Purdue's Engineer of 2020
Seed Grant Funding for 2008-2009
Purdue University

Project Title: Students' Attitudes and Threshold Concepts Towards Engineering as an Environmental Career: Research by Participatory Design of an Educational Game

Target Attribute(s) to be studied/implemented:
Abilities: Teamwork, Communication, Decision Making, Synthesize Engineering, Business and Societal Perspectives
Knowledge areas: Engineering fundamentals, analytical skills, open-ended design and problem solving skills, multidisciplinarity within and beyond engineering,
Qualities: Innovative, ethically responsible in global, social, intellectual and technological context, curious and persistent continuous learners

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A. Project Description:

OBJECTIVE OF THE STUDY

The value and importance of environmental education has been endorsed both in the United States and internationally (e.g. United Nations Educational, Scientific and Cultural Organization, 1975, 1978; North American Association for Environmental Education, 1999). Despite this, 'two-thirds of adult Americans consistently fail simple tests of environmental knowledge' (National Environmental Education and Training Foundation, 2005, p. 10).

It can only be imagined, how many high school and beginning college students know about environmental and ecological engineering and that engineering is a major career choice for students who want to make an environmentally and ecologically sustainable impact.

The following examples demonstrate that engineering skills and knowledge are essential to environmental protection and enhancement. First, would a person switch from a standard residential home to an "energy efficient home", if s/he knew that the carbon footprint, use of energy, and greenhouse gas emissions of constructing the home were substantial compared to the energy consumed while residing in the home? Consider another example: If one already owns a mobile phone, how to quantify the impact of upgrading the phone every year or two?? The growing number of electronics devices do not harm the environment during use, but their lifetimes are so short and there are so many of them that disposal is an issue. These are not just questions for the individual end user; the questions aim at the core of engineering and highlights that the design, manufacturing, use, and disposal of products, in short the product life-cycle, has an equal if not higher impact on the environment than just the end users' actions.

The objectives of this study is to research the attitudes and threshold concepts (key concepts or gate keeper concepts) of beginning engineering students towards the relationship between environment/ecology and engineering, specifically towards choosing either (a) engineering as a career to make an environmental impact or (b) choosing environmental and ecological engineering as a specific engineering profession. The project is situated in the context of life cycle analysis and the environmental impacts of design, manufacturing, use and disposal of products.

The study will be theoretically grounded in (1) 'social cognitive career theory' (SCCT) and the (2) theory of "threshold concepts" (TC). SCCT maintains that people's interests in certain careers stem partly from their self-efficacy (beliefs about personal capabilities) and outcome expectations (beliefs about the outcomes of engaging in particular courses of action) (Lent et al., 1994, 2003, 2005). TC argues that there are key concepts, once understood change the way in which students view a discipline. This study researches students' change of attitudes and conceptions especially in regards to outcome expectations (as defined by SCCT), meaning: how well do students understand that their environmental/ecological impact is extremely high by choosing an engineering career and which concepts seem to be "threshold" concepts?

The study employs also an innovative research design: The researchers investigate students' conceptions and attitudes (and change of both) by asking students to co-design an educational game with them. Of particular focus will be the change of students' conceptual understanding of core environmental and ecological concepts during the design process.

Expected outcome: A better understanding of students' attitudes and threshold concepts towards environmental engineering and a baseline to design new interventions to support a stronger view of engineering as a career for environmental impact. This research project will also build the foundation of two NSF proposals, a CCLI Phase I and a Advanced Learning Technologies (ALT).

BACKGROUND LITERATURE TO ESTABLISH THE NEED FOR AND SIGNIFICANCE OF THE PROPOSED PROJECT

Conceptions and attitudes of engineering students towards environmental/ecological issues

Through documentaries like "An Inconvenient Truth" and other means, the general awareness on ecological and environmental issues increased in the last years. Looking at available data, reports like "Environmental Literacy in America: What 10 Years of NEETF/Roper Research and Related Studies Say About Environmental Literacy in the U.S" (NEETF, 2005) show mixed results: On the one hand, the report shows a "confused public that performs poorly on basic environmental literacy questionnaires", on the other hand "95% of this public supports environmental education in our schools" (p.3).

Earlier work on environmental literacy in the field of engineering showed a similar pattern amongst engineering students: In a worldwide survey amongst engineering students, Azapagic et al. (2005) found (a) unsatisfactory knowledge, and at the same time (b) a general belief that environmental issues are very important. Although reports exist in the engineering education literature, especially on individual lesson design (Nair, 1998; Velazquez et al., 1999) and curricula design (Nair et al., 2002; Mulder, 2006), there is a gap in the literature and a general lack of more detailed research into the conceptions and attitudes of students towards environmental and ecological issues, especially how both relate to engineering careers.

Threshold Concepts and attitudes

Conceptual change is among the conceptions of learning that have recently been most closely embraced by the educational psychology and learning sciences communities, (Sinatra & Pintrich, 2003). Humans naturally build simplified and intuitive theories to explain their surroundings. The cognitive process of adapting and restructuring these theories based on experience and reflection is referred to as conceptual change. Most research indicates that conceptual change arises from interaction between experience and current conceptions during higher-order cognitive activity, especially when cognitive conflict arises (Strike & Posner, 1992). Cognitive conflict or 'troublesome knowledge' (Perkins, 2006), however, is not always sufficient for engaging conceptual change. Students often ignore, reject, exclude, or reinterpret anomalous data or they hold them in abeyance (Chinn & Brewer, 1993), which is largely due to beliefs and attitudes (Sinatra & Pintrich, 2003).

The new emerging theory of threshold concepts (Meyer & Land, 2006) argues further that there are hierarchies within concepts, in which certain concepts are threshold or gatekeeper concepts. Attributes, of threshold concepts are (a) transformative (transforming the understanding of a domain), (b) irreversible (change of perception is unlikely to be forgotten), (c) integrative (exposes other relationships), (d) bounded (context-specific) and (e) troublesome (counter intuitive) (Meyer & Land, 2006).

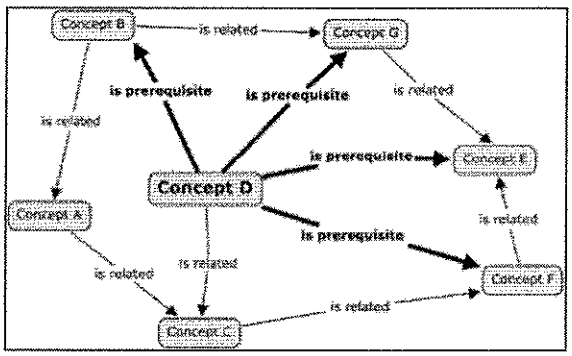

Figure 1: "Concept D" as a Threshold Concept

As depicted in Figure 1, 'concept D' is such a threshold concept, meaning if concept D is not understood properly, it is most likely that concepts B, G, E, and F will not be properly understood, since concept D is the prerequisite for these other concepts. Given such complex and concept-rich domains as in engineering, threshold concepts become increasingly important: Results of 'threshold concept' research can inform teachers and administrators on where to set priorities and allocate resources to maximize impact on students' learning.

Participatory design

"Participatory Design of computer applications is about the direct participation of those who will be affected by the development of a particular computer application in the decision-making, design and/or de-

velopment process" (Törpel, 2005, p. 177). In this proposed project, students are collaborative co-designers of an educational game from which other students benefit. The concept of participatory design, used primarily in product design, has long roots in educational design and research practice as well:

Stemming from a constructivist paradigm (Bodner, 1986), the role of computers as "mindtools" or "cognitive tools" is emphasized: meaning to utilize the computer as a partner for the intellectual and social endeavors of the learners rather than utilizing the computer as a glorified teacher (Papert, 1993). As Jonassen et al. (1993) report, instructional designers learned far more by designing CAI (computer-assisted instruction) than the target audience will probably ever learn by using the designed CAI. Both concepts argue for a reciprocal relationship between learners and content, and highlight the notion of "designers as learners" and "learners as designers". Additionally, as the rich teach-back literature (for example, Johnson & Johnson, 1987) shows, learners are especially successful when teaching newly acquired knowledge and skills to other learners.

In this particular proposal, we utilize the participatory design process for two different purposes:

(a) To ensure that end-users are early and iteratively involved in the design of the game to make certain that the game targets the needs and expectations of the end-user.

(b) A novel way to utilize the participatory design process as an elicitation technique to understand students' attitudes and conceptions (especially threshold concepts) about ecological and environmental engineering.

EVALUATION PLAN INCLUDING APPROACH, IMPLEMENTATION METHODS, EXPECTED RESULTS AND ASSESSMENT METHODS

Approach

Over the period of a year, the researchers work with three teams of up to four students each on the participatory design of an educational game incorporating ideas of life cycle analysis. This includes also the analysis and synthesis of the data. Students will be recruited from ENGR 100, which includes the entire population of incoming first-year students. All volunteers will be surveyed on demographics and a baseline testing (see below in assessment methods for details). Based on the findings, mixed background and knowledge level students will be assigned to three teams of maximum of four members. To receive adequate response rates, the project will provide a participation stipend of $100 for students completing all aspects of the study.

Methodologies and Methods

This research study utilizes the following methodological frameworks and methods:

- Design-based research: understanding complexity of learning by intervention
- Participatory design (prototyping): users as designers
- Individual base line testing, elicitation by design, and focus group exit interviews

Design-based research

The methodological framework for this study is 'comparative design-based' (Strobel *et al.*, in press). Since the seminal paper by Brown (1992) who coined the term, "design-based research" approaches are enjoying increasingly popularity in linking developments in learning theories with the design and support of naturalistic learning environments (see Linn *et al.*, 2004 for examples). According to Sandoval & Bell (2004) design based research is practiced when "educators seek to refine theories of learning by designing, studying, and refining rich, theory-based innovations in naturalistic environments". Since the context of learning and the particular environment plays an enormous role (Barab & Squire, 2004), we propose a comparative design-based approach (Strobel et al., in press): As outlined before, we will study the complex phenomena of attitudes and conceptions with three different student groups (see for selection criteria

above the approach section). This allows us to compare the findings and the research therefore already will provide a model for scalability of the research findings and interventions.

Participatory design

Participatory design is summarized above in the literature section.

For our project this approach means: We will work with three teams of students designing an educational game for high school and beginning engineering students (total of 12 participants). Students will work in teams designing the game, having process support (on game design) and content support (on Life Cycle Analysis). Students will be sketching and drawing storyboards on the interactive whiteboard and will build paper prototypes of the game. During the advanced stages of the design, electronic prototyping of the game will extend the paper prototyping resulting in a functional prototype of a game.

Assessment methods

The research will utilize standard assessment instruments on environmental knowledge and attitudes such as AELK (Alternative Energy, Likelihood and Knowledge) Scale (Dender, 2004) and the attitudes and knowledge instruments as used by the National Environmental Education and Training Foundation (NEETF, 2005). In addition, an instrument will be developed on key concepts of environmental and ecological engineering, especially focused around Life Cycle Analysis (LCA). These tests will build the base line and will be administered at the beginning of the study.

During the participatory design phase, all artifacts will be collected, including printouts of the interactive white-boards, and paper prototypes. Additionally, observational data will be collected.

At the end of the project, focus group interviews will be conducted comprised of the three teams. The focus group interview will center on issues that arose from analyzing the participants' artifacts and the overall goals of the project. Consistent with focus group research (Krueger & Cassey, 2000) the discussion that follows will be summarized by the trained focus group leader (the PI of this project) and checked with participants. Subsequently, the themes of the focus group will be written up following the analysis of the transcripts of the focus groups and circulated to participants to obtain their feedback on the accuracy of the points summarized.

Data Analyses. Data will be analyzed by both quantitative and qualitative methods including analytical induction of the raw qualitative data (Bogdan & Biklen, 1992), and content and constant comparison analyses of the interviews (Strauss & Corbin, 1990). Additionally, statistical analysis of the surveys will be conducted. In this mixed method design, the statistical analysis of the surveys will guide the further qualitative investigation and the qualitative research results will inform further survey development. Using additionally focus group interview transcripts, overall themes of the participants' conceptions and attitudes will be analyzed and compared. Particular focus of the data analysis will be given on the change of conceptions and attitudes and on hierarchies of concepts to detect and formalize a model of threshold concepts for the particular context of the project.

Expected Results

There are four expected results

1) A model of threshold concepts, attitudes, and the relationship between these concepts and attitudes of students. This model will help us to prioritize which concepts are key concepts and attitudes towards understanding engineering as an environmental career and therefore can provide us with leverage points on where to spend the most effort in instructional design and curriculum development. Papers with the findings will be submitted to engineering education and environmental education journals.

2) Evaluation on the usefulness and effectiveness of participatory design and the 'concept elicitation by design' methodology, our research/design methodology, to capture and change students' conceptions and

attitudes. An effective process can add to the methodological toolkit of researchers and results will be published in engineering education and educational methodology journals

3) A paper-based game and an electronic prototype to change attitudes and conceptions of students (high school and beginning college students). This game will be tested and further developed. Funding is already requested from the Environmental Protection Agency to further develop the game (pending). Impact of the game on conceptual and attitudinal development will be further investigated to test the effectiveness of the game. Major classes and learning initiatives at Purdue (including p-12 stem outreach) already committed to utilize the game in their respective contexts: This includes ENGR 100 (enrollment ~1900 students per year), CE 350: Introduction to Environmental Engineering (enrollment ~200 per year), CE 355: Engineering Environmental Sustainability (enrollment ~75 per year) and in EEE the signature course of environmental and ecological engineering yet to be developed. The game will be introduced in the "Engineering for the Planet" student learning community through their involvement in the class ENGR 103.

4) Further grant proposals to appropriate funding agencies. A design/development grant proposal for an environmental game is already submitted to the Environmental Protection Agency (EPA), however under EPA's education program, no funding was permitted to conduct research. Additional proposal submissions are planned for NSF's Course, Curriculum, and Laboratory Improvement (CCLI) program and Advanced Learning Technologies (ALT) program.

The different contexts for implementation also ensure a rich test base for further testing and refinement.

PLAN FOR DISSEMINATION OF FINDINGS WITHIN COLLEGE OF ENGINEERING

The game will be hosted on the publicly available website of the Division of Environmental and Ecological Engineering (DEEE) as part of the recruitment hook for students. Through the deployment of the game at a publicly accessible web site, the project has the potential to reach a wider audience as well. Link exchanges with existing web sites outside of Purdue will be fostered to ensure wider reach.

The DEEE will serve as a primary portal through which the findings of this project will be disseminated to the College of Engineering (CoE). After the project has concluded, the DEEE will host and publicize a seminar by the PI, J. Strobel, during which the project outcomes will be discussed. In addition, the PIs will participate in future "Engineer of 2020" workshops sponsored by the CoE and will present findings at those workshops. The PI, J. Strobel will also present the outcomes from this project and on the process how to teach towards threshold concepts via workshops within the CoE, and ASEE regional and national meetings.

In the spirit of "learners as designers," efforts will also be made to disseminate the findings of this project to the undergraduate and graduate student population at Purdue. Strobel and Hua will prepare a brief summary, comprehensible to a broad audience (including students) and distribute to a student-list serve maintained by DEEE. This list-serve is a channel to students in the CoE who have expressed some level of interest in environmental and ecological engineering.

B. Timeline and Implementation Strategy

Summary Implementation Strategy

The detailed time-line (see below) specifies the implementation of the grant over the funding period of one year. Further to this, the results of the project (a) research findings on conceptions and attitudes of students and (b) the game prototype (paper and electronic) will be implemented in different classes across the CoE. Further grants from NSF (CCLI and ALT) will be sought to implement the results into concrete interventions and contribute further strategic plan of CoE.

Time-line

Objective	Activities	Timeline	Assignment	Outcomes
Project phase-in	Hire GRA. Hire undergraduate students. Select products and scenario for inclusion. Compile and develop base-line instrument.	07/01/08 – 08/20/08	Project director and Co-PI Co-PI and undergrad. students	Quality staff hired. Products and initial scenario selected. Instruments ready.
Recruit & Train	Recruit participants in ENGR 100 + Base line Testing Start training of GRA and undergraduates	08/21/08 – 09/20/08	PI and Co-PI and graduate student PI and Co-PI	Students recruited
Data Collection Game prototyping Game platform preparation Content collection	Group assembly Develop paper prototypes of different narratives and sketches (2 sessions) Selection of gaming platform and initial work for electronic prototype Selection of content and information	09/21/08 – 11/20/08	PI, grad. student Participants (grad student) PI undergraduate students Participants, graduate & undergraduate	Groups assembled Prototypes developed Game platform selected Content information to products collected
Storyboard & development of the game First round of analysis	Develop detailed story-board and design/develop paper prototypes and electronic prototype (2 sessions) Analysis of the first observational data and the initial prototypes.	11/21/08 – 02/01/09	PI, GRA, undergrad, participants PI, Co-PI & GRA	Completed detailed storyboard. First round of analysis complete
Finish game (paper and electronic prototype) Focus group interviews Final analysis	Develop further detailed story-board and design/develop paper prototypes and electronic prototype Collect data from focus group Analysis of all the data	02/01/09 – 04/01/09 04/02/09 – 04/15/09 04/20/08 – 06/30/08	Participants, GRA, PI & Co-PI GRA and PI GRA, PI and Co-PI	Completed prototypes Data ready for analysis Analysis of date

C. Personnel Requirements
Please indicate the portion of FTE that each faculty member will dedicate to the project

Faculty member	Summer 08	Fall 08	Spring 09
Strobel, Johannes	5%	10%	10%
Hua, Inez	5%	10%	10%

D. Budget
The budget worksheet is provided to assist you in developing your budget. You may fill this out and paste it directly into your proposal.

Faculty/Staff Member Funding
Please indicate the funding (dollars and time) you are requesting for the grant for this project)

Faculty/Staff Name:	Grant funds requested		
	% Time	Fringe Benefits	$$
Strobel, Johannes	25	$782	$2,222
Subtotal Faculty/Staff Funding			$ 3,004

Graduate Students

Type of position	Grant funds requested			
	% Time	Insurance + Fee Remit	Fringe Benefits	$$
GRA TBA (data collection, analysis, instructional design)	50%	$7,320	$137	$22,800
Subtotal Graduate Student Personnel				$ $30,257

Undergraduate Student Funding
Please indicate the student resources (funding and time) you are requesting from the grant for this project.

Type of position	Grant funds requested		
	Hrs/week	Fringe Benefits	$$
Programmer and graphic design	12 (45 weeks)	$491	$5,775
Environmental/Ecological engineering student or equivalent	12 (45 weeks)	$491	$5,775
Participation stipend	$100 x 12 students		$1,200

Subtotal Undergraduate Student Personnel			$15,848

Equipment $ Software Funding

Please list all specialized equipment and software required for the project. (Do not include standard computer equipment and commonly-available software, e.g. Microsoft Office, Microsoft Windows). Mark whether any of the equipment or software is provided by the department. (Note that only 10% of the funds can be used to purchase equipment and it needs to be dedicated to the goals of the project.

Name of Equipment	Funds Requested
Smart Whiteboard or equivalent (for capturing and storing design ideas)	$2,000
Subtotal Equipment	$2,000.00
Name of Software	
Adobe Creative Suite 3 Web Premium (to develop electronic prototype)	$550
Subtotal Software	$550.00
Other miscellaneous items (Computer media, cables, etc)	
Subtotal miscellaneous	$0.00
Other expenses	
Supplies (for the paper prototyping)	$500
Subtotal other expenses	$500
TOTAL	$50,043

E. Budget Justification

Dr. Johannes Strobel (25% FTE requested) will oversee the participatory design and the game development. Dr. Inez Hua is overseeing the selection, preparation, and accuracy of the content material. Both will be involved in the construction of the research instruments and analysis and reporting of the data. While Dr. Hua will expend effort on the project, her salary for the effort will be supported by DEEE.

One graduate student will be hired to support the facilitation of the research, the design of research materials, the data collection, analysis, and reporting of the data.

One undergraduate student from computer science, computer graphic design will be hired to develop the electronic prototype of the game.

One undergraduate student in environmental and ecological engineering will be hired to support the selection and preparation of the content.

Participants will be paid a stipend of $100, if they participate in the study, including base line test, designing of prototypes and focus groups.

Equipment and Software
One interactive whiteboard (SMART or equivalent) will be purchased. The whiteboard will be used so design ideas as crafted by the research participants can be easily captured. The interactive whiteboard allows to save drawings and writings to a computer.

Software includes educational licenses for Adobe Creative Suite 3 Web Premium (including Flash and Photoshop). This software package is needed to develop the electronic prototype of the game.

Other expenses include supplies (paper, pens). This is particularly necessary, since a large portion of the research involves students to create paper prototypes.

F. References

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G. PI Biosketch
Biographical Sketch Johannes Strobel, Ph.D.

(i) Professional Preparation:

Munich School of Philosophy, Germany, Philosophy, B.Ph., 1997
Saarland University, Germany, Religious Studies, B.A. (equiv.), 1998
Saarland University, Germany, Information Science, B.S. (equiv.), 1999
University of Missouri-Columbia, Learning Technologies, M.Ed., 2002
University of Missouri-Columbia, Information Science and Learning Technologies, Ph.D., 2004

(ii) Appointments:

Assistant Professor, Department of Engineering Education and Currculum & Instruction (Educational Technology), Purdue University, 2007 – current
Assistant Professor, Department of Education, Concordia University, Montreal, 2005 – 2007
GRA, Manager & Fellow in Learning Sciences, University of Missouri-Columbia, 2000 – 2004
GRA, Graduate Instructor and TA, Saarland University, Germany, 1998 – 2000

(iii) Publications

Five Publications Closely Related:

Strobel, J., Lowerison, G., Bethel, E.C., Cote, R., Lavoie, M.-C. & Abrami, P.C. (in press) Capturing Learning Context: Reflections on the Modeling of Learning Units with IMS-LD. In: L. Lockyer, S. Bennett, S. Agostinho & B. Harper (in contract) Handbook of Research on Learning Design and Learning Objects: Issues, Applications and Technologies

Clariana, R. & Strobel, J. (2008) Modeling Technologies. in J.M. Spector, M.D. Merrill, J.J.G. van Merriënboer, & M.P. Driscoll (Eds.) AECT Handbook of Educational Communications and Technology. 3rd Ed., Mahwah, NJ, USA: Lawrence Erlbaum Associates.

Jonassen, D., Strobel, J., & Lee, C.B. (2006) Everyday Problem Solving in Engineering: Lessons for Engineering Educators, Journal of Engineering Education, 95, 2, 139-150.

Hyslop-Margison, E.J. & Strobel, J. (2008) Constructivism and Education: Misunderstandings and Pedagogical Implications. The Teacher Educator.

Strobel, J. (2007) Composition of Compound Problems and Transitions within Compound Problems: Workplace Research to Inform Engineering Education. Proceedings of the First International Conference on Research in Engineering Education, Hawaii: June, 22 – June, 24 2007.

Five Other Publications:

Strobel, J., Jonassen, D.H. & Ionas, I.G. (in press) The evolution of a collaborative authoring system for non-linear hypertext: A design-based research study. Computers & Education.

Niederhauser, D. S., Lindstrom, D. L., & Strobel, J. (in press). Addressing the NETS*S in K-12 Classrooms: Implications for Teacher Education. Journal of Technology and Teacher Education.

Strobel, J. & Tillberg-Webb, H. (2006) Applying a critical and humanizing framework of instructional technologies to educational practice. Paper presented at the First Research Symposium of the Association of Educational Communications and Technology (AECT), Indiana Bloomington, June 22-25, 2006. (invited for publication in the Proceedings, Springer Publication).

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Strobel, J., Cernusca, D., Jonassen, D.H. (2004) Different majors - different epistemological beliefs?, Academic Exchange Quarterly, Spring 2004, 208-211.

(iv) Synergistic Activities:

Children and Biodiversity, a web site containing goal-based scenarios for children developed for United Nations Environment Program, Secretariat for the Convention on Biodiversity.
Problem Solving Bibliographic Database & Engineering Problem Inventory (University of Missouri-Columbia)
KITE – Case-based reasoning system for teachers to integrate technology into classrooms (University of Missouri-Columbia)

(v) Collaborators & Other Affiliations:

(a) Collaborators:
Abrami, Philip C., Concordia University, Montreal, Canada
Bethel, Edward C., Concordia University, Montreal, Canada
Clariana, Roy, The Pennsylvania State University
Dicks, Dennis, Concordia University, Montreal, Canada
High, Steven, Concordia University, Montreal, Canada
Hung, Woei, University of North Dakota
Hyslop-Margison, Emery, University of New Brunswick, Canada
Ionas Gelu Ioan, University of Missouri-Columbia
Lee, Chwee Beng, Nanyang Technological University, Singapoore
Lowerison, Gretchen, Concordia University, Montreal, Canada
Niederhauser, Dale, Iowa State University
Gilbert Paquette, TELUQ, Montreal, Canada
Razlogova, Elena, Concordia University, Montreal, Canada
Shaikh, Kamran, Concordia University, Montreal, Canada
Shaw, Steven, Concordia University, Montreal, Canada
Spector, Michael, Florida State University
Tillberg-Webb, Heather, Elizabethtown College
Zhang, Dai, Concordia University, Montreal, Canada

(b) Graduate Advisors:
David Jonassen, Richard Callahan, Rose Marra, James Laffey, & Sanda Erdelez, all University of Missouri-Columbia

(c) Thesis Advisor:
Glenn Wadman, Concordia University, Montreal, Canada
Tzemopoulos, Antonia, Concordia University, Montreal, Canada
Levine, Reisa, National Film Board, Canada
Taylor, Ray, Acorda Design Inc.
Ilkbasaran, Deniz, University of California, San Diego
Idan, Einat, Concordia University, Montreal, Canada
Gomez-Umana, Alejandro, Atlantic Council for International Cooperation, Halifax, Canada
Araki, Marci, Concordia University, Montreal, Canada

Total Graduate and Post Doctoral Students Directed: **8**

INEZ HUA
School of Civil Engineering and the Division of Environmental and Ecological Engineering
Purdue University, West Lafayette, IN 47907
Ph: (765) 494-2409; FAX: (765) 496-1988; Email: hua@ecn.purdue.edu

A. Education

California Institute of Technology, Pasadena	Environmental Science and Engineering	PhD	1996
California Institute of Technology, Pasadena	Environmental Science and Engineering	MS	1992
University of California, Berkeley	Biochemistry	BA	1990

B. Academic Appointments

July 2007 – present	Full Professor, School of Civil Engineering, Purdue University
July 2006 – present	Founding Interim Head, Division of Environmental and Ecological Engineering, Purdue University
August 2001 – present	Associate Professor, School of Civil Engineering, Purdue University
January 1996 – August 2001	Assistant Professor, School of Civil Engineering, Purdue University

C. Non-Academic Appointments

June - August 2004	NASA/ASEE Faculty Fellowship (first and second year award)
June - August 2003	NASA Ames Research Center, Mountain View, CA
July – December 2002	Sabbatical leave - U. S. Environmental Protection Agency, Region 9 Headquarters, San Francisco, CA
September 1990- December 1995	California Institute of Technology, Pasadena, CA Graduate research assistant
June-September 1990; June-January 1990	The Dow Chemical Company, Pittsburgh, CA Intern
May-September 1998; January-May 1989	Department of Chemistry University of California, Berkeley, CA Undergraduate Research Assistant
May-August 1986	Lawrence Berkeley Laboratory, Berkeley, CA Intern

D. Publications

Five publications – closely related to proposed project

1. Ahn, M.-Y.; Filley, T. R.; Jafvert, C. T.; Nies, L.; Hua, I.; Bezares-Cruz, J., **Photodegradation of Decabromodiphenyl Ether Adsorbed onto Clay Minerals, Metal Oxides, and Sediment**, *Environ. Sci. Technol.* 40(1), pp. 215-220, 2006.
2. Ahn, M.-Y.; Filley, T. R.; Jafvert, C. T.; Nies, L.; Hua, I.; **Birnessite Mediated Debromination of Decabromodiphenyl Ether**, *Chemosphere* 64(11), 1801-1807, 2006.
3. Bezares-Cruz, J., Jafvert, C., Hua, I., **Solar Photodecomposition of Decabromodiphenyl Ether: Products and Quantum Yield**, *Environmental Science and Technology*, 8(15), pp. 4149 -4156, 2004.
4. Hua, I, Kang, N., Jafvert, C., Fábrega-Duque, J. **Heterogeneous Photochemical Reactions of Decabromodiphenyl Ether,** *Environmental Toxicology and Chemistry*, 22(4), pp. 798-

804, 2003.
5. Beckett, M. and Hua, I.; **Enhanced Sonochemical Decomposition of 1,4-Dioxane by the Fenton Process**, *Water Research*, 37(10), pp. 2372-2376, 2003.

Five additional significant publications
1. Kang, N., Hua., I., Rao, P. S. C., **Enhanced Fenton's Destruction of Non-aqueous Phase Perchloroethylene in Soil Systems**, *Chemosphere*, 63(10), pp. 1685-1698, 2006.
2. Zhai, X., Hua, I., Rao, P. S. C., Lee, L. S., **Co-solvent Enhanced Chemical Oxidation of Perchloroethylene by Potassium Permanganate**, *Journal of Contaminant Hydrology*, 82(1-2), pp. 61-74, 2006.
3. Kang, N., Hua, I., Rao, P. S. C., **Production and Characterization of Encapsulated Potassium Permanganate for Sustained Release as an In Situ Oxidant,** *Industrial and Engineering Chemistry Research*, 43 (17), pp. 5187 -5193, 2004.
4. Kang, N., Hua, I., Xiao, C., **Impacts of Sonochemical Process Variables on Number Average Molecular Weight Reduction of Asphaltene,** *Industrial and Engineering Chemistry Research,* 45(15), 5239-5245, 2006.
5. Kang, N., and Hua, I., **Fenton oxidation of BTEX Compounds in Soil Slurry Systems**, *Chemosphere*, 61(7), pp. 909-922, 2005.

D. Synergistic Activities
(i) Founding Interim Head, Division of Environmental and Ecological Engineering, Purdue
(ii) Member, Committee for the Technical Assessment of Environmental Programs at the Los Alamos National Laboratory, Nuclear and Radiation Studies Board, **The National Academies** (2006).
(iii) Participant in a multi-stakeholder partnership organized by the **U.S. EPA** Design for Environment (DfE) Program to examine environmental effects of flame retardants in electronics (2006).
(iv) Member of a review panel convened by the **U.S. Department of Energy** to review the Environmental Molecular Sciences Laboratory (EMSL) of Pacific Northwest National Laboratory (2005).
(v) Member, Internal Executive Committee (IEC) for the Purdue University **Center for the Environment**, located in Discovery Park (2005).

E. Collaborators and Other Affiliations
(i) Collaborators and Co-Editors
Purdue University: C. Jafvert, L. Nies, T. Filley, L. Lee, P. S. C. Rao, R. Mohtar, M. Helgesen, R. Turco, H. Acuna-Ochoa, M. Sepulveda, L. Raymond, C. Handwerker, J. Strobel.
NASA Ames (Mountain View, CA): L. Iraci.
University of West Florida: J.A. Stuart Williams
Rochester Institute of Technology: T. Seager
University of Alaska: T. Sutton
(ii) Graduate (Doctoral) Advisor: Dr. Michael R. Hoffmann, California Institute of Technology
(iii) Thesis and Post-Doctoral Scholar Sponsor (Research)
Graduated with thesis MS or PhD: Ulrike Pfalzer-Thompson (MS), Jennifer Baldwin (formerly Schramm) (PhD), Michael Beckett (PhD), Guangming Zhang (PhD), Namgoo Kang (PhD), Xihong Zhai (PhD).
Post-Doctoral Scholars: Dr. Jose Duque Fabrega, Dr. Mi-Youn Ahn, Dr. Amanda Nienow, Dr. Jeonghhyub Ha.
Currently supervising or co-supervising: Three Ph.D. students (Brianna Dorie, Yin-Ming Kuo, and Cesar Bezares) and one MS student (Irene Poyer).

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

Investigator: Dr. Johannes Strobel	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Life stories of Montrealers displaced by war, genocide, and other human rights violations

Source of Support: Social Studies and Humanities Research Council (SSHRC), Canada

Total Award Amount: $1,000,000 (CAD) Total Award Period Covered: 2007-2012

Location of Project: Concordia University, Montreal Canada

Person-Months Per Year Committed to the Project. 0 Cal: 0 Acad: Sumr: 0

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Electronic Portfolios for Lifelong Learning Across the Curriculum.

Source of Support: Le Fonds québécois de la recherche sur la société et la culture (FQRSC) and Ministry of Education,

Total Award Amount: $200,000 (CAD) Total Award Period Covered: 2006-2010

Location of Project: Concordia University, Montreal, Canada

Person-Months Per Year Committed to the Project. 0 Cal: 0 Acad: Sumr: 0

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Therapeutic and Tissue Design: From Laboratory to Clinical Market

Source of Support: NSF - IGERT

Total Award Amount: $3,000,000 Total Award Period Covered: 2008 - 2012

Location of Project: Purdue University

Person-Months Per Year Committed to the Project. Cal: 0.5 Acad: Sumr: 0.5

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Living Library: Connecting Stories, Storytellers and the Public

Source of Support: MacArthur Foundation

Total Award Amount: $96,000 Total Award Period Covered: 2008 - 2009

Location of Project: Purdue University

Person-Months Per Year Committed to the Project. Cal: 0.5 Acad: Sumr: 1.0

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Career choices around ecological product life-cycle : An educational game for attitude change of prospective and current engineering students

Source of Support: EPA

Total Award Amount: $ 75,000 Total Award Period Covered: 2008 - 2009

Location of Project: Purdue University

Person-Months Per Year Committed to the Project. Cal: 0.5 Acad: Sumr: 0.5

Support: ☐ Cur- ☒ Pending ☐ Submis- ☐ *Transfer of Support

Project/Proposal Title:

HUB_designer: Customized Virtual Engineering Research and Education Communities using a Social-Cognitive-Technological Design Framework

Source of Support: NSF – CDI Phase II (Pre-proposal)
Total Award Amount: $2,000,000 Total Award Period Covered: 2008 - 2012
Location of Project: Purdue University
Person-Months Per Year Committed to the Project. Cal: 0.5 Acad: Sumr: 0.5
Support: ☐ Cur- ☒ Pending ☐ Submis- ☐ *Transfer of Support

Project/Proposal Title:
Collaborative Research: ciHub, a Virtual Community to Support Research, Development, and Dissemination of Concept Inventories

Source of Support: NSF – CCLI Phase III
Total Award Amount: $2,000,000 Total Award Period Covered: 2008 - 2011
Location of Project: Purdue University
Person-Months Per Year Committed to the Project. Cal: 0.5 Acad: Sumr: 1.5
Support: ☐ Cur- ☒ Pending ☐ Submis- ☐ *Transfer of Support

Project/Proposal Title:
Purdue Center for Digital Games and Virtual Environments for Learning

Source of Support: Discovery Learning Center – Seed Grant
Total Award Amount: $100,000 Total Award Period Covered: 2008 -2009
Location of Project: Purdue University
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:
Support: ☐ Cur- ☒ Pending ☐ Submis- ☐ *Transfer of Support

Project/Proposal Title:
Workplace Research to Benefit Engineering Education: Problem Solving of Professional Engineers

Source of Support: PRF Year long
Total Award Amount: $2,000,000 Total Award Period Covered: 2008 -2009
Location of Project: Purdue University
Person-Months Per Year Committed to the Project. Cal: 0.5 Acad: Sumr: 0.5
Support: ☐ Cur- ☒ Pending ☐ Submis- ☐ *Transfer of Support

Project/Proposal Title:
Serious design without knowing it: Design identities of users in Second Life

Source of Support: Spencer Foundation
Total Award Amount: $50,000 Total Award Period Covered: 2008 -2009
Location of Project: Purdue University
Person-Months Per Year Committed to the Project. Cal: 0.5 Acad: Sumr: 0.5

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **Inez Hua**

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Muses: Life-Cycle and Policy Aspects of Brominated Flame Retardants

Source of Support: National Science Foundation

Total Award Amount: $ 412,000 Total Award Period Covered: 08/16/05 – 07/14/08

Location of Project: Purdue University

Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Sumr: 1.00

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Ecotoxicology of Brominated Flame Retardants in Great Lakes Biota

Source of Support: U.S. Environmental Protection Agency

Total Award Amount: $ 128,478 Total Award Period Covered: 10/01/05 – 09/30/07

Location of Project: Purdue University

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: .50

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Innovative Remediation Technology Implementation Plan for the Crawfordsville INDOT ROW Site

Source of Support: Joint Transportation Research Program/INDOT

Total Award Amount: $ 150,000 Total Award Period Covered: 07/01/05 – 06/30/08

Location of Project: Purdue University

Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Sumr: 1.00

Support: X Current Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Photochemical Fate of Manufactured Carbon Nanomaterials in the Aquatic Environment

Source of Support: U.S. Environmental Protection Agency

Total Award Amount: $ 199,990 Total Award Period Covered: 03/01/07 – 02/03/09

Location of Project: Purdue University

Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Sumr: 1.00

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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **Inez Hua**	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current X Pending Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Infrastructure Characterization and Enhanced Materials for Pollution Control in Urban Systems

Source of Support: National Science Foundation

Total Award Amount: $ 536,676 Total Award Period Covered: 07/01/08 – 06/30/11

Location of Project: Purdue University

Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Capacity Vitalization of Megacities

Source of Support: National Science Foundation

Total Award Amount: $ 16,250,000 Total Award Period Covered: 8/1/08-7/31/13

Location of Project: Purdue University

Person-Months Per Year Committed to the Project. Cal: Acad: 1.5 Sumr: 1

Support: ☐ Current X Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Career choices around ecological product life-cycle :
An educational game for attitude change of prospective and current engineering students

Source of Support: U. S. EPA

Total Award Amount: $75,000 Total Award Period Covered: 07/01/08-06/30/09

Location of Project: Purdue University

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 0.3

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.