets of society, empowering individuals to seek opportunity where others see insurmountable problems. Technology entrepreneurship is a style of business leadership that involves identifying high-potential, technology-intensive commercial opportunities, gathering resources such as talent and capital, and managing rapid growth and significant risks using principled decision-making skills.

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This book presents innovation and entrepreneurship as a purposeful and systematic discipline that explains and analyzes the challenges and opportunities of America's new entrepreneurial economy. *Innovation and Entrepreneurship* explains what established businesses, public service institutions, and new ventures need to know and do to succeed in today's economy.

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Hollensen, S. (2003). *Global Marketing: A Market-Responsive Approach*. Harlow, Great Britain: Financial Times Prentice Hall.

Hruby, F. M. (2006). *Techno Leverage: Using the Power of Technology to Outperform the Competition*. New York, NY: American Management Association.

This work provides tips to companies to use technology more effectively, so as to better struggle in terms of growth, profitability, and value.

Kaplan, R.S., & Norton, D.P. (1996). *The Balanced Scorecard: Translating Strategy into Action*. Boston, Mass: Harvard Business School Press.

The Balanced Scorecard translates a company's vision and strategy into a coherent set of performance measures. The four perspectives of the scorecard – f inancial measures, customer knowledge, internal business processes, and learning and growth – offer a balance between short-term and long-term objectives, between outcomes desired and performance drivers of those outcomes, and between hard objective measures and softer, more subjective measures.

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

The author, general manager of the Silicon Valley based design firm IDEO, takes readers behind the scenes of this wildly imaginative and energized company to reveal the strategies and secrets it uses to turn out hit after hit.

Link, A.N., & Scott, J.T. (1998). *Public Accountability: Evaluating Technology-Based Institutions.* Norwell, MA: Kluwer Academic Publishers.

Markides, C., & Geroski, P. (2005). *Fast Second: How Smart Companies Bypass Radical Innovation to Enter and Dominate New Markets*. San Francisco, CA: Jossey-Bass.

The thesis of this book is that being a "fast second" in a market is often more financially rewarding than being at the cutting edge.

Narayanan, V.K. (2001). *Managing Technology and Innovation for Competitive Advantage*. Upper Saddle River, NJ: Prentice Hall.

National Academy of Engineering (2005). *Educating the Engineer of 2020: Adapting Engineering Education to the New Century*. National Academies Press: Washington, D.C.

Rogers, E.M. (2003). *Diffusion of Innovations* (5th ed.). New York, NY: The Free Press.

The author provides a new set of case examples that illustrate diffusion scholarship in the past decade. The book also includes a revised bibliography.

Santarelli, E. (2006). *Entrepreneurship, Growth, and Innovation: The Dynamics of Firms and Industries*. New York, NY: Springer.

This book provides insight into the economics of entrepreneurship, claiming that this recently established discipline should establish a framework of analysis that integrates the understanding of the determinants and the effects of both entrepreneurship and innovation without neglecting the functioning of the inducement mechanisms. For this purpose, the book combines theoretical prescriptions and international empirical evidence. Contributions by scholars in the economics of entrepreneurship and innovation investigate whether the interrelationships between the forces that affect firm and industry dynamics and ultimately determine economic growth are subject to change across countries and over time.

Schilling, M.A. (2007). *Strategic Management of Technological Innovation*. New York, NY: McGraw-Hill Irwin.

Shenhar, A., & Dvir, D. (2007). *Reinventing Project Management: The Diamond Approach to Successful Growth and Innovation*. Boston, Mass: Harvard Business School Press.

Projects are the engines that drive innovation from idea to commercialization. The number of projects in most organizations today is expanding while operations are shrinking. Yet, since many companies still focus on operational excellence and efficiency, most projects fail – largely because conventional project management concepts cannot adapt to a dynamic business environment. Moreover, top managers neglect their company's project activity, and line managers treat all their projects alike – as part of operations.

Tidd, J., Bessant, J.R., & Pavitt, K. (2001). *Managing Innovation: Integrating Technological, Market and Organizational Change*. Chichester, England: John Wiley.

Utterback, J. M. (1994). *Mastering the Dynamics of Innovation: How Companies Can Seize Opportunities in the Face of Technological Change*. Boston, Mass: Harvard Business School Press.

The author looks at how innovation transforms industries, raising the fortunes of some firms while destroying others. The book draws on the history of innovation by inventors and entrepreneurs to develop a practical model for how innovation enters an industry, how mainstream firms typically respond, and how, over time, new and old players wrestle for dominance.

Articles

Adams, J.D., Chiang, E.P., & Starkey, K. (2000). Industry-university cooperative research centers. *NBER Working Paper Series*, 7843. Cambridge, Mass: NBER.

Amasaka, K. (2007). Applying new JIT: Toyota's global production strategy: Epoch-making innovation of the work environment. *Robotics and Computer Integrated Manufacturing.* 23 (3), 285-293.

> In order to strengthen management technology strategy, the author has recently developed a new management technology principle, New JIT, based on TMS, TDS, TPS and TQM-S. In developing "Global Marketing" that can win the global competition for quality and cost, the key for domestic and foreign companies is to successfully achieve "Global Production" that enables simultaneous production start-up (the same quality and production at optimal locations) throughout the world. This paper analyzes and proves the significance of strategically applying New JIT—a global production strategy activity called AWD6P/J—for epoch-making innovation of the work environment, as verified at Toyota. While many vehicle assembly shops depend on a young, male workforce, innovation in optimizing an aging workforce is a necessary prerequisite of TPS — a production strategy of New JIT. Elements necessary for enhancing work value and motivation, and work energy, including working conditions and work environment (amenities and ergonomics), were investigated through objective survey and analyzed from labor science perspectives.

Anand, N., Gardner, H.K., & Morris, T. (2007). Knowledge-based innovation: Emergence and embedding of new practice areas in management consulting firms. *Academy of Management Journal.* 50 (2), 406-428.

> The authors address how innovative knowledge-based structures emerge and become embedded in organizations. They use theories of knowledge intensive firms, communities of practice and professional service firms to conduct a multiple-case process analysis of new practice area creation in management consulting firms. Qualitative analysis identifies four generative elements that are critical to the process: socialized agency, differentiated expertise, defensible turf, and organizational support. The article's thesis is that these elements need to be combined in specific pathways for the successful emergence and embedding of knowledge-based innovative structures. The pathways emerge from three sources of new knowledge: networks of practitioners, markets for knowledge-based services, and hierarchies of professional firms.

Andersson, M., & Karlsson, C. (2007). Knowledge in regional economic growth – the role of knowledge accessibility. *Industry and Innovation.* 14 (2), 129-149.

> This paper looks at the idea of variation in knowledge depending on regions and whether or not it explains growth in certain areas. The paper concludes that if knowledge is accessible to people in those areas the more value added an employee is in that region increasing overall knowledge and growth in those areas. However, knowledge does flow across boundaries but they usually tend to stay near their functional areas.

Atkinson, R.D., & Correa, D.K. (2007). The 2007 state new economy index: Benchmarking economic transformation in the states. *The Information Technology and Innovation Foundation*. Retrieved April 6, 2007 from http://www.itif.org/index.php?id=30

Attridge, J. (2007). Innovation models in the biopharmaceutical sector. *International Journal of Innovation Management.* 11 (02), 215-243.

The innovation process in the biopharmaceutical sector is influenced by long business cycles, multiple stakeholders and complex interactions. Early models of the innovation process are inadequate to capture the complexity of innovation in the life sciences sector. In particular, narrow classifications which describe innovations as "radical" or "incremental" are not particularly useful when considered in the context of the complex patterns of interrelated innovations observed in practice. Many partial models of the innovation process which equate innovation to inventive research, patenting and product development fail to recognize that innovation is a cyclical and business-driven process and underscore the final phase of the innovation process, namely, achieving timely market diffusion and adoption of innovations to benefit patients and innovators. Innovation is sustained if it is appropriately rewarded. Investment in the science base alone without appropriate reward system for innovations is unlikely to promote renewed competitiveness in the European biopharmaceutical industry.

Atun, R.A., Harvey, I., & Wild, J. (2007). Innovation, patents and economic growth. *International Journal of Innovation Management.* 11 (02), 279-297.

Empirical evidence demonstrates the value of intellectual property (IP) in creating economic growth, enhancing productivity and profitability, and increasing enterprise value. Research and development (R&D) intensive industries, such as the life sciences, where patents are critical to competition, need an enabling environment to institutionalize innovation and IP generation and reward investments in IP. The US has approached IP strategically and created an IP infrastructure. Japan aims to develop into an "IP nation." China has an increasingly well-developed IP system. In contrast, the European Union (EU), which aims to become the world's leading knowledge-based economy, has a fragmented and expensive system of national patents. It lacks an environment which values investment in IP generation and management. Until recently, the EU enjoyed global competitive advantage in the life sciences, but this advantage has been lost. To regain this competitive advantage the EU must invest substantially in R&D, IP generation and commercialization of these outputs.

Barsh, J., Capozzi, M., & Davidson, J. (2008). Leadership and innovation. *The McKinsey Quarterly.* (1), 36-47.

Baxter, H. (2003, August 14). Ten tips for driving innovation by managing knowledge. Message posted to *Knowledge Board* http://www.knowledgeboard.com/cgi-bin/item.cgi?id=354

This article discusses the linkage between knowledge and innovation, specifically the management and emphasis on retaining and sharing of knowledge. She makes ten key points for innovation: Use of knowledge management for efficiencies, Leveraging content management systems, Reusing knowledge, Identifying experts and obtaining access to them, Distribute Best Practices, Build Communities for intradepartmental knowledge sharing, publicize resources, practice innovation in Human Resources, Encourage Learning, and support a knowledge management infrastructure.

Bernstein, J.I., & Nadiri, M.I. (1989). Research and development and intra-industry spillovers: an empirical application of dynamic duality. Cambridge, MA: *National Bureau of Economic Research*. Preprint / NBER, 1283.

Biemans, W., Griffin, A., & Moenaert, R. (2007). Twenty years of the Journal of Product Innovation Management: History, participants, and knowledge stock and flows. *Journal of Product Innovation Management.* 24 (3), 193-213.

The *Journal of Product Innovation Management* (JPIM) serves as a marketplace for science-based, innovative ideas that are produced and consumed by scholars and businesspeople. Now that JPIM has existed for 20 years, two intriguing questions emerge: (1) How has the journal evolved over time in terms of knowledge stock, that is, what are the characteristics of the growing stock of knowledge published by JPIM over the years; and (2) how has the journal evolved in knowledge flow, that is, how is JPIM influenced by other scientific publications and what is its impact on other journals? In terms of knowledge stock, over 35% of the articles published over the 20 years investigate processes and metrics for performance management. The next most frequently published area was strategy, planning, and decision making (20%), followed by customer and market research (17%). The dominant research method used was a cross-sectional large-sample survey, and the focus most usually is at the project level of the firm. The large majority of JPIM authors (60%) have a marketing background, with the remaining 40% representing numerous functional domains. Academics at all levels publish in JPIM, and though most authors hail from North America, the Dutch are a significant second group. JPIM was analyzed from a knowledge-flow perspective by looking at the scientific sources used by JPIM authors to develop their ideas and articles. To this end a bibliometric analysis was performed by analyzing all references in articles published in JPIM. During 1984–2003 JPIM published 488 articles, containing 10,314 references to journals and 6,533 references to other sources. Some 20% of these references (2,020) were self-references to JPIM articles. The remaining 8,294 journal references were to articles in 287 journals in the fields of management (25%), marketing (24%), and management of technology (14%).

Bourne, J., Mayadas, F., & Campbell, J. (2000). Asynchronous learning networks: An information-technology-based infrastructure for engineering education. *Proceedings of the IEEE*, 88(1), 63-71.

Brenner, T. (2007). Local knowledge resources and knowledge flows. *Industry and Innovation.* 14 (2), 121-128.

Brette, O., & Chappoz, Y. (2007). The French competitiveness clusters: Toward a new public policy for innovation and research? *Journal of Economic Issues.* 41 (2), 391-398.

In December 2002, the French government gave impetus to a new public policy for regional planning and development. Almost two years later, in November of 2004, the implementation of this policy resulted in a call for projects to create "competitiveness

clusters" ("pôles de compétitivité"). This initiative primarily aimed at promoting partnerships between companies, higher education hubs and research units on a regional or interregional scale around innovative projects. The call for projects was a great success, far beyond governmental expectations. The Interministerial Committee for Regional Planning and Development (Comité interministériel d'aménagement et de développement du territoire – CIADT) meeting on July 12, 2005, confirmed 67 competitiveness clusters among the 105 projects which were submitted. This paper assesses the extent to which the French policy in favor of competitiveness clusters lays the foundations of a new kind of public policy to foster innovation and research. Its first objective is to place the scheme in favor of competitiveness clusters in the history of French policy of innovation and research, since 1945. Secondly, it points out that the main stake of the cluster policy is to promote the emergent effects of the partnerships between geographically close actors. Such an aim implies a break from the linear view of the relations between public research and innovation. Thirdly, it puts forward the idea that this policy may be conceived of as an implementation of the model of the "collective production of public goods," which was supported by the participants of the Paris Forum on Science, Economy and Society organized by the Forum Engelberg in 1999. This model is based on a multilateral frame of knowledge production and transfer. Thus, it opens a potentially successful via media between the traditional model of open science and the strictly market-based model that has appeared in some.

Brokel, T, & Binder, M. (2007). The regional dimension of knowledge transfer-a behavioral approach. *Industry and Innovation*, 14(2), 151-175.

This paper discusses the idea that innovations are directly correlated with knowledge transfers. The paper argues whether or not face-to-face contact is the most effective way to transfer knowledge or if there are other effective ways to do so.

Brown, A. (2007). A learning design framework for university/corporate educational collaboration. *Proceedings from the 14th EDINEB Conference*, Vienna, Austria, track 2.

Brown, R., & Odgers, J. (1995). Producing enterprising engineers through integrated technology and business experiential learning. *Proceedings from the 1995 Frontiers in Education Conference*, November 2-4, session *4a4.5.*

Burpitt, W.J., & Bigoness, W.J. (1997). Leadership and innovation among teams: The impact of empowerment. *Small Group Research.* 28 (3), 414-423.

This study investigated the effects of leader-empowering behavior on the level of innovation among professional project teams. The study was conducted in two phases. Phase I used extensive field-based interviews to develop measures of leader-empowering behavior and team-level innovation. Phase II applied the scales to test the relationship between the two variables. Ratings of team-level innovation were supplied by the principals of 20 firms. Ratings of leader-empowering behavior were supplied by members of 60 teams within the 20 firms. The results demonstrated a significant relationship between leaders' empowering behavior and evaluations of team innovation made by the principals. The study identifies explicit behaviors managers can employ to stimulate innovation among teams.

Caballero-Sanz, F., Moner-Colonques, R., & Sempere-Monerris, J. (2005). Licensing policies for a new product. *Economics of Innovation and New Technology.* 14 (8), 697-713.

The article is about the best licensing policies for the owner of a new product. It concludes that the best licensing policy for the patent holder is fixed fee licensing with an exclusive territory clause.

Cainelli, G., Evangelista, R., & Savona, M. (2006). Innovation and economic performance in services: A firm-level analysis. *Cambridge Journal of Economics.* 30 (3), 435-458.

This paper explores the two-way relationship between innovation and economic performance in services using a longitudinal firm-level dataset which matches data from the second Community Innovation Survey, CIS II (1993-95), against a set of economic variables provided by the System of Enterprise Accounts (1993-98). The results presented show that innovation is positively affected by past economic performance and that innovation activities (especially investments in ICTs) have a positive impact on both growth and productivity. Furthermore, productivity and innovation act as a self-reinforcing mechanism, which further boosts economic performance. These findings provide empirical support for the endogenous nature of innovation in services and the presence in this sector of competition models and selection mechanisms based on innovation.

Calantone, R.J., & Stanko, M.A. (2007). Drivers of outsourced innovation: An exploratory study. *Journal of Product Innovation Management.* 24 (3), 230-241.

The outsourcing of innovation has been on the rise for years, but research in this area lags behind industry practice. Interviews with managers and a theory base grounded in transaction cost analysis are used to guide the development of an exploratory model that details potential drivers of the outsourcing of innovation activities. Using industry-level data, the proposed model is partially tested using two distinct regression analyses that reveal significant effects both contemporaneously and persisting over time. Several of the proposed drivers of outsourced innovation are shown to be significant, including exploratory research performed and profit margin. The finding that exploratory research performed is significantly related to the outsourcing of innovation activities represents a significant contribution to the innovation and organizational learning literatures. As well, finding a relationship between margins and organizational sourcing fills a gap in the business to business marketing literature. Managerial implications are drawn for both managers of the innovation process in traditional firms and those in firms wishing to garner outsourced innovation contracts. The drivers found to be significant in this study should allow for better resource planning from innovation managers in traditional firms as well as better targeting of perspective clients from firms seeking contract innovation business.

Camp, S.M. (2005). The innovation-entrepreneurship NEXUS a national assessment of entrepreneurship and regional economic growth and development. Washington, D.C.: SBA Office of Advocacy. http://purl.access.gpo.gov/GPO/LPS95743.

Carlson, L., & Sullivan, J. (1999). Hands on engineering: learning by doing in the integrated teaching and learning program. *International Journal of Engineering Education*, 15(1), 20-31.

Council on Competitiveness (2005). Measuring regional innovation: A guidebook for conducting regional innovation assessments. Retrieved October 19, 2008 from http://www.compete.org/images/uploads/File/PDF%20Files/Regional_Innovation_Guidebook.pdf

Cefis, E., & Marsili, O. (2005). A matter of life and death: Innovation and firm survival. *Industrial and Corporate Change.* 14(6), 1167-1192.

> This article examines the effects of innovation on survival using data on all manufacturing firms active in the Netherlands and the Community Innovation Survey. By estimating a parametric duration model, we show that firms benefit from an innovation premium that extends their life expectancy, independent of firm-specific traits such as age and size. Process innovation in particular seems to have a distinctive effect on survival. Furthermore, survival chances increase with the age and growth rate of a firm, the latter being more crucial than initial size. Finally, high intensity technology sectors are the most favorable to firm's survival.

Chesbrough, H., & Rosenbloom, R.S. (2002). The role of the business model in capturing value from innovation: Evidence from Xerox Corporation's technology spin-off companies. *Industrial and Corporate Change.* 11(3), 529.

> This paper explores the role of the business model in capturing value from early stage technology. A successful business model creates a heuristic logic that connects technical potential with the realization of economic value. The business model unlocks latent value from a technology, but its logic constrains the subsequent search for new, alternative models for other technologies later on – an implicit cognitive dimension overlooked in most discourse on the topic. The article explores the intellectual roots of the concept, offer a working definition and show how the Xerox Corporation arose by employing an effective business model to commercialize a technology rejected by other leading companies of the day. It then shows the long shadow that this model cast upon Xerox's later management of selected spin-off companies from Xerox PARC. Xerox evaluated the technical potential of these spin-offs through its own business model, while those spin-offs that became successful did so through evolving business models that came to differ substantially from that of Xerox. The search and learning for an effective business model in failed ventures, by contrast, were quite limited.

Cockburn, I., & Henderson, R. (1996). Public-private interaction in pharmaceutical research. *Proceedings- National Academy of Sciences USA.* 93(23), 12725-12730.

Cockburn, I., & Henderson, R. (1998). Absorptive capacity, coauthoring behavior, and the organization of research in drug discovery. *Journal of Industrial Economics.* 46(2), 157-182.

Cohen, L. (1994). When can government subsidize research joint ventures: politics, economics, and limits to technology policy. *American Economic Review Papers and Proceedings*. 84(2), 151-163.

Conference Board of Canada (2002). Success by design: what works in workforce development. (CBC Report No. 280-02). Ottawa, ON: Bloom, M. and Campbell, A.

Cooke, P. (2001). Regional innovation systems, clusters, and the knowledge economy. *Industrial and Corporate Change*. 10(4), 945-974.

This paper presents a systematic account of the idea and content of regional innovation systems following discoveries made by regional scientists, economic geographers and innovation analysts. It considers the conditions and criteria for empirical recognition and judgment as to whether scientifically analyzed, concrete cases of innovation activity warrant the designation of regional innovation system. The paper concludes by claiming that the source for Europe's innovation gap with the United States rests on excess reliance on public intervention, which signifies major market failure. The future will require widespread evolution of public innovation support systems along with stronger institutional and organizational support from the private sector.

Cozzarin, B.P., & Percival, J. (2006). Complementarities between organizational strategies and innovation. *Economics of Innovation New Technology*. 15(3), 195-217.

The article examines the complementarily between organizational strategies and innovation according to different manufacturing industries.

Doring, T., & Schnellenbach, J. (2006). What do we know about geographical knowledge spillovers and regional growth? A survey of the literature. *Regional Studies -Cambridge & New York*. 40 (3), 375-395.

This paper looks at a survey composed to try to find some insight regarding clusters in different areas that carry different levels of growth. The paper discusses both the spatial dimension of knowledge and the empirical evidence concerning these thoughts.

Etro, F. (2004). Innovation by leaders. *The Economic Journal*. 114 (495), 281-303.

A new rationale for the persistence of monopolies is based on a pre-commitment of the incumbent monopolist to invest in R&D. In a patent race, as long as entry is free, the Arrow effect disappears: The incumbent has more incentives to invest than any outsider. Paradoxically, a market with some persistence of monopoly is competitive, while one with continuous leapfrogging must hide some barriers to entry. When the size of innovations is endogenous, leaders invest in more radical innovations. If there is a sequence of innovations, cycling investment emerges.

European Union Commission on Enterprise and Industry Innovation Policy (October 17, 2008). Towards world-class clusters in the European Union: implementing the broad-based innovation strategy. Retrieved October 17 from http://ec.europa.eu/enterprise/innovation/doc/com_2008_652_en.pdf

Ewing, J. (May 4, 2007). First mover in mobile. *Business Week*. Retrieved October 17, 2008 from http://www.businessweek.com/innovate/content/may2007/id20070504_299909.htm?chan=innovation_special+report+--+2007+most+innovative+companies_2007+most+innovative+companies

The article analyzes Nokia's innovation in the industry and how Nokia is selling cell phones to the developing world.

Farazmand, A. (2004). Innovation in strategic human resource management: Building capacity in the age of globalization. *Public Organization Review*. 4 (1), 3-24.

This article addresses innovation as a strategic instrument in human resource management capacity building in the age of globalization. To meet the challenges of globalization – negative as well as positive – capacity building is needed in areas of organization, management, governance, and public administration all over the world. Innovation is defined, strategic innovations and innovative strategies are explained, capacity building is delineated, and over 22 areas or realms of innovation are identified, explained, and emphasized as strategic instruments of capacity building. Viewing human resources as human capital and beyond, the article argues that without human resources nothing can be accomplished, and without a well-trained, well-developed, well-appreciated, and well-managed human resources, modern organizations of government and business cannot meet the challenges of the globalization age, which demands a new generation of future-oriented, anticipatory managers who can develop effective visions and manage organizations by riding the high waves of change in the turbulent world.

Fisher, K., Lobaugh, M., & Parente, D. (2006). An assessment of desired business knowledge attributes for engineering technology graduates. *Journal of Engineering Technology*, 23, 10-15.

Fortenberry, N., Sullivan, J., Jordan, P., & Knight, D. (2007). Retention: Engineering education research aids instruction. *Science*, 31 August 2007, 317(5842), 1175-1176.

Fountain, M. (2004). The development and implementation of an interdisciplinary graduate course linking business, engineering, arts and sciences and medical students with university research investigators to develop strategies to commercialize new technologies. *Proceedings from the 2003 ECI Conference on Teaching Entrepreneurship to Engineering Students*, Monterey, CA, Paper 17.

Fritsch, M., & Slavtchev, V. (2007). Universities and innovation in space. *Industry and Innovation*. 14 (2), 201-218.

The article investigates the role of universities as a knowledge source for regional innovation processes. The contribution of universities is tested on the level of German NUTS-3 regions (Kreise) by using a variety of indicators. The intensity and quality of the research conducted by the universities have a significant effect on regional innovative output while pure size is unimportant. Therefore, a policy that wants to promote regional innovation processes by building up universities should place substantial emphasis on the intensity and quality of the research conducted there. The article also finds the effects of universities to be concentrated in space. Obviously, the geographical proximity to particular knowledge sources is important for regional innovative activities.

Fry, C.C., & Leman, G. (2007). International technology entrepreneurship: Immersion into interdisciplinary innovation (I^5) in Shanghai. *Proceedings of the 37th ASEE/IEEE Frontiers in Education Conference T2E-3*, Milwaukee, WI, October 10-13, 2007.

Gassmann, O., & Becker, B. (2006). Towards a resource-based view of corporate incubators. *International Journal of Innovation Management.* 10 (01), 19-45.

The article describes how incubators work and especially how and where they find their resources. While tangible resources, such as the financial, physical and even explicit knowledge flow, are all visible, and therefore easy to measure, intangible resources such as tacit knowledge and branding flow are harder to detect and localize.

Getz, I., & Robinson, A. (2003). Innovate or die: Is that a fact? *Journal of Creativity and Innovation Management*, 12(3), 130-136. Retrieved from http://www.blackwellpublishing.com/journal.asp?ref=0963-1690&site=1

This article explores why business leaders have been so prone to fall for such a naïve message, and shows how it has caused them to overlook the true sources of long-term high performance.

Gordon, I.R., & McCann, P. (2005). Innovation, agglomeration, and regional development. *Journal of Economic Geography.* 5 (5), 523-543.

This paper provides a critical examination of the widely disseminated view that innovation in all or most activities is favored by certain common characteristics in the local "milieu," involving a cluster of many small firms benefiting from flexible inter-firm alliances, supported by mutual information exchanges of both an informal and formal nature. The general applicability of this model, and the localness of crucial linkages, is questioned initially on the basis of a review of different hypotheses about the geography of innovation. Moreover, examination of new survey evidence from a large number of firms in the London conurbation suggests that the importance of specifically local informal information spillovers for successful innovation is very much more limited than has been suggested, as are the supposed advantages of firm smallness.

Griliches, Z. (1958). Research costs and social returns: Hybrid corn and related innovations. *Econometrica.* 66, 419-431.

Hall, J.L.(2007). Developing historical 50-state indices of innovation capacity and commercialization capacity. *Economic Development Quarterly.* 21(2),107-123.

Recent attention to innovation as the core of a knowledge-based economy has resulted in an array of studies and reports that seek to measure states' relative ranks as they advance their economic agendas. This study improves on state performance measurement by distinguishing innovation capacity from innovation outcomes by examining change over a 20-year period with consistent measures and by empirically grouping measures into core resource categories using factor analysis. Factor analysis is used to generate new measures of innovation capacity, and the efficacy of these new measures is tested using pooled cross-sectional time-series analysis to examine their effects on state patent generation. The findings indicate moderate to strong impacts of the innovation capacity variables on patent generation; the results provide a new grounded metric for examining state capacity for innovation and state financial capacity for commercialization over time.

Hall, S., & Bryant, V. (2008). Assessment of professional skills for students in computing and engineering programs. *Journal of Computing Sciences in Colleges*, 23(4), 146-152.

Hoetker, G., Rajshree, A. (2007). Death hurts, but it isn't fatal: The post exit diffusion of knowledge created by innovative companies. *Academy of Management Journal.* 50(2), 446-467.

This article studies whether a company's innovative knowledge dies with the company or after the company leaves the respective industry. A study was done specifically on the disk drive industry, and it showed that knowledge outlives the firm and how firms should consider failing companies in order to help increase innovation.

Huse, M., Newbaum, D., & Gabrielsson, J. (2005). Corporate innovation and competitive environment. *International Entrepreneurship and Management Journal*. 1(3), 313-333.

This article examines the environment for corporate innovation relationship in Norwegian manufacturing firms. Second, it examines how the firms' corporate innovation activities are influenced by their international activities. Results indicate that environment and internationalization are positively related to corporate innovation, but models developed using U.S. firms may not generalize to firms from other countries.

Irwin, D., & Klenow, P. (1996). High-tech R&D subsidies-estimating the effects of SEMATECH. *Journal of International Economics*. 40, 323-344.

Jaffe, A.B., Fogarty, M.S., & Banks, B.A. (1998). Evidence from patents and patent citations on the impact of NASA and other federal labs on commercial innovation. *The Journal of Industrial Economics.* 46 (2), 183.

Jaffe, A.B., & Lerner, J. (1999). Privatizing R&D: Patent policy and the commercialization of national laboratory technologies. *Working Paper Series.* (7064).

Jana, R. (March 29, 2007). Service innovation: The next big thing. *Business Week*. Retrieved October 17, 2008 from http://www.businessweek.com/innovate/content/mar2007/id20070329_376916.htm?chan=search

IBM, Oracle, and other tech companies have formed a new nonprofit consortium dedicated to the advancement of this hot concept.

Jaruzelski, B., & Dehoff, K. (Winter 2007). The customer connection: The global innovation 1000. *Strategy & Business.* (49), 68. Reprint No 07407.

Booz-Allen Hamilton's annual study of the world's largest corporate R&D spenders finds two primary success factors: Aligning the innovation model to corporate strategy and listening to customers.

Jones, R., & Oberst, B. (2004). International entrepreneurship education. *Proceedings from the 2003 ECI Conference on Teaching Entrepreneurship to Engineering Students*, Monterey, CA, Paper 6.

Ketels, C.H.M. (November 23, 2003). The development of the cluster concept: Present experiences and further developments. *Harvard Institute for Strategy and Competitiveness*. Retrieved October 19, 2008 from http://www.isc.hbs.edu/pdf/Frontiers_of_Cluster_Research_2003.11.23.pdf

Clusters develop and are important because they create economic benefits. The benefits of a cluster come in three dimensions. First, companies can operate with a higher level of efficiency, drawing on more specialized assets and suppliers with shorter reaction times than they could in isolation. Second, companies and research institutions can achieve higher levels of innovation. Knowledge spillovers and the close interaction with customers and other companies create more new ideas and provide intense pressure to innovate while the cluster environment lowers the cost of experimenting. Third, the level of business formation tends to be higher in clusters. Start-ups are more reliant on external suppliers and partners, all of which they find in a cluster. Clusters also reduce the cost of failure, as entrepreneurs can fall back on local employment opportunities in the many other companies in the same field. These benefits are important both for cluster participants and for public policy. For companies, they create additional value that outweighs the often-higher costs of more intense competition for specialized real estate, skills, and customers at the location. They are thus the reasons that clusters emerge naturally from profit-maximizing decisions. For public policy, higher productivity and innovation in clusters are critical because they are the factors that in the long term define the sustainable level of prosperity in a region. Note, however, that the interests of these groups are not identical: Public policy is not concerned about the distribution of the cluster benefits among companies, employees, and owners of critical assets such as real estate, while company owners clearly are. The performance of a cluster at a specific location is driven by the business environment that the cluster is operating in. “Business environment” is a broad and naturally vague term: almost everything – from the quality of the schools to the strategies of local competitors – matters for the level of productivity and innovation that companies in the cluster reach at this specific location.

Kleyn, D., Kitney, R., & Atun, R.A. (2007). Partnership and innovation in the life sciences. *International Journal of Innovation Management.* 11 (02), 323-347.

Government support for partnering between BioPharma companies and universities is growing in the UK and some European countries, but few studies have explored these partnerships. Through interviews and a survey of key institutions the authors explored perceptions of key informants on industry and university partnerships. Study participants identified that partnering helped them to increase innovation in R&D and led them to adopt more open approaches to innovation. Organizational structures to coordinate and support partnerships; flexibility in operational management to solve problems in establishing and running these partnerships; leadership, especially by investigators to champion and lead collaborations; developing organizational capabilities of universities; and creation of an enabling environment by governments were identified as the critical success factors for partnering. The challenges faced were identified as lack of funding for university research teams; pressure on pricing from industry partners; disagreements on IP ownership; asymmetry of industry and university capabilities in partnering; and lack of administrative support with excessive bureaucracy from universities.

Knott, T., Lohani, V., Griffin, O., Loganathan, G., Adel, G., & Widman, T. (2004). Bridges for engineering education: Exploring eportfolios in engineering education at Virginia Tech.

Proceedings of the 2004 American Society for Engineering Education Annual Conference & Exposition, American Society for Engineering Education, session 3130.

Kock, C. J., & Guillen, M. F. (2001). Strategy and structure in developing countries: Business groups as an evolutionary response to opportunities for unrelated diversification. *Industrial and Corporate Change.* 10 (1), 77.

Business groups are a common type of enterprise in developing countries, yet their existence appears to be at odds with extant theory in strategic management. The authors suggest that entrepreneurs in late development build a business group by engaging in a distinct type of innovation. Instead of creating new products they leverage local and foreign contacts to combine foreign technology and local markets. The capability to leverage contacts is broadly applicable to diverse industries, creating incentives for unrelated diversification. The authors argue first that the main (initial) cause for the creation of business groups can be traced to the selection environment at the beginning of economic development in late-industrializing countries, when the ability to use contacts outweighs other capabilities in importance. Expanding businesses based on this core capability (which is different from the one underlying business success in developed countries) leads to unrelated diversification in terms of products and technological and organizational capabilities, as well as a loose organizational structure. Second, the selection environment in late-industrializing countries changes systematically over time, altering the reasons underlying the continued existence and creation of business groups. The authors formulate several testable propositions on the evolution of business groups predicting patterns of diversification and organizational structure over time.

Kramer, B., Tucker, J., Jones, T., Beikmann, M., & Windholz, R. (2002). The engineering learning center: a model for mentored product innovation. *Proceedings of the 32nd ASEE/IEEE Frontiers in Education Conference*, Boston, MA, session *F1H-24.*

Lagendijk, A., & Lorentzen, A. (2007). Proximity, knowledge and innovation in peripheral regions: On the intersection between geographical and organizational proximity. *European Planning Studies.* 15 (4), 457-466.

What role do various kinds of proximity play in the current and projected development of peripheral areas? In summarizing and drawing conclusions from this special issue on proximity, this paper elaborates on two core notions of proximity, geographical and organizational. It presents a framework in which the relationship between geographical and organizational proximity is conceptualized in a way that is somewhat different from previous contributions, notably by the French School on Proximity. The framework is used to evaluate the outcomes of the various contributions in this issue. The findings endorse the idea that economic performance relies more on localized capacities to build "global" connections, complemented with an adequate local resource base, than on local networking and clustering.

Laursen, K., & Foss, N. (2003). New human resource management practices, complementarities and the impact on innovation performance. *Cambridge Journal of Economics.* 27 (2), 243-263.

This paper takes a theoretical point of departure in recent work in organizational economics on systems of human resource management (HRM) practices. The authors develop the argument that just as complementarities between new HRM practices influence financial performance positively, there are theoretical reasons for expecting them also to influence innovation performance positively. This overall hypothesis was examined by estimating an empirical model of innovation performance, using data from a Danish survey of 1,900 business firms. Using principal component analysis, two HRM systems, conducive to innovation, are identified. In the first one, seven of our nine HRM variables matter (almost) equally for the ability to innovate. The second system is dominated by firm-internal and firm-external training. Of the total of nine sectors that are considered, four manufacturing sectors correlate with the first system. Firms belonging to wholesale trade and to the ICT intensive service sectors tend to be associated with the second system.

Leathers, C.G., & Raines, J.P. (2004). The Schumpeterian role of financial innovations in the New Economy's business cycle. *Cambridge Journal of Economics.* 28 (5), 667-681.

U.S. Federal Reserve Chairman Alan Greenspan claims that modern financial innovations, especially financial derivatives, were major contributors to a Schumpeterian process of "creative destruction" which produced a high-growth "New Economy" and opposes their regulation. A different perspective emerges when it is recognized that the "New Economy" followed the general contours of a Schumpeterian business cycle, and the role of modern financial innovations is examined in that context. The authors argue that the primary role of financial derivatives has been in contributing to "reckless finance" and speculative excesses in the second phase of that cycle, and that Schumpeter would favor subjecting the use of derivatives to more regulation.

Leenders, M.A., & Voermans, C.A. (2007). Beating the odds in the innovation arena: The role of market and technology signals classification and noise. *Industrial Marketing Management.* 36 (4), 420-429.

In this study, Signal Detection Theory (SDT) is introduced to show that it may be less important to improve innovation practices in companies than it is to change the nature of the projects that enter the corporate innovation funnel. In an empirical study of 44 innovation projects in the pharmaceutical and electronics industries, the authors show that pursuing more noisy signals (uncertain technological and market opportunities) is currently beneficial for innovation success. In general, companies allocate too few resources to noisy innovation opportunities. The authors find a positive, and not an inverted U-shaped, relationship between noise/signal ratios and innovation success. This indicates that there are almost no companies that take too much risk in the current competitive environment and that many can gain from increasing their noise tolerance.

Lerner, J. (1999). The government as venture capitalist: the long-run impact of the SBIR program. *Journal of Business -Chicago-.* 72 (3), 285-318.

Lerner, J., & Merges, E.P. (1998). The control of technology alliances: An empirical analysis of the biotechnology industry. *The Journal of Industrial Economics.* 46 (2), 125.

Leyden, D.P., & Link, A.N. (1999). Federal laboratories and research partners. *International Journal of Industrial Organization*. 17 (4), 572-592.

Lichtenberg, F.R., & Siegel, D. (1991). The impact of R&D investment on productivity-new evidence using linked R&D-LRD data. *Economic Inquiry*. 29(2), 203-228.

Los Angeles County Economic Development Corporation for Otis College of Art & Design. (March 1, 2007). Report on the creative economy of the Los Angeles Region. Los Angeles, CA: Samuel Hoi.

Mazzoleni, R. (2006). The effects of university patenting and licensing on downstream R&D investment and social welfare. *Journal of Technology Transfer*. 31(4), 431-441.

McGregor, J. (May 4, 2007). Are patents the measure of innovation? *Business Week*. Retrieved October 17. 2008 from http://www.businessweek.com/innovate/content/may2007/id20070504_323562.htm?chan=innovation_special+report+--+2007+most+innovative+companies_2007+most+innovative+companies

The article analyzes the extent to which patenting activity reflects a company's creative prowess.

McNair, L., Paretti, M., Knott, M., & Wolfe, M. (2006). Work in progress: using e-portfolio to define, teach, and assess ABET Professional Skills. *Proceedings of the 36th ASEE/IEEE Frontiers in Education Conference*, San Diego, CA, session T1J.

Meyer, M. (2006). Academic inventiveness and entrepreneurship: On the importance of start-up companies in commercializing academic patents. *Journal of Technology Transfer*. 31 (4), 501-510.

Mugge, P.C. (2006). CIMS innovation management framework (whitepaper). North Carolina State University Center for Innovation and Management Studies. Retrieved October 19, 2008 from http://cims.ncsu.edu/documents/IM_Competence_Model.pdf

Muller, C. (1997). The potential of industrial e-mentoring as a retention strategy for women in science and engineering. *IEEE Frontiers in Education Conference 2007*, session F1E.

National Academy of Engineering (2004). *The Engineer of 2020: Visions of Engineering in the New Century*. National Academies Press: Washington, D.C.

National Governors' Association (2007). Innovation American: Cluster-based strategies for growing state economies. Council on Competitiveness. Retrieved October 19, 2008 from http://www.compete.org/images/uploads/File/PDF%20Files/NGA_Govs_Guide_Clusters_2007.pdf

Niosi, J. (2006). Introduction to the symposium: Universities as a source of commercial technology. *Journal of Technology Transfer*. 31(4), 399-402.

Liebeskind, J., Oliver, A., Zucker, L., & Brewer, M. (1996). Social networks, learning, and flexibility: Sourcing scientific knowledge in new biotechnology firms. *Organization Science: A Journal of the Institute of Management Sciences.* 7 (4), 428.

Link, A.N. (1998). A case study of R&D efficiency in ATP joint ventures. *Journal of Technology Transfer*. 23(2), 43-51.

Link, A. N., & Scott, J. T. (2001). Public/private partnerships: stimulating competition in a dynamic market. *International Journal of Industrial Organization*. 19(5), 763-794.

Madanmohan, T.R. (2005). Incremental technical innovations and their determinants. *International Journal of Innovation Management*. 9, 481-510.

> This article deals with incremental innovations (value-added process) classified as material, operations, scale and product innovations. Based on a field study of 83 manufacturing firms in India, the study has found that government policies, customer orientation and formalization are the predictors of material innovations. Operational innovations are related to inter-functional coordination, process orientation, centralization and annual demand of the product. Customer orientation and formalization are the predictors of scale innovations. Finally, incremental product innovations are related to technology planning and R&D intensity.

Mairesse, J., & Mohnen, P. (2005). The importance of R&D on innovation: A reassessment using French survey data. *Journal of Technology Transfer*. 30(1-2), 183-197.

> This paper compares the contribution of R&D to innovation in terms of the various innovation output measures provided by the third Community Innovation Survey (CIS 3) for French manufacturing firms and in terms of accounting for inter-industry innovation differences.

Mansfield, E., Rapoport, J., Romeo, A., Wagner, S., & Beardsley, G. (1998). Social and private rates of return from industrial innovations. *Quarterly Journal of Economics, XCI* (2), May, 221-40. *International Library of Critical Writings In Economics.* 89, 231-252.

Martin, S., & Scott, J.T. (2000). The nature of innovation market failure and the design of public support for private innovation. *Research Policy*. 29(4-5), 437-448.

McGregor, J. (May 4, 2007). The world's 25 most innovative companies. *Business Week*. 14, 52-60.

> The article listes25 most innovative companies, explaining why and showing statistics of stock returns and margin growth. Most of these companies are capable of developing new breakthrough products, which typically requires a large amount of money in R&D. Companies should be financially healthy and boldly determined to be innovators in the industry.

McKie, S. (2004). Let innovation thrive. *Intelligent Enterprise.* 7 (1), 28-33

> In this article, the author explores the definition of innovation, the value of innovation to businesses today, and five business processes that are fundamental to innovation

management (road mapping, scanning, collaborating, sparking ideas and shepherding innovation projects).

McKie, S. (2004). Practical tools for new ideas. *Intelligent Enterprise.* 7 (2), 32-35.

Miller, D.J., Fern, M.J., & Cardinal, L.B. (2007). The use of knowledge for technological innovation within diversified firms. *Academy of Management Journal.* 50 (2), 308-326.

The authors propose that searching for and transferring knowledge across divisions in a diversified firm can cultivate innovation. Using a sample of 211,636 patents from 1,644 companies from 1985 to 1996, they find that the use of interdivisional knowledge positively affects the impact of an invention on subsequent technological developments. Furthermore, the positive effect of the use of interdivisional knowledge on the impact of an invention is stronger than the effect of using knowledge from within divisional boundaries or from outside the boundaries of the firm.

Moultrie, J., Nilsson, M., Dissel, M., Haner, U.E., Janssen, S., & Van der Lugt, R. (2007). Innovation spaces: Towards a framework for understanding the role of the physical environment in innovation. *Creativity and Innovation Management.* 16 (1), 53-65.

This paper discusses the physical environment's design, role, and goals in innovation.

Muller, A., Vuralikangas, L., & Merlyn, P. (2005). Metrics for innovation: Guidelines for developing a customized suite of innovation metrics. *Strategy and Leadership.* 33 (1), 37-45.

This article offers managers both general principles in the development of innovation metrics as well as sample specific metrics that they can begin to use immediately. It constructed an innovation framework in 3 views, the resource view, the leadership view, and the capability view. Under different views, they also created respective matrix to measure innovation.

Murray, A. (2000). Strategic choice under knowledge competition. In R. E. Grosse (Ed.), *Thunderbird on Global Business Strategy* (pp.46-87). New York, NY: Wiley.

Nooteboom, B. (1999). Innovation, learning and industrial organisation. *Cambridge Journal of Economics*. 23, 127-150.

Innovation, learning and organization are analyzed from a perspective which seeks to integrate evolutionary economics, the resource/competence view of the firm, an extended theory of transaction costs and insights derived from cognitive science. Firms are subject to selection by competitive forces, but they also adapt by organizational learning. Uncertainty is crucial in this, and to deal with it we need a "logic of abduction": a heuristic to move from present competence to novel competence, while surviving in the process. Such a heuristic is specified and some features are clarified by means of the notion of a script, taken from cognitive science. The heuristic is applied in an analysis of changes of industrial structure, the complementarily of large and small firms, the roles of multinational enterprises and industrial districts.

Ollerenshaw, P. (2006). Innovation and corporate failure: Cyril Lord in U.K. textiles, 1945–1968. *Oxford University Press.* 7, 777-811.

This article is a response to Patrick Fridenson's call for more research into the life cycle of enterprises and especially into business failure. Its subject is the textile group established in 1945 by Cyril Lord, which went on to encompass merchandising, manufacturing, retailing, and finance, operating in the United Kingdom, the United States, and South Africa. The article explains the nature of Lord's financial, mercantile, and manufacturing networks, and his rapid growth, based on product innovation, novel sales techniques, and massive advertising. The article then examines his subsequent insolvency and receivership in 1968.

Pence, C.C. & Wulf, C. (2008). Innovation in Cross Border Multi-Cultural Learning. *Proceedings from the 15th EDINEB Conference*, Malaga, Spain.

Pistor, K., Keinan, Y., Kleinheisterkamp, J., & West, M.D. (2003). Innovation in corporate law. *Journal Of Comparative Economics.* 31 (4), 676-694.

The authors suggest that the resilience of the corporate form is a function of the adaptability of the legal framework to a changing environment. The authors analyze a country's capacity to innovate using the rate of statutory legal change, the flexibility of corporate law, and institutional change as indicators. Their findings suggest that origin countries are more innovative than transplant countries.

Radnor, Z.J., & Noke, H. (2006). Development of an audit tool for product innovation: The innovation compass. *International Journal of Innovation Management.* 10 (1), 1-18.

The article presents an audit tool called the innovation compass. The article shows how it could be used and developed in considering innovation and new product development. The tool enables the assessment of a company's product innovation capability by considering the context, structure, teams, leadership and outputs. The paper gives a greater understanding of the elements of the tool and how it could be used and developed in other research projects considering innovation and new product development.

Rickards, T., & Moger, S. (2006). Creative leaders: A decade of contributions from creativity and innovation management journal. *Creativity and Innovation Management.* 15 (1), 4-18.

This article has been examined for the contributions to understanding of leadership as a process contributing to creativity and innovation. The study reveals nine overlapping themes, within each of which leadership plays a part in the production of creative insights or innovative productivity.

Rugarcia, A., Felder, R., Woods, D., & Stice, J. (2000). The future of engineering education: a vision for a new century. *Chemical Engineering Education*, 34(1), 16-25.

Shuman, L., Besterfield-Sacre, M., & McCourty, J. (2005). ABET professional skills: Can they be taught? *Journal of Engineering Education*. 94(1), 41-55.

Simoneau, R., Magenau, J., & Ford, R. (2005). Work in progress-on building a business/ engineering education partnership. *Proceedings of the 35th ASEE/IEEE Frontiers in Education Conference*, Indianapolis, IN, session *F1D-16.*

S&P Industry Analysis: Aerospace & Defense (August 2008). Retrieved October 17, 2008 from http://www.netadvantage.standardpoor.com/NASApp/NetAdvantage/showIndustrySurvey.do?code=aed&date=/aed_0708/aed_0708.htm

Sampson, R.C. (2007). R&D alliances and firm performance: The impact of technological diversity and alliance organization on innovation. *Academy of Management Journal.* 50 (2), 364-386.

This paper discusses the impact of companies that partner with one another that have moderate levels of diversity (two companies are somewhat alike) contribute more to a firm's innovation than companies with high or low levels of diversity. The paper discusses a sample size of 463 R&D alliances that partner with one another which led to incentives to sharing information, hence increasing innovation.

Santoro, M.D., & Gopalakrishnan, S. (2001). Relationship dynamics between university research centers and industrial firms: Their impact on technology transfer activities. *Journal of Technology Transfer.* 26, 163-171.

Scanlon, J. (November 16, 2006). How to turn money into innovation. *Business Week*. Retrieved October 17, 2008 from http://www.businessweek.com/innovate/content/nov2006/id20061114_428152.htm?chan=search

The Global Innovation 1,000 survey shows which companies are just throwing money into R&D and which ones can boast about innovation.

Schankerman, M. (1981). The effects of double-counting and expensing on the measured returns to R&D. *The Review of Economics and Statistics, MIT Press.* 63 (3), 454-458.

Selman, J. (2002). Leadership and innovation: relating to circumstances and change. *The Innovation Journal*, 7(3). Retrieved October 17, 2008 from http://www.innovation.cc/discussion-papers/selman.pdf

There is no shared interpretation of what we mean or what we are observing when we use the word "innovation." Moreover, we lack practices for deliberately and consistently producing "leadership" and "innovation". This is evident in the fact that in spite of thousands of books on these subjects, reading and understanding the books doesn't enable us to be leaders or innovators.

Siegel, D., Waldman, D., & Link, A. (1999). Assessing the impact of organizational practices on the productivity of university technology transfer offices: An exploratory study. *Working Paper Series.* (7256).

Siegel, D.S., Waldman, D.A., Atwater, L.E., & Link, A.N. (2003). Commercial knowledge transfers from universities to firms: Improving the effectiveness of university-industry collaboration. *Journal of High Technology Management Research.* 14 (1), 111-133.

Tan, B.S. (2007). The consequences of innovation. *The Innovation Journal* 9(3). Retrieved October 17, 2007 from http://www.innovation.cc/peer-reviewed/tan-9-3.pdf

Virtually all companies talk about innovation, and the importance of “doing” innovation, many actually try to “do it,” and only few actually succeed in doing it. The reality is that innovation, for the most part, frightens organizations because it is inevitably linked to risk. Even though innovation is debated in senior level meetings as being the lifeblood of the company, and occasional resources and R&D funds are thrown at it, often the commitment usually ends there.

Tanner, D. (1994). Creativity and Innovation in R&D. *R&D Innovator* 3(7), 101-150.

The author defines creativity as the generation of novel, useful ideas. The author defines innovation as the process for bringing the best ideas to reality. Creativity plays an essential role in all three types of innovation. It helps generate the original idea and overcome barriers to bringing the idea to reality. Research with fraternal and identical twins supports the view that different abilities to think, and to think creatively, are not inherited.

Tassoul, M., & Buijs, J. (2007). Clustering: An essential step from diverging to converging. *Creativity and Innovation Management.* 16 (1), 16-26.

Clustering is said to be about expanding knowledge, connecting ideas, connecting ideas to problems, functionalities, and vales and consequences. The understanding phase (divergent phase) is an important creative activity. Four types of clusters are identified: object, morphological, functional, and gestalt.

Thieme, J. (2007). Perspective: The world’s top innovation management scholars and their social capital. *Journal of Product Innovation Management.* 24 (3), 214-229.

Using 959 articles reflecting the work of 1,179 scholars, this study ranks the world’s top scholars in innovation management (IM) on the basis of the number of research articles published across 14 top academic journals in technology and innovation management, marketing, and management between 1990 and 2004. Guided by social capital theory, the present study analyzes the embeddedness characteristics of IM scholars to determine the extent to which social capital explains scholarly productivity. A current controversy in the social capital literature is the embeddedness characteristics that create social capital. On the one hand, the closure perspective argues that social capital results from strong relational ties with others in a dense, local neighborhood of actors who are relatively disconnected from others. On the other hand, the brokerage perspective argues that social capital is created when actors have relational ties that span these dense, local neighborhoods. The findings in the present study support both perspectives. Furthermore, the results suggest that strategic orientation is a contingency variable that clarifies the conditions in which closure- or brokerage-based embeddedness is appropriate.

Traylor, R., Heer, D., Fiez, T. (2003). Using an integrated platform for learning to reinvent engineering education. *IEEE transactions on Education*, 46(4), 409-419.

Tsuda,H. (December 18, 2006). The Tsuda style of presidency: giving directions right on the site of development. [Interviewed Fujimoto, A, & Matsunaga, H.] *Car Styling.* 176: 5-10.

In this interview, the president of Suzuki talks about what he thinks is important: active personality, developed with roots in the target market and the importance of designers.

He also suggests that new design and products need to be tested in the market and constantly revised and modified according to the feedback of customers.

Turrell, M., Pluskowski, B., & Chapman, M. (2006). Innovation dimensions. *Imaginatik Research* . Whitepaper retrieved from http://www.imaginatik.com/site/pdfs/Imaginatik%20WP-0506-1%20Innovation%20Dimensions.pdf

Ulijn, J., O'Hair, D., Weggeman, M., Ledlow, G., & Hall, H.T. (2000). Innovation, corporate strategy, and cultural context: What is the mission for international business communication? *Journal of Business Communication.* 37 (3), 293-317.

A global economy requires business organizations to cultivate their international holdings by respecting the national differences of their host countries and coordinating efforts for rapid innovation. In this article, the authors first review relevant literature in the areas of communication and innovation and explore how efforts toward innovative practices are directly related to globalization and business strategy. The authors then focus on issues associated with national culture, corporate culture, and professional culture that are relevant to strategies for researching business communication in global contexts. Finally, the authors suggest directions for future work.

Vandermerwe, S. (1987). Diffusing new ideas in-house. *Journal of Product Innovation Management.* 4 (4), 256-264.

New ideas trigger the innovation process and the development of new products. This article is concerned with new ideas generated in-house and ways to ensure that these ideas have the maximum chance of being captured and diffused. The author reports results of an exploratory study involving an international group of senior executives concerning their attempts to introduce new ideas and gain support for them within their firms. In particular, she was alert to reports of organizational resistance, when it was reported. She asked why this resistance occurred and what might be done to improve the receptivity to new ideas. The article examines the executives' responses and highlights an interesting feature of the findings: that new technological ideas may, by their very nature, be slow-movers. Firms are encouraged to put more conscious effort into internal diffusion activity as they do externally in the marketplace. This would require new skills and a new role for originating individuals.

Vintergaard, C. (2005). Opportunities in corporate venturing – actors creating passageways. *International Journal of Innovation Management.* 09 (02), 215-239.

The article deals with corporate venture strategies to show how opportunities develop and take shape in the interaction between actors. This paper develops a conceptual understanding of how corporate venture managers recognize and discover opportunities in a network environment. In an effort to create a better understanding of who is involved in the process, this paper reports on the development path of several entrepreneurial opportunities of the Danish corporate venture capitalist, Danfoss A/S.

Wallsten, S.J. (2000). The effects of government-industry R&D programs on private R&D: the case of the Small Business Innovation Research program. *RAND Journal of Economics.* 31 (1).

Walters, H. (April 20, 2007). An official measure of innovation. *Business Week*. Retrieved October 17, 2008 from http://www.businessweek.com/innovate/content/apr2007/id20070420_997596.htm?chan=search

A U.S. government-sponsored brain-trust is developing a better set of metrics for innovation initiatives—and they're asking the public to help.

Wonglimpiyarat, J. (2006). The Boston Route 128 model of high-tech industry development. *International Journal of Innovation Management.* 10 (01), 47-63.

This paper discusses the idea that the success of the greater Boston area was created by the innovative ideas of the clusters of high-technology based firms. This paper uses the Boston Model as a bench mark to evaluate and understand other high-tech industries.

Workforce Investment Board Toolkit. Retrieved September 10, 2008 from http://www.wibtoolkit.net Innovate California Website: www.innovatecalifornia.net

Wu, Y.C., & Lee, P.J. (2007). The use of patent analysis in assessing ITS innovations: US, Europe and Japan. *Transportation Research. Part A, Policy and Practice.* 41 (6), 568-586.

A wealth of research on ITS has been carried out for the past two decades. In view of the rapid technological development and innovations occurring in ITS, the ITS stakeholders need to be aware of the usefulness and availability of patents associated with ITS technology. Among the national and international reviews which have been made available in journals of record and freely available public sources, little use has been made of patent information in assessing ITS innovations. Therefore, the paper looks at the ITS technology developments from the international perspective through utilizing rich, reliable information provided by ITS-related invention patents in the world's three leading patent databases (EPO, USPTO, and JPO) to provide an overall picture of ITS innovations. The research findings show that the patent analysis can provide firms involved in the ITS sector and ITS researchers with information that can assist in their strategic planning efforts.

Yu, L. (Fall 2002). How location clusters affect innovation. *MIT Sloan Management Review*. 44(1), 16.

While researching innovation in clusters, the hypothesis was that clusters promote innovation and would result in more products and less R&D spending. The opposite was found. There is less innovation and products resulting from cluster areas and the leaders were those that spent on R&D.

Zhao, C. & Kuh, G. (2004). Adding value: learning communities and student engagement. *Research in Higher Education*, 45(2), 115-138.

Websites

ABET Accreditation. Retrieved September 10, 2008 from http://www.abet.org/forms.shtml.

Association of University Technology Managers. Retrieved November 16, 2008 from http://www.autm.net/index.cfm

Manages information relative to tech transfer issues.

European Union Innovation Network. Retrieved October 17, 2008 from http://www.europe-innova.org/index.jsp

EIMS. Retrieved October 17, 2008 from http://ec.europa.eu/enterprise/innovation/index_en.htm

The EIMS was launched in the early 1990s under the SPRINT Programme with the aim of providing firms, intermediaries, academics and policy makers with information, analysis and research on the factors shaping, promoting and inhibiting innovation at company level across Europe.

Technology Analysis and Strategic Management. Retrieved October 17, 2008 from http://www.tii.org

The European Association for the Transfer of Technologies, Innovation, and Industrial Information Offers: Information and networking, special interest sections, technology transfer facilitation, and professional development.

Appendix 2: Company Survey Pre-study Prep Sheet

General Info:

1. Company Name: ____
2. Location: (Include map & directions):____
3. Phone/Fax/Email: ____
4. Company Web Address: ____
5. No. of Employees: ____

Interviewee Info:

6. Person to be interviewed: (Mr. /Mrs. /Ms. /Dr.) _______________________________
7. Interviewee's gender: ☐ Male ☐ Female
8. Interviewee's age: ____
9. Interviewee's Department: ____
10. Interviewee's Job Function(title/position): _____________________________________
11. Interviewee's phone /fax: ____
12. Interviewee's email: ____

Internal/External Study:

13. Industry of the company: ____
14. Company History/Background (incl. merger/acquisition): ________________________
    ____
15. Office Locations: ____
16. Major Competitors: ____
17. Major Products: ____
18. Total Annual Revenue (last year): ____
    Financial info may only available for public traded companies.
19. Patent & trademark Info (if any): ____
    Patent info can be found on US patent and trademark office, http://www.uspto.gov/
20. Recent Press Release or News: ____

Appendix 3: WIRED Innovation Study Interviews Questionnaire

Interviewer: ____
Company: ____
Date: ____
* Please provide us with an organization chart and copy of vision / mission statement

Part I: Idea generation process, company culture (incl. encouragement & reward system)

1. Please select the followings that best fits your organization in terms of individual employees: (select all that apply)
- ☐ People openly discuss mistakes in order to learn from them
- ☐ People identify skills they need for future work tasks
- ☐ People help each other learn
- ☐ People can get money and other paid resources to support their lifelong learning
- ☐ People are given time to support learning
- ☐ People view problems in their work as an opportunity to learn
- ☐ People are rewarded for learning
- ☐ People give open and honest feedback to each other
- ☐ People listen to others' views before speaking
- ☐ People are encouraged to ask "why" regardless of rank
- ☐ Whenever people state their view, they also ask what others think
- ☐ People treat each other with respect
- ☐ People spend time building trust with each other

2. Please select the followings that best fits your organization in terms of team/group performances: (select all that apply)
- ☐ Teams/groups have the freedom to adapt their goals as needed
- ☐ Teams/groups treat members as equals, regardless of rank, culture, or other differences
- ☐ Teams/groups focus both on the group's task and on how well the group is working
- ☐ Teams/groups revise their thinking as a result of group discussions or information collected
- ☐ Teams/groups are rewarded for their achievements as a team/group
- ☐ Teams/groups are confident that the organization will act on their recommendations

3. Which of the following two-way communication system is used at your organization? (Select all that apply)
- ☐ Suggestion systems
- ☐ Electronic bulletin boards
- ☐ Open meetings
- ☐ Private emails/phone calls
- ☐ None

4. Does your organization have formal commitments to: (Select all that apply)

- ☐ Enable people to get needed information at any time quickly and easily
- ☐ Recognize people for taking initiative
- ☐ Give people choices in their work assignments
- ☐ Give people control over the resources they need to accomplish their work
- ☐ Support employees who take calculated risks
- ☐ Encourage people to think from a global perspective
- ☐ Encourage everyone to bring the customers' views into the decision making process
- ☐ Encourage people to get answers from across the organization when solving problems
- ☐ Invite people to contribute to the organization's vision

5. How would you define the occupational breakdown at your organization?

- ☐ ____% engineers
- ☐ ____% managers
- ☐ ____% scientists
- ☐ ____% engineer-managers
- ☐ ____% staff (non technical)
- ☐ ____% other

6. What is the educational background of your key people involved in innovation efforts?

	BA	BS	MS	MBA	PhD	High School
☐ Liberal Arts						
☐ Engineering						
☐ Sciences						
☐ Business						
☐ Other						

7. When hiring technical talent, do you prefer to hire?

Degree	Local	So Cal	No Cal	All CA	All USA	Canada	MX	S.America	SE Asia	India	Europe	MEA	Russia \Eastern Europe
HS													
BA/BS													
MS/MBA													
PhD													
Other													

8. What are the reward systems for innovation at your organization?

- ☐ Monetary reward
- ☐ Stock options

- Promotion
- Increase research budget
- Patent Rights: _____% inventor _____ % company
- Other: ___________________________

9. Are there spaces in your office where employees can meet easily to share ideas or collaborate on creative problem solving?
- No
- Just regular meeting rooms
- Informal gathering spaces
- Other _____________________

10. How is innovation encouraged in your organization?
- Formal. Please list: _________________
- Informal efforts. Please list: __________________ (e.g. Friday "off", idea contest)
- Other ___________________

Part II: Decision making process & reasons to innovate

1. Generally, who makes the final decision on innovation projects at your organization?
- CEO
- Board of advisors
- Board of directors
- Director of R&D
- Other: ___________________________

2. How do you evaluate project priority at your organization?
- Rank by budget availability
- Rank by market/customer demands
- Rank by CEO's decision
- Rank by R&D department's choice
- Other: ___________________________

3. If your R&D area needs more experienced people, how do they get them? Explain the approval process.
- R&D interviews/selects its hire
- R&D recommends its hire
- R&D depends upon HR advertising-hiring selection
- CEO makes the decision
- CFO makes the decision
- R&D chooses to outsource
- Other (please specify) _________________________

4. In general in your firm, which functional area recommends the hire?
- The area which needs the person
- HR

- ☐ Finance
- ☐ Executive level
- ☐ Other _______________

5. How quickly can your company set up a new operation to pursue a new opportunity?
- ☐ Instantaneously _________Days
- ☐ After approval from top management _________Days
- ☐ After approval from direct superior _________Days
- ☐ After approval from the Board of Directors _________Days

6. How do consumers help drive the innovation process at your company?
- ☐ Previous product evaluations
- ☐ Surveys of current proposals
- ☐ Participation in focus groups for new proposals
- ☐ Feedback after service
- ☐ Other _______________

7. How do you maintain competitive advantage in your industry?
- ☐ Branding
- ☐ Financial Strength
- ☐ Robust Intellectual Property (e.g. Patents)
- ☐ Manager Expertise
- ☐ Other _______________

8. How does your company differentiate itself from your competitors?
- ☐ Price
- ☐ Quality
- ☐ Service
- ☐ Innovative products
- ☐ Other _______________

9. What is the role of competitors in your innovation process?
- ☐ Leader of innovation process
- ☐ Follower of innovation process
- ☐ Innovate only in response to competition
- ☐ Other _______________

10. Do you try to match your competitors' innovation spending?
- ☐ Yes
- ☐ No

Part III: Financing & budgeting that impact on innovation

1. What is the relationship between your total capitalization and your approach to innovating new products/services and processes?

- ☐ The higher the capitalization the more we innovate processes
- ☐ The higher the capitalization the more we innovate products
- ☐ The lower the capitalization the more we try to innovate processes
- ☐ The lower the capitalization the more we try to innovate products
- ☐ There is little or no relationship between total capitalization and innovation of

2. Currently, at what rate is sales revenue growing per year?
- ☐ 0-10%
- ☐ 0-25%
- ☐ 25-40%
- ☐ 40-50%
- ☐ 50%+

3. If you are currently working with venture capital, at what stage is the investment?
- ☐ Seed
- ☐ First round
- ☐ Second- Third round
- ☐ Mezzanine
- ☐ Final round

4. What's percentage of your current annual operating budget is dedicated to R&D?
- ☐ < 10%
- ☐ 10 – 20%
- ☐ 20 – 30%
- ☐ 30 – 40%
- ☐ 40 – 50%
- ☐ 50%

5. In absolute terms, has the size and distribution of your annual operating budget in R&D increased or decreased the in the past 3 years? (Indicate approximate % change)

	So Cal	No Cal	Asia	Africa	Europe	South America	North America
☐ Increased							
☐ Decreased							
☐ No Change							

6. What is your exit strategy?
- ☐ None
- ☐ IPO
- ☐ Family succession

- ☐ Merger
- ☐ Outright sale
- ☐ Leveraged buyout
- ☐ Other _______________
- ☐ Not relevant

7. When do you intend to enforce your exit strategy?

- ☐ < 1 year
- ☐ 1 – 3 years
- ☐ 3 – 5 years
- ☐ 5 – 10 years
- ☐ 10 years

Part IV: Innovation development processes & IP protection

1. How do you develop your R&D?

- ☐ Outsourcing
- ☐ Internal R&D department
- ☐ External Collaboration with another firm or industry consortia
- ☐ External Collaboration with university lab
- ☐ External Collaboration with private research lab
- ☐ Acquisition of another firm
- ☐ Other __________

2. What department drives your R&D efforts?

- ☐ Marketing
- ☐ Engineering
- ☐ Top Management
- ☐ Sales
- ☐ Other __________________

3. Where are the external organizations that interact with your R&D research projects located?

- ☐ Within California
- ☐ Within other States
- ☐ Within foreign countries
- ☐ Why do you use external collaborators?
- ☐ Proximity to your firms
- ☐ Specialized expertise
- ☐ Cost effectiveness
- ☐ Efficiency for final successful innovation
- ☐ Other __________________

4. Is R&D a multi-disciplinary activity in your firm involving participants from more than one functional area? (Mark all that apply)
- ☐ Not multi-disciplinary
- ☐ Not multi-functional areas
- ☐ Yes multi-disciplinary
- ☐ Yes multi-functional areas

5. What approaches are involved in the idea development and validation processes?
- ☐ Experimentation
- ☐ Modeling (simulation)
- ☐ Brain storming
- ☐ Other _____________

6. How do you protect your innovations?
- ☐ Patents
- ☐ Trademarks
- ☐ Copyrights
- ☐ Complexity of innovation
- ☐ Trade secrets
- ☐ None

7. Is risk of IP loss a big impediment to your company choosing to develop in foreign countries?
- ☐ Yes
- ☐ No

8. What do you do to mitigate this risk?
- ☐ Keep Trade Secrets in the US
- ☐ Get foreign patent
- ☐ Negotiate fair sharing of rewards
- ☐ Hope and pray

9. What is the desired outcome of your R&D?
- ☐ New product
- ☐ Improvement on existing products
- ☐ New process
- ☐ Improvement on existing process

10. What happens to your inventions/innovations which your firm does not commercialize?
- ☐ We actively promote them as licensable
- ☐ We let them sit on the shelf and do nothing
- ☐ We revisit them systematically in our evaluation of strategy direction

Part V: Production & outsourcing processes that impact on innovation

1. How does being in California assist in your innovation process? (Check all that apply)
- ☐ Financial benefit (tax etc.), please list: _________________
- ☐ Proximity to financial sources
- ☐ Established business network/community
- ☐ Sources of skills (availability of highly educated professionals)
- ☐ Training/Educational facilities
- ☐ Research Facilities
- ☐ Special government assistance, please list:________________
- ☐ Other _____________________

2. Do you outsource or are you considering outsourcing at the moment?
- ☐ Yes (continue to questions 3-7)
- ☐ No (continue to question 8)

3. Why do you not outsource?
- ☐ Too costly
- ☐ Too time consuming
- ☐ Too difficult to assure the safety of our Intellectual Property
- ☐ Our products/processes are too difficult and complicated
- ☐ Possible outsourcing candidates are too distant from us
- ☐ Possible outsourcing candidates do not speak the same language as you do
- ☐ Other _______________________

4. What and where do you outsource currently?

	So Cal	No Cal	Asia	Africa	Europe	South America	North America
☐ Information Technology							
☐ Manufacturing							
☐ Sales/Marketing							
☐ Accounting							
☐ R&D							
☐ Customer Services							
☐ Other___________							

5. Which function is most likely to be outsourced next?

	Where do you outsource currently?						
	So Cal	No Cal	Asia	Africa	Europe	South America	North America
□ Information Technology							
□ Manufacturing							
□ Sales/Marketing							
□ Accounting							
□ R&D							
□ Customer Services							
□ Other____________							

6. If any of your operations is outsourced external to California, what are the reasons?
- □ Labor compensation
- □ Investment opportunities/conveniences
- □ New market penetration
- □ Tax benefits
- □ Land costs
- □ Other _____________

7. If you are planning to stop outsourcing, why?
- □ Too costly
- □ Too time consuming
- □ Too difficult to assure the safety of our Intellectual Property
- □ Our products/processes are too difficult and complicated
- □ Possible outsourcing candidates are too distant from us
- □ Possible outsourcing candidates do not speak the same language as you do
- □ We no longer have a need to outsource
- □ Other _________________________

8. What norms do you use to validate quality? (Product and process)
- □ ISO standards
- □ Six sigma
- □ Other _______________
- □ No standardized norms

9. Why do you use those norms/standards to help your innovative process or product?
- □ Everyone else does
- □ Competitor edge
- □ Consumer requires
- □ Consumer expects

- ☐ Other _______________

10. Do you think Norms kill innovation process/product?

- ☐ No
- ☐ Yes If Yes, how: __________________

11. How do you measure the results of innovation?

- ☐ Profitability
- ☐ Sales growth
- ☐ Market share
- ☐ Geographic penetration
- ☐ Stock price performance
- ☐ Free cash
- ☐ Employee turnover rate

Other ____________________________________

Appendix 4: Human Resource Site Visit Evaluation Template

<table>
<tr><th colspan="4">COMPANY INFORMATION</th></tr>
<tr><td>NAME OF COMPANY</td><td></td><td>DATE</td><td></td></tr>
<tr><td>ADDRESS</td><td></td><td>CONTACT PERSON(S)</td><td></td></tr>
<tr><td>KEY POINTS</td><td colspan="3"></td></tr>
<tr><td>INDUSTRY REQUIREMENTS</td><td colspan="3"></td></tr>
<tr><td>APPLICATION TO EDUCATION/SKILL DEVELOPMENT</td><td colspan="3"></td></tr>
<tr><td colspan="4">CONCLUSION:</td></tr>
</table>

Appendix 5: Online Questionnaire

WiRED Innovation Study BACKUP

Page 1. WIRED Online Innovation Study

1. Required information. No company specific information will be disseminated. This includes any factors which could be used to identify your business, business products, business practices, personnel, or future plans.

Details	Name of organization	0
Details	Your title	0
	Number of Respondents	0
	Number or respondents who skipped this question	0

2. Optional information. Our goal is to understand the key factors which affect the innovation atmosphere, not your company's protected information. The final collated results will be published. Please give us the opportunity to send you the key findings from our research.

Details	Your name	0
Details	E-mail	0
Details	Phone	0
	Number of Respondents	0
	Number or respondents who skipped this question	0

Page 2. Part 1 of 5 - Company Culture

3. Please select from the following stimuli of innovation that are available to employees in your organization: (select all that apply)	% of Respondents	Number of Respondents
People can get money and other paid resources to support their lifelong learning	0.00%	0
People are given time to support learning	0.00%	0
People identify skills they need for future work tasks	0.00%	0
People view problems in their work as an opportunity to learn	0.00%	0
People are encouraged to ask "why" regardless of rank	0.00%	0
Number of respondents		0
Number or respondents who skipped this question		0

4. Please select from the following behaviors that persist among employees in your organization to enhance group performances: (select all that apply)	% of Respondents	Number of Respondents
They treat members as equals, regardless of rank, culture, or other differences	0.00%	0
They focus both on the group's task and on how well the group is working	0.00%	0
They have the freedom to adapt their goals as needed	0.00%	0
They are rewarded for their achievements as a group	0.00%	0
They are confident that the organization will act on their recommendations	0.00%	0
Number of respondents		0
Number or respondents who skipped this question		0

5. How are ideas shared and communicated within your organization? (Select all that apply)	% of Respondents	Number of Respondents
Informal gathering spaces	0.00%	0

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WiRED Innovation Study BACKUP

Page 1. WIRED Online Innovation Study

1. Required information. No company specific information will be disseminated. This includes any factors which could be used to identify your business, business products, business practices, personnel, or future plans.

Details	*Name of organization*	0
Details	*Your title*	0
	Number of Respondents	0
	Number or respondents who skipped this question	0

2. Optional information. Our goal is to understand the key factors which affect the innovation atmosphere, not your company's protected information. The final collated results will be published. Please give us the opportunity to send you the key findings from our research.

Details	*Your name*	0
Details	*E-mail*	0
Details	*Phone*	0
	Number of Respondents	0
	Number or respondents who skipped this question	0

Page 2. Part 1 of 5 - Company Culture

3. Please select from the following stimuli of innovation that are available to employees in your organization: (select all that apply)	% of Respondents	Number of Respondents
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People are given time to support learning	0.00%	0
People identify skills they need for future work tasks	0.00%	0
People view problems in their work as an opportunity to learn	0.00%	0
People are encouraged to ask "why" regardless of rank	0.00%	0
Number of respondents		*0*
Number or respondents who skipped this question		*0*

4. Please select from the following behaviors that persist among employees in your organization to enhance group performances: (select all that apply)	% of Respondents	Number of Respondents
They treat members as equals, regardless of rank, culture, or other differences	0.00%	0
They focus both on the group's task and on how well the group is working	0.00%	0
They have the freedom to adapt their goals as needed	0.00%	0
They are rewarded for their achievements as a group	0.00%	0
They are confident that the organization will act on their recommendations	0.00%	0
Number of respondents		*0*
Number or respondents who skipped this question		*0*

5. How are ideas shared and communicated within your organization? (Select all that apply)	% of Respondents	Number of Respondents
Informal gathering spaces	0.00%	0

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WIRED Innovation Study BACKUP

	% of Respondents	Number of Respondents
Private emails/phone calls	0.00%	0
Suggestion systems (box)	0.00%	0
Electronic bulletin boards (wiki)	0.00%	0
Open meetings	0.00%	0
Number of respondents		*0*
Number or respondents who skipped this question		*0*

6. Does your organization have formal commitments to: (Select all that apply)	% of Respondents	Number of Respondents
Encourage people to get answers from across the organization when solving problems	0.00%	0
Encourage everyone to bring the customers' views into the decision making process	0.00%	0
Give people control over the resources they need to accomplish their work	0.00%	0
Support employees who take calculated risks	0.00%	0
Give people the freedom to adapt their goals as needed	0.00%	0
Number of respondents		*0*
Number or respondents who skipped this question		*0*

7. When hiring technical talent, from where and from what level do you prefer to hire? (select all that apply)

	Southern California	Northern California	All USA	Canada	Mexico	South America	South East Asia	India	Europe	Russia/Eastern Europe	Middle East	Number of Respondents
High School	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0
BA/BS	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0
MS/MBA	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0
PhD	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0
Trade Diploma	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0
Number of Respondents												*0*
Number or respondents who skipped this question												*0*

8. What are the reward systems for innovation at your organization? (select all that apply)	% of Respondents	Number of Respondents
Monetary reward	0.00%	0
Stock options	0.00%	0
Promotion	0.00%	0
Number of respondents		*0*
Number or respondents who skipped this question		*0*

Page 3. Part 2 of 5 - Decision Making Process

9. How do you select projects to pursue at your organization?	% of Respondents	Number of Respondents
Technology	0.00%	0
Return On Investment	0.00%	0
Time to market	0.00%	0
Customer demands	0.00%	0

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CEO's vision	0.00%	0
Number of respondents		*0*
Number or respondents who skipped this question		*0*

10. In general in your firm, which functional area recommends the hire?	% of Respondents	Number of Respondents
Executive level	0.00%	0
Finance	0.00%	0
The area which needs the person	0.00%	0
HR	0.00%	0
Number of respondents		*0*
Number or respondents who skipped this question		*0*

11. How do consumers help drive the innovation process at your company? (select all that apply)	% of Respondents	Number of Respondents
Feedback after service	0.00%	0
Participation in focus groups for new proposals	0.00%	0
Previous product evaluations	0.00%	0
Surveys of current proposals	0.00%	0
Number of respondents		*0*
Number or respondents who skipped this question		*0*

12. How do you maintain competitive advantage in your industry? (select all that apply)	% of Respondents	Number of Respondents
Manager Expertise	0.00%	0
Branding	0.00%	0
Financial Strength	0.00%	0
Robust Intellectual Property (e.g. Patents)	0.00%	0
Technology	0.00%	0
Number of respondents		*0*
Number or respondents who skipped this question		*0*

13. How does your company differentiate itself from your competitors? (select all that apply)	% of Respondents	Number of Respondents
Technology	0.00%	0
Service	0.00%	0
Price	0.00%	0
Quality	0.00%	0
Number of respondents		*0*
Number or respondents who skipped this question		*0*

14. How would you characterize your company relative to your competitors?	% of Respondents	Number of Respondents
Innovate only in response to competition	0.00%	0
Follower of innovation process	0.00%	0

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WIRED Innovation Study BACKUP

Leader of innovation process	0.00%	0
Number of respondents		*0*
Number or respondents who skipped this question		*0*

15. How great is your spending on innovation relative to your competitors?	% of Respondents	Number of Respondents
Higher	0.00%	0
Lower	0.00%	0
Number of respondents		*0*
Number or respondents who skipped this question		*0*

Page 4. Part 3 of 5 - Financing & Budgeting

16. What is the relationship between your total capitalization and your innovation?	% of Respondents	Number of Respondents
Higher capitalization leads to more innovative products/processes	0.00%	0
Lower capitalization leads to more innovative products/processes	0.00%	0
There is no relationship between capitalization and innovation	0.00%	0
Number of respondents		*0*
Number or respondents who skipped this question		*0*

17. What is your annual revenue growth?	% of Respondents	Number of Respondents
0-5%	0.00%	0
6-10%	0.00%	0
11-20%	0.00%	0
21-50%	0.00%	0
>50%	0.00%	0
Number of respondents		*0*
Number or respondents who skipped this question		*0*

18. What's percentage of your current annual operating budget is dedicated to R&D?	% of Respondents	Number of Respondents
0-5%	0.00%	0
6-10%	0.00%	0
11-20%	0.00%	0
21-30%	0.00%	0
31-50%	0.00%	0
>50%	0.00%	0
Number of respondents		*0*
Number or respondents who skipped this question		*0*

19. How and where has your R&D spending changed in the past three years? (select all that apply)

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	Southern California	Northern California	All USA	Canada	Mexico	South America	South East Asia	India	Europe	Russia/Eastern Europe	Middle East	Number of Respondents
Increased	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0
Decreased	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0
No Change	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0
											Number of Respondents	*0*
											Number or respondents who skipped this question	*0*

20. What is the age of your corporation?	% of Respondents	Number of Respondents
0-5	0.00%	0
6-10	0.00%	0
11-20	0.00%	0
>20	0.00%	0
Number of respondents		*0*
Number or respondents who skipped this question		*0*

Page 5. Part 3 of 5 - Financing & Budgeting Continued

21. If you are currently working with venture capital, at what stage are you?	% of Respondents	Number of Respondents
Seed	0.00%	0
First round	0.00%	0
Second- Third round	0.00%	0
Mezzanine	0.00%	0
Final round	0.00%	0
Number of respondents		*0*
Number or respondents who skipped this question		*0*

22. What is your exit strategy?	% of Respondents	Number of Respondents
IPO	0.00%	0
Family succession	0.00%	0
Merger & Acquisition	0.00%	0
Outright sale	0.00%	0
Leveraged buyout	0.00%	0
None	0.00%	0
Number of respondents		*0*
Number or respondents who skipped this question		*0*

23. When do you intend to enforce your exit strategy?	% of Respondents	Number of Respondents
< 1 year	0.00%	0
1–3 years	0.00%	0
4–6 years	0.00%	0

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7–10 years	0.00%	0
>10 years	0.00%	0
Number of respondents		*0*
Number or respondents who skipped this question		*0*

Page 6. Part 4 of 5 - Innovation & IP protection

24. What department drives your R&D efforts? (select all that apply)	% of Respondents	Number of Respondents
Sales	0.00%	0
Top Management	0.00%	0
Marketing	0.00%	0
Engineering	0.00%	0
Number of respondents		*0*
Number or respondents who skipped this question		*0*

25. How do you do R&D? (select all that apply)	% of Respondents	Number of Respondents
External Collaboration with private research lab	0.00%	0
External Collaboration with university lab	0.00%	0
Outsourcing	0.00%	0
Internal R&D department	0.00%	0
External Collaboration with another firm or industry consortia	0.00%	0
Acquisition of firms	0.00%	0
Number of respondents		*0*
Number or respondents who skipped this question		*0*

26. Where are the external organizations that interact with your R&D research projects located? (select all that apply)	% of Respondents	Number of Respondents
Within California	0.00%	0
Within other States	0.00%	0
Within foreign countries	0.00%	0
Number of respondents		*0*
Number or respondents who skipped this question		*0*

27. Why do you use external collaborators? (select all that apply)	% of Respondents	Number of Respondents
Goodwill	0.00%	0
Time savings	0.00%	0
Specialized expertise	0.00%	0
Cost efficiency	0.00%	0
Number of respondents		*0*
Number or respondents who skipped this question		*0*

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28. How do you protect your innovations? (select all that apply)	% of Respondents	Number of Respondents
Patents	0.00%	0
Trademarks	0.00%	0
Copyrights	0.00%	0
Compartmentalization (cells)	0.00%	0
Trade secrets	0.00%	0
None	0.00%	0
Number of respondents		*0*
Number or respondents who skipped this question		*0*

29. What do you do to mitigate risk from collaboration or outsourcing? (select all that apply)	% of Respondents	Number of Respondents
Keep Trade Secrets in the US	0.00%	0
Get foreign patent	0.00%	0
Negotiate fair sharing of rewards	0.00%	0
Hope and pray	0.00%	0
Number of respondents		*0*
Number or respondents who skipped this question		*0*

Page 7. Part 5 of 5 - Innovation process

30. How would you characterize your company?	% of Respondents	Number of Respondents
Need Seeker (identify unmet consumer demands)	0.00%	0
Market Reader (focus on incremental improvements, second mover)	0.00%	0
Technology Driver (new radical (disruptive) technology from internal R&D)	0.00%	0
Number of respondents		*0*
Number or respondents who skipped this question		*0*

31. What happens to your innovations that your firm does not commercialize? (select all that apply)	% of Respondents	Number of Respondents
We actively promote them as licensable	0.00%	0
We let them sit on the shelf and do nothing	0.00%	0
We revisit them systematically in our evaluation of strategy direction	0.00%	0
Number of respondents		*0*
Number or respondents who skipped this question		*0*

32. How does being in California support your ability to innovate? (Check all that apply)	% of Respondents	Number of Respondents
Research Facilities	0.00%	0
Sources of skills and experiences	0.00%	0
Availability of venture and angel capital	0.00%	0

WIRED Innovation Study BACKUP

	% of Respondents	Number of Respondents
Established business network/community	0.00%	0
Training/Educational facilities	0.00%	0
Financial benefit (tax etc.)	0.00%	0
Availability of highly educated professionals	0.00%	0
Industry cluster	0.00%	0
Number of respondents		*0*
Number or respondents who skipped this question		*0*

33. What norms or regulations do you use to validate quality? (Product and process)	% of Respondents	Number of Respondents
Lean	0.00%	0
No standardized norms	0.00%	0
ISO standards	0.00%	0
Six sigma	0.00%	0
Number of respondents		*0*
Number or respondents who skipped this question		*0*

34. Why do you follow those norms/standards in your innovation processes? (select all that apply)	% of Respondents	Number of Respondents
Cost efficiency	0.00%	0
Everyone else does	0.00%	0
Creates a competitive advantage	0.00%	0
Customer demand	0.00%	0
Governmental requirement	0.00%	0
Number of respondents		*0*
Number or respondents who skipped this question		*0*

35. What is the effects of these norms/standards to your company? (select all that apply)	% of Respondents	Number of Respondents
Increase costs and "time to market"	0.00%	0
Drive innovation	0.00%	0
Stifles innovation	0.00%	0
Creates a barrier to entry the industry	0.00%	0
Number of respondents		*0*
Number or respondents who skipped this question		*0*

36. How do you measure the results of innovation? (check all that apply)	% of Respondents	Number of Respondents
Customer satisfaction	0.00%	0
Stock market value	0.00%	0
Number of new products/services	0.00%	0
Relative market share size	0.00%	0
Number of strategic options	0.00%	0

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WIRED Innovation Study BACKUP

	% of Respondents	Number of Respondents
Number of new competencies	0.00%	0
Employee satisfaction	0.00%	0
New markets	0.00%	0
Effects on revenue	0.00%	0
Time to market	0.00%	0
Number of respondents		*0*
Number or respondents who skipped this question		*0*

37. If any of your operations is outsourced external to California, what are the reasons? (select all that apply)

	% of Respondents	Number of Respondents
Land costs	0.00%	0
Tax benefits	0.00%	0
Labor compensation	0.00%	0
Investment opportunities/conveniences	0.00%	0
New market penetration	0.00%	0
Number of respondents		*0*
Number or respondents who skipped this question		*0*

38. What is your current concerns about outsourcing? (select all that apply)

	% of Respondents	Number of Respondents
Possible outsourcing candidates are too distant from us	0.00%	0
Our products/processes are difficult and complicated	0.00%	0
Too costly	0.00%	0
Too time consuming	0.00%	0
Difficult to assure the safety of our Intellectual Property	0.00%	0
Possible outsourcing candidates do not speak the same language as you do	0.00%	0
Number of respondents		*0*
Number or respondents who skipped this question		*0*

39. To where and what are you currently outsourcing? (select all that apply)

	Southern California	Northern California	All USA	Canada	Mexico	South America	South East Asia	India	Europe	Russia/Eastern Europe	Middle East	Number of Respondents
IT	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0
Manufacturing	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0
Sales/Marketing	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0
Accounting	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0
R&D	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0
Customer Services	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0
Number of Respondents												*0*
Number or respondents who skipped this question												*0*

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Appendix 6: Poster Contest-UCR Tech Horizons Conference 2008

UCR Tech Horizons Conference 2008

"Engineering a Sustainable Future:
New Energy, New Materials, New Transportation"

May 13-14, 2008

College Wide Poster Competition

Tech Horizons 2008 is about sustainability. New technologies with near term commercialization potential will be presented in bio-energy, solar energy, advanced materials, and environmental engineering. In four technical sessions over two days, UCR engineering faculty, scientists, industry leaders, investors, national funding agencies, and economic development managers will present current research, applications and potential applications, and implications for long term global sustainability. Networking sessions throughout the conference will encourage fruitful exchange for all participants.

This year we are seeking posters which showcase the best of our college wide research.
There are several award categories including the "Tech Horizons 2008" conference awards for the top four posters which address this year's specific conference themes.
All posters, abstracts, and résumés will be published in the Tech Horizons 2008 proceedings.

Posters will be judged based upon the following criteria:

- Originality of the research project
- Contribution to the field of study
- Level of difficulty
- Organization and clarity
- Commercialization potential

Submission guidelines: **Deadline 4 April 2008 midnight**
(Results to be announced by 15 April)

- Submit to PostersTH2008@engr.ucr.edu
- A 300 word abstract with the author's one page professional résumé

Participants will be contacted by members of the Workforce Innovation in Regional Economic Development Project (WIRED) who will provide a team to help with poster design and presentation skills with an emphasis on application and commercialization potential. This is a great opportunity for students to interact with the WIRED participants and to familiarize themselves with what they are finding to be innovation best practices in industry. The top posters and their authors will be asked to participate in the Tech Horizons 2008 Conference where they will showcase their work throughout the two days.

Contact information:
Mehrzad Khakpour, Mechanical Engineering PhD candidate mkhakpou@engr.ucr.edu
http://www.techhorizons.engr.ucr.edu/Posters

Appendix 7: UCR Authors and Faculty Participants

Reza Abbaschian

Dean and Distinguished Professor

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Biography

Reza Abbaschian received his Ph.D. in Materials Science and Engineering from the University of California, Berkeley in 1971. Prior to joining UC Riverside in 2005 as Dean of Engineering and Distinguished Professor of Mechanical Engineering, he was Chairman of the Department of Materials Science & Engineering at the University of Florida. He has also held the positions of Chairman and Professor at the Pahlavi University in Shiraz, Iran, Visiting Associate Professor at the University of Illinois and Visiting Scientist at Massachusetts Institute of Technology. Dr. Abbaschian has more than 230 scientific publications, four patents and eight books. He is a Fellow and the President of ASM International, the largest materials society in the world.

Degrees

B.S. Mining (Metallurgy) 1965 - University of Tehran, Tehran, Iran
M.S. Metallurgical Engineering 1968 - Michigan Tech. University, Houghton, MI
Ph.D. Materials Science Technology 1971 - University of California, Berkeley, CA

Research Area

The emphasis of Dr. Abbaschian's research is the fundamental understanding of the role of interfaces on the processing and/or properties of material. Current projects involve investigations in solidification, high pressure-high temperature growth of diamond crystals, and electromagnetic levitation processing of alloys.

Awards

- Alpha Sigma Mu, Distinguished life membership, 2007
- Fellow, American Association for the Advancement of Science (AAAS), 2006
- ASEE Donald E. Marlowe Award in recognition of "creative and distinguished administrative leadership in engineering and engineering technology education", 2003
- Davis Productivity Award, 2002
- Minerals, Metals & Materials Society (TMS) Fellow, 2000
- Minerals, Metals & Materials Society (TMS) Leadership Award, 1999
- Fellow, American Society for Metals (ASM), 1992

Guillermo Aguilar

Associate Professor

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Biography

Professor Guillermo Aguilar received his Bachelors degree in Mechanical and Electrical Engineering from the National Autonomous University of Mexico (UNAM) in 1993, and his Masters and Doctor of Philosophy degrees in Mechanical Engineering from the University of California, Santa Barbara in 1995 and 1999, respectively.

Degrees

B.Sc. Mech. Engineering 1993 - Universidad Nacional Autónoma de México (UNAM)
M.Sc. Mechanical Engineering 1995 – UC Santa Barbara
Ph.D. Mechanical Engineering 1999 – UC Santa Barbara

Research Area

Cryogen spray cooling, laser-tissue interactions, thermal processes in biomedical optics and medical laser applications thermo-mechanical response of human tissue, laser-assisted cryosurgery, photopneumatic therapy, droplet deposition, thermodynamics, and heat transfer induced by atomized sprays.

Awards

- Whitaker Foundation fellowship for post doctoral research (UCI), 1999-2001
- National Institutes of Health, Research Scientist Development Award, 2002-2007
- American Society of Lasers in Medicine and Surgery (ASLMS), fellow since 2003
- Regents' Faculty Fellowship/Faculty Development Award, 2006

Bahman Anvari

Professor

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Biography

Dr. Anvari's research is directed towards development and application of photonics-based instrumentation to obtain quantitative information that will provide insight into the fundamental mechanisms underlying a biological phenomenon, and to achieve effective optical modalities for diagnosis and therapy of specific tissue malformations. Specific Areas: Current research in Dr. Anvari's laboratory is focused on: (1) investigating the nanoelectromechanical characteristics of cell membranes, particularly as they relate to the electromechanics of the outer hair cells within the cochlea; and (2) use of exogenous chromophores to enhance optical diagnosis and therapy of tissue malformations.

Degrees

B.A. Biophysics 1985 – UC Berkeley
M.S. Biomedical Engineering 1988 - California State University, Sacramento
Ph.D. Bioengineering 1993 - Texas A&M University

Research Areas

Electromechanics of outer hair cells and biomembranes; use of exogenous chromophores for optical imaging and therapy

Awards

- 2008 Fellow, American Institute for Medical and Biological Engineering (AIMBE)
- 2006 NIH/NIDCD R01 Grant
- 2005 Biophotonics Partnership Initiative Program, National Science Foundation
- 2002 Texas Higher Education Coordinating Board Technology Development and Transfer grant
- 2001 NIH/NIDCD R01 Grant

Gerardo Beni

Professor

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Biography

Professor Gerardo Beni -- Laurea in Physics (1970), Universita' di Firenze, Italy; Ph.D. in Physics (1974) University of California, Los Angeles. Fellow, American Physical Society (1982); Fellow, American Association for the Advancement of Science (1999). Who's Who in America (1988); Who's Who in the World (1992) Co-founder, co-director of the NSF Center for Robotic Systems in Microelectronics, UC Santa Barbara (1985-1990). Co-founder, director "Journal of Robotic Systems", John Wiley, (1982-2005).

Degrees

Laurea Physics 1970 - Universita'di Firenze, Florence, Italy
Ph.D. Physics 1974 - UC Los Angeles

Research Area

1. Swarm Intelligence, Distributed Robotic Systems
2. Multimedia (3D animation) for education technology applications.
3. Financial Engineering.

Awards

- 1979 U.S. Government (I.C.A.) Brazil on Physics of Energy Technology 1982 Fellow, American Physical Society (APS)
- 1983 Distinguished Member of Technical Staff, AT&T Bell Laboratories
- 1984 Journal of the Year award for Journal of Robotic Systems
- 1988 Listed in Who's Who in America
- 1992 Who's Who in the World, (since 1992)
- 1999 Fellow, American Association for the Advancement of Science (AAAS)

Michalis Faloutsos

Associate Professor

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Biography

Dr. Faloutsos' interests are in the general area of computer networks. More specifically, his interests include internet protocols, quality of service support in networks, mobile and ad-hoc networks, online and distributed algorithms. Lately his focus is in two areas: QoS-Friendly Internet protocols-multicasting. Modeling and Generation of Real Graphs (i.e. Internet, Web)

Degrees

Ph.D. Computer Science 1999 - University of Toronto

Research Area

Dr. Faloutsos' research is in the areas of: (a) network security: secure routing, intrusion detection, application classification, URL hijacking; (b) Peer-to-peer networks: measurements, models, and implications, and; (c) measurements and routing in any form: Internet, ad hoc networks, multicast, and BGP.

Awards

- Annual awards for being in the top ten of the class of 150 students at the National Technical University of Athens (1988, 1989 and 1991)
- University of Toronto Open Fellowship (1993), along with a Differential Fee Waiver for International Students
- Connaught Scholarship (1994, 1995 and 1996) a prestigious scholarship (offered to 2 out of 150 graduate students in CS) offered by the School of Graduate Studies of the University of Toronto
- Teaching Assistant Award, Computer Science Department, University of Toronto (Spring 1996) second best amongst teaching assistants
- Ontario Graduate Scholarship (1997) offered by the Ministry of Education and Training
- NSF CAREER Award, July 2000

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Qing Jiang
Professor

Biography

Professor Qing Jiang received his Ph.D. degree in Applied Mathematics from California Institute of Technology in 1990. He joined the University of California in 1998, from the University of Nebraska-Lincoln where he served as Professor for Engineering Mechanics. He held guest scientist appointments at the National Institute of Standards and Technology and at the Karlsruhe Research Center, Germany, respectively, in 1996 and 1997.

Degrees

Ph.D. Engineering and Applied Science 1990 - California Institute of Technology

Research Area

For the past several years, Professor Jiang's research has been focusing on development of smart materials, electrically active materials specifically, for sensing and actuation applications. His current research is directed to the development of smart sensors and nano-structured materials, in particular, the inter-locked molecules based on carbon nanotubes, as well as their applications as nanoscale devices

Awards

- Departmental Nomination for Outstanding Teaching Award, College of Engineering and Technology, University of Nebraska-Lincoln, 1995
- Departmental nomination for Outstanding Teaching Award, Tau Beta Pi Engineering Society, 1995
- Outstanding Research Award, College of Engineering and Technology, U. of Nebraska-Lincoln, 1996
- Visit/Study Fellowship, German Academic Exchange Office, 1997

Ping Liang

Associate Professor

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Biography

Professor Ping Liang is a senior member of IEEE, and was Associate Editor of the journals Pattern Recognition and Multidimensional Systems and Signal Processing. He was the founder and CEO of a semiconductor company and led the development of an industry standard on embedded interconnectivity. He architectured and led the development of multiple ASIC chips, semiconductor IP cores and embedded software product that are used by many Fortune 100 companies worldwide in over 100 million units of products ranging from cell phones, digital cameras, printers, PDAs, MP3 players, storage drives, to network gateways and routers, adapters and set-top boxes. His research in industry has led to eight granted patents and many more pending patent applications.

Degrees

B.Sc. Computer Science & Engineering 1982 - Jiatong University, Xian, China
M.Sc. Electrical & Computer Engineering 1983 - University of Pittsburgh
Ph.D. Electrical & Computer Engineering 1987 - University of Pittsburgh

Research Area

Dr. Liang's current research interests include VLSI/ASIC architectures for signal, video and multimedia processing and network-on-chips, and information retrieval systems.

Awards

- Provost's Fellowship, Univ. of Pittsburgh, 1982-83
- Outstanding Conference Paper, 2nd IEEE Conference on Artificial Intelligence & Applications, 1985
- Outstanding Conference Paper, 3rd IEEE International Electronics Manufacturing Technical Symposium, 1987
- DOE/AWU Faculty Fellow, 1996
- U.S. Air Force Summer Faculty Fellow, 1997

Jiayu Liao

Assistant Professor

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Biography

Dr. Liao's research includes studies on signal transduction pathways, small ubiquitin-like modifier ligase, G protein-coupled receptors, and lipid receptors. He has developed several high-throughput screening systems for drug candidates. Dr. Liao has made some important discoveries of novel G-protein coupled receptors (GPCRs) particularly associated with taste receptors utilizing bioinformatic methods. Recently he has found evidence for several fatty acid receptors that may play an important role in understanding fatty acid induced insulin resistance and the relationship between obesity and diabetes.

Degrees

B.S. Biochemistry 1988 – Peking University, Beijing, P.R. China
Ph.D. Biological Chemistry 1999 – UC Los Angeles

Research Area

Signal transduction pathways, small ubiquitin-like modifier ligase, G protein-coupled receptors, fatty acid induced insulin resistance, high-throughput screening, bioinformatics

Awards

- Department of Biology Fellowship, UCLA 1990
- Wang Kuan Chen Scholar, Chinese Academic of Science, 2004
- UC Regent's Faculty Development Award, 2006
- Bai Yulan Award, Shanghai Government, 2006
- Outstanding Overseas Young Scholar Award, NSFC, 2006

Walid Najjar
Professor

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Biography
Professor Najjar is very active in the area of compilation for FPGA-based code acceleration and reconfigurable computing. His research has been supported by NSF, DARPA and various industry sponsors. He received a B.E. in Electrical Engineering from the American University of Beirut in 1979 and the M.S. and Ph.D. degrees in Computer Engineering from the University of Southern California in 1985 and 1988 respectively. He was on the faculty of the Department of Computer Science at Colorado State University (1989 to 2000), before that he was with the USC-Information Sciences Institute. He has served on the program committees for a number of leading conferences in this area including CASES, ISSS-CODES, DATE, HPCA, and MICRO.

Degrees
B.E. Electrical Engineering 1979 - American University, Beirut Lebanon
M.S. Computer Engineering 1985 - University of Southern California
Ph.D. Computer Engineering 1988 - University of Southern California

Research Area
Architecture Design of Computer Systems, compilation and optimizations for parallel and re-configurable computer systems; modeling and performance evaluation of computer systems

Awards
• Graduate Teaching Award, College of Natural Sciences, Colorado State University, 1995-96
•Fellow, IEEE, 2007

Thomas Payne
Associate Professor

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Biography

Dr. Payne's current research involves the efficient implementation of various programming language features related to issues in operating systems: concurrency, protection, and dynamic binding.

Degrees

Ph.D. Mathematics 1967 - University of Notre Dame

Research Area

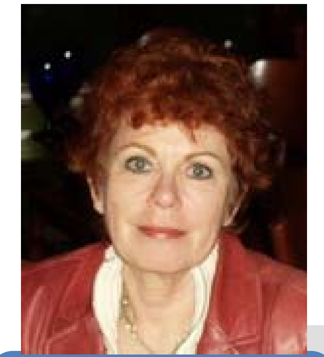
Efficient implementation of programming language features related to operating systems, such as concurrency, protection, dynamic binding

Awards

- T. J. Watson Memorial Scholarship
- NASA Traineeship

Christine Cope Pence

Project Manager, Director Workforce Innovation Programs



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Biography

As a practicing e**ntrepreneur for the past twenty-**four years out of **her office base in France, Dr. Pence** built a major international logistics and spares support operation for civilian aircraft operators. Upon returning to the **United States in 2004, she** joined the faculty of the University of California Riverside in international entrepreneurship and strategy. Continually searching for new ways to build entrepreneurial offers which will sustain growth, **she has served for the past two years as** project manager for WIRED (Workforce **Innovation in** Regional Economic Development) out of UCR's Bourns **College of Engineering.** In this role, **she has designed and supervised** research on innovation in California business under the auspices of the California Space Authority's grant with the U.S. Department of Labor.

Degrees

M.S. Quantitative Methods-Business Administration 1975- University of California Irvine
Ph.D. Business Administration-Venture Capital Decision Making 1981- University of California Irvine

Research Area

International innovation and entrepreneurial development; modeling innovation metrics for wealth generation; innovation metrics and supply chain development.

Marko Princevac

Assistant Professor

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Biography

Professor Princevac has worked as an industrial laboratory and field supervisor in Mexico, and for the roller-bearing industry in Serbia. He is a member of the American Society of Mechanical Engineers and the Air & Waste Management Association. Dr. Princevac is interested in fundamental and applied fluid mechanics research - in particular, the application of fundamental turbulence concepts to studies in environmental flows. During his graduate studies and a short post-doctoral period afterward, he gained a strong background in laboratory and field experimental work. This helped him identify some physical phenomena and build simple physical (laboratory) models that can successfully explain complex field observations or a part thereof. He also has experience in developing idealized theoretical models to explain fluid dynamic processes. His approach has been to cross-fertilize field measurements with carefully designed laboratory experiments and simple theoretical analysis. His early research was focused on “engineering flows,” specifically ship’s propulsion and resistance. This research resulted in several polynomial models for the estimation of the power and resistance for the specific type of semi-displacement hull forms. In graduate school he focused his research on thermally driven environmental flows, motivated by tremendous air quality problems that are occurring in cities located in the areas of complex terrain. Currently, he is focusing on field experimental research on urban flows, specifically on urban dispersion (pollutants or toxic releases, industrial disasters or terrorist attacks) and parameterizations of turbulence within urban canyons.

Degrees

B.Sc. Mechanical Engineering and Naval Architecture 1997 - University of Belgrade, Serbia
Ph.D. Mechanical Engineering 2003 - Arizona State University

Research Area

Fluid Mechanics

Awards

• Air & Waste Management Association Fellowship

Victor G. J. Rodgers

Professor

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Biography

Although a chemical engineer by training, Professor Rodgers has concentrated on applications of chemical engineering fundamentals to the development and better understanding of biomedical and biological systems. His specific focus uses the fundamentals of transport phenomena, mathematical modeling, thermodynamics and kinetics. His work is largely interdisciplinary and collaborative with colleagues at medical school and pharmaceutical and bioscience programs, particularly at the University of Iowa.

Degrees

B.S. Chemical Engineering 1980 - University of Dayton, OH
M.S. Chemical Engineering 1985 - University of Pittsburgh, Pittsburgh, PA
D.Sc. Chemical Engineering, 1989 - Washington University, St. Louis, MO

Research Area

Biotransport, Bioreactions in Cells, Artificial Organs, Thermodynamics of Crowded Proteins, Membrane Separations, Bioseparations, Bioreactor Design, Drug Delivery Vehicles

Awards

- 2006 Fellow, American Association for the Advancement of Science (AAAS)
- 2005 Distinguished Educator Award, University of Iowa
- 2004 Catalyst Award, University of Iowa
- 2004 Collegiate Service Award, University of Iowa
- 2001 Iowa daVinci Celebration and Conference for Leadership and Excellence in Engineering
- 1999 Distinguished Service Award, AIChE, Minority Affairs Committee

Jerome Schultz

Department Chair & Distinguished Professor

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827-6416 (fax)

Biography

Jerome Schultz started his career in the pharmaceutical industry (Lederle Labs) then joined the University of Michigan, where he was Chairman of the Department of Chemical Engineering. He spent two years at the National Science Foundation as Deputy Director of the Engineering Centers Program. In 1987 he joined the University of Pittsburgh as Director of the Center for Biotechnology and Bioengineering, and was the Founding Chairman of the Department of Bioengineering, a nationally ranked degree program in Bioengineering. He recently spent a year at NASA's Ames Research Center as a Senior Scientist in their Fundamental Biology Program. In 2004 Dr. Schultz joined the faculty at the UC Riverside and founded the Department of Bioengineering's undergraduate and graduate degree programs. He also serves as the Director of the newly formed Center for Bioengineering Research.

Degrees

B.S. Chemical Engineering 1954 - Columbia University
M.S. Chemical Engineering 1956 - Columbia University
Ph.D. Biochemistry 1958 - University of Wisconsin

Research Area

Biosensors, transport processes in tissues, pharmacokinetics, immobilized enzymes, biomaterials, membrane-based separations

Awards

- "One Hundred Engineers of the Modern Era," American Institute of Chemical Engineers, 2008
- Fellow, Biomedical Engineering Society, 2005
- Donald Katz Lectureship, University of Michigan, School of Engineering, 2002

Thomas Stahovich
Associate Professor

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Biography

Professor Stahovich received his Ph.D. in Mechanical Engineering from the Massachusetts Institute of Technology in 1995, where he conducted his Ph.D. research in the Artificial Intelligence Laboratory. He joined the University of California in 2003 from Carnegie Mellon University, where he served as an Associate Professor of Mechanical Engineering. Professor Stahovich was the founding director of the Smart Tools Lab at Carnegie Mellon.

Research Area

Professor Stahovich's research is in the area of design and artificial intelligence. Current projects include: LearnIT, a system for capturing and preserving design procedures; RedesignIT, a system for managing design changes in large scale systems; and ExplainIT, a system for automatically documenting designs. In recent work, Professor Stahovich has begun applying design automation techniques to the problem of cryosurgical planning. Another major research focus is sketch understanding. Professor Stahovich and his students are developing techniques to enable natural, sketch-based user interfaces for a variety of software applications, such as engineering design and analysis software.

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Kambiz Vafai
Professor

Biography
Professor Kambiz Vafai received his B.S. in Mechanical Engineering from the University of Minnesota at Minneapolis in 1975. He received his M.S. degree in Mechanical Engineering from UC Berkeley in 1977 and his Ph.D. degree in Mechanical Engineering also from UC Berkeley in 1980. He comes to UC Riverside from Ohio State University in Columbus, Ohio.

Degrees
Ph.D. Mechanical Engineering 1980 - UC Berkeley

Research Area
Kambiz Vafai's research interests include transport through porous media, multiphase transport, natural convection in complex configurations, analysis of porous insulations, heat flux applications, free surface flows, unconventional heat pipes, and power electronics. Basic and applied research is conducted in several areas related to heat and mass transfer, such as Fundamental Aspects of Transport through Porous Media, Natural Convection in Open-Ended Configurations, Condensation and Phase Change, Multiphase Transport through Porous Media, Heat Pipe Analysis as Applied to Flat Shaped Heat Pipes, Flow and Heat Transfer in the Brake Housing of an Aircraft, Heat Transfer and Phase Change Effects on Insulation and in Partial Insulations, and Free Surface Analysis in regular and porous media.

Awards
- Citation in NEWS IN ENGINEERING (The Ohio State University) Vol. 71, No.3, P 18, December, 1999
- Director/Chair of the Second International Conference on Porous Media and its Applications in Science, Engineering and Industry sponsored by Engineering Conferences International, sponsored by NSF and ECI, Kauai, Hawaii, 2007
- Chair of K-6 Committee on Heat Transfer in Energy Systems, National ASME

Sundararajan Venkatadriagaram
Assistant Professor

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Biography

V. Sundararajan received his Ph.D. from UC Berkeley in 2000, majoring in Mechanical Engineering. Prior to joining the Mechanical Engineering faculty, he was an associate specialist at the Berkeley Manufacturing Institute at UC Berkeley.

Degrees

B.E. Mechanical Engineering 1995 - University of Pune, India
M.S. Mechanical Engineering 1997 – UC Berkeley
Ph.D. Mechanical Engineering 2000 – UC Berkeley

Research Area

Design and Manufacturing Systems: automated process planning, supply-chain integration, computer-aided design and manufacturing, computational geometry, solid modeling, feature technology, software engineering process and environment modeling with sensor networks, fault-diagnostics and condition monitoring, energy harvesting for wireless sensor nodes, applications to manufacturing and inspections, environmental monitoring, energy utilization.

Junlan Wang
Associate Professor

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Biography

Professor Junlan Wang received her Bachelor of Science and Master of Engineering degrees in Mechanics and Mechanical Engineering from the University of Science and Technology of China in 1994 and 1997, respectively, and her Doctor of Philosophy degree in Theoretical and Applied Mechanics from the University of Illinois at Urbana-Champaign in 2002. She joined UC Riverside in 2003 after spending one year as a post-doctoral research associate at Brown University.

Degrees

Ph.D. Theoretical and Applied Mechanics 2002 - University of Illinois at Urbana-Champaign

Research Area

Professor Wang's research interests are in the fields of nano- and micro-mechanics of materials. In particular, she is interested in developing new experimental techniques complemented by theoretical modeling and numerical analysis to study the mechanical behavior of thin films and other small-featured structures, mechanics of interfaces and surfaces, and nanoporous multifunctional materials. Her recent research includes characterization of thin film adhesion, scale bridging in fabrication and property testing of nano and microstructures, surface roughness evolution and residual stress development caused by nano-scale contact, and mechanical characterization of nanoporous zeolites.

Awards

- Materials Division Certificate of Recognition, American Society of Mechanical Engineers (ASME) (2006)
- Ferdinand P. Beer and E. Russell Johnston Outstanding New Mechanics Educator Award, American Society for Engineering Education (ASEE) (2007)
- Bourns College of Engineering Excellence in Teaching Award (2006-07)
- NSF CAREER Award (2008)

Yushan Yan

Professor

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Biography

Professor Yan received his B. S. in Chemical Physics from the University of Science and Technology of China in 1988, and his M. S. and Ph.D. in Chemical Engineering from the California Institute of Technology in 1995 and 1997, respectively. He worked for AlliedSignal Inc. as a Senior Staff Engineer and Project Leader from 1996 to 1998. He came to the University of California, Riverside in 1998 as Assistant Professor. He was promoted to Associate Professor in 2002 and Professor in 2005. In 2006 he was chosen as one of the five inaugural University Scholars.

Degrees

B.S. Chemical Physics 1988 - University of Science & Technology of China
M.S. Chemical Engineering 1995 - California Institute of Technology
Ph.D. Chemical Engineering 1997 - California Institute of Technology

Research Area

Biological production of cellulosic ethanol and other sustainable fuels and chemicals from cellulosic biomass with a focus on pretreatment and enzymatic hydrolysis

Awards

- **2006 University Scholar (2006-2009)**
- **2003 Oversea Young Investigator, Chinese Academy of Sciences**
- **Regents' Faculty Fellowship/Development Award, July 2001**
- **Executive Committee Member, UC-DISCOVERY Program (2000-date)**
- **Regents' Faculty Fellowship, University of California, Riverside 2000**
- **New, Junior Faculty Research Award, UC-SMART Program, 1999**
- **Guest Professor, Department of Chemistry, Jilin University, China, 1998-2003**
- **Recognition of Contribution, Allied Signal Aerospace Equipment Systems, 1997**
- **Li Ming Scholarship, California Institute of Technology (1994)**

Victor Zordan

Assistant Professor

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Biography

Victor Zordan received his Ph.D. in Computer Science from Georgia Institute of Technology in 2002, where he worked in the animation lab affiliated with the Graphics, Visualization and Usability Center at Georgia Institute of Technology. Dr. Zordan directs the Riverside Graphics Lab in developing cutting-edge techniques in graphics and animation with a focus on physically based modeling and human motion. Victor has been an animation enthusiast and graphics programmer for more than 20 years and a researcher investigating animation techniques for more than 10. His interests are in physical simulation, motion capture, and algorithms used to create believable (and unbelievable) motion and to explore novel uses for animation in electronic games, medical and training applications, and 3D virtual worlds.

Degrees

B.S. Mechanical Engineering 1992 - Boston University
Ph.D. Computer Science 2002 - Georgia Institute of Technology

Research Area

Computer graphics, animation and interactive media; research in the areas of physically based modeling and human animation based on motion examples

Awards

•Regents Faculty Fellow 2008-2009
•UCR Teaching Innovation Award 2008
•UC Discovery Grant Recipient 2007
•Omnibus Senate Grant Recipient 2007-2008
•Office of Research Collaborative Seed Grant 2006-2007
•Omnibus Senate Grant Recipient 2003-2004
•NSF Summer Institute in Japan 1996