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Product Design and Innovation: Evolution of an Interdisciplinary Design Curriculum*

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Successful competition in the global economy is increasingly dependent on new products and services that reveal new business and infrastructure possibilities. New products and services must be regarded not only as commodities in a marketplace, but as social actors constraining or enabling the quality of our life. In recognition of these two perspectives, Product Design and Innovation (PDI) is a three-year old undergraduate dual degree program educating students for new product invention and development. PDI satisfies the requirements for the Bachelor of Science programs in Architecture and Science, Technology and Society (STS); or Mechanical Engineering and STS. Design programs played a lead role as the PDI curricular model for integrated and studio teaching, linking all three dimensions of the program—the technical, the aesthetic, and the social—with an emphasis on creativity, the imaginative application of new technologies and materials, and the social and political dimensions through design.

BACKGROUND

THE PACE of technological change is unprecedented and the impacts of technological innovation are often profound. There is also a growing recognition that significant challenges await us in the years ahead if the nation is to compete successfully in a highly competitive global economy, while also seeking to share social well-being and restore the natural environment upon which all life—and technology—depends. While uncertainty and insecurity clearly exist, so do opportunities for innovative and creative thinking; traditional disciplinary boundaries are more permeable, and new connections can be forged.

Encouraging future engineers to 'contemplate their work in the larger context,' NSF Acting Deputy Director Joseph Bordogna [1] enlists philosopher José Ortega y Gasset to support his call for a greater emphasis on integration. Ortega writes, 'The need to create sound syntheses and systemization of knowledge . . . will call out a kind of scientific genius which hitherto has existed only as an aberration: the genius for integration. Of necessity this means specialization, as all creative effort does, but this time the [person] will be specializing in the construction of the whole'. With this as his inspiration, Bordogna asserts:

> 'Design becomes the leverage point of determining a product's impact on our lives. In this sense, when we educate any of our students engaged with the incorporation of technology we must instill in them not only technical expertise but we must also lead them to examine and question the goals and value-system of the society they are being prepared to build.'

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To achieve these goals engineering design education must provide concrete experience in integrating first-rate technical competence with a thorough understanding of the social and cultural context of technologies and the design processes that shape them. The School of Architecture and the School of Humanities and Social Science (H + SS) saw this as a call to action for a proposal that could inform the general engineering community around us. This multidisciplinary approach to building science and engineering design education demands that the relevant knowledge base be expanded to include facility and expertise not currently being required of engineering students. What is often taken for granted by architectural educators, the collision of the formal with the social and technical through design, is a radical shift for engineering pedagogy.

Over the past eight years, supported by internal and national grants, professors from the Schools of Engineering, Architecture, and Humanities and Social Sciences (H&SS) have been working together to develop an inter-school, multidisciplinary design pedagogy. According to a survey that we conducted of industrial and product design programs around the country [2], these programs fall into two categories: one stresses technical or engineering expertise (housed in an engineering school), and the second stresses aesthetic or arts expertise (housed in an arts and/or architecture school). Since there is little, if any, overlap, they fail to integrate the insights and expertise of each other. Moreover, neither incorporates into the curriculum an adequate expertise in how products shape social and cultural relationships and how in turn these relationships shape products. The challenge is to provide training and experience in integrating all three kinds of expertise as equal components of design education: the technical, the social/cultural, and the aesthetic. The innovative product designer is able to observe the world from a perspective informed by both understanding technology and 'seeing' (or 'reading') the mutual shaping of technology and society. The strong technical education allows the product designer to understand the 'inner workings' of technological products or systems, as well as to imagine how the elements of these inner workings—entirely new elements or 'technological enablers'—might be put to work in previously unrecognized ways. The strong education in the social sciences helps understand ways of life deeply enough either to anticipate a future need in those lives or to escape being trapped by everyday inertia [3].

Our inter-school program in Product Design and Innovation (PDI) integrates these basic ingredients of design education:

- a sense of creativity and visualization;
- sensitive perceptual and communication skills;
- hands-on modeling and drawing skills;
- an understanding of the human body and its ergonomics;
- a design sense, including an understanding of problem formulation, idea generation, and solution iteration;
- the ability to work well on teams;
- technical skills, including machining, rapid prototyping to computer aided design (CAD);
- an understanding of basic engineering science and manufacturing, with the art of functional analysis;
- an understanding of the basic disciplines in science and technology studies, featuring the art of reading a culture (ethnographic methodology);
- an understanding of how a product is/will be situated in our lives, or rather, the art of reading a user;
- basic market and human factors analysis skills;
- an ability to work at all scales of a product's context and life history;
- presentation skills to convey all of these ingredients at once.

The design experiences in the program will cultivate in students the ability to function effectively in new situations and unfamiliar environments, to collaborate with a diverse constituency to formulate and analyze problems of varying complexity, and to work individually or in teams to produce innovative design solutions that reflect this 'genius for integration.'

THE STUDIO-BASED PDI CURRICULUM

The core of PDI is the design studio that students take every semester, giving them a hands-on opportunity to bring together the two major curricula. The engineering/ building science curriculum includes courses in engineering mechanics and electronics, energy, construction, materials, and manufacturing. The STS curriculum covers the social and cultural dimensions of product development and innovation, including case studies of successes and failures (see Appendix). The design studios also challenge students to integrate and balance these two domains of learning with PDI's third domain, the aesthetic, including the relevant elements of arts and architecture design.

Product Design and Innovation 1

PDI 1 is based on the premise that disciplined, creative design is learned through the act of doing and making in the studio experience. PDI design studios seek to develop active, dynamic drivers of innovation, and strive to uncover, and get rid of, overt and tacit barriers to creativity within each student. The central concerns of this semester are to open up ways of being in the world—through sensory awareness, through experimentation and physical engagement with artifact, client, site and program and through working methods for suggestive and precise communication. These studies are meant to encourage curiosity and risk while maintaining exhaustive rigor and investigation. The development of reflective judgment is a significant aspect of this course. At the same time, the first design studio (PDI 1) begins the process of building a toolkit—primarily on the exploratory and aesthetic side—that the student will use throughout the entire program.

In this third iteration of the first semester, we decided to offer this studio as a collaborative 'fundamentals' with architects. There are ongoing seminars and assignments in freehand drawing and computing parallel to the main design studies that are linked to the main design studies in varying degrees and at various times. They are designed to give students multiple modes of understanding and delving into design processes. For this studio, we are working on projects for which our culture's habituated physical design responses are unsuited. This calls taken-for-granted assumptions into question. The unfamiliarity helps set aside accumulated habitual responses and encourages continual deciding which of the norms should be retained and worked with and which should be questioned and replaced. Only at this level of what we call 'root questions' are we able to insure that we can become aware of the tacit assumptions that all too often control our designing.

While practical creativity is the primary emphasis of PDI 1, a concern for the social context of design is introduced in each assignment's review process. By challenging novice designers to reconsider their designs in light of social considerations, which were not an explicit focus of the design assignment, PDI 1 seeks to demonstrate early in the process the importance of the social context, but without prematurely dampening creativity by assigning projects that are too complex.

Our third iteration of the studio began by developing an imagined topological construction that addressed very specific, but open-ended constraints where we were looking carefully at the relationship between form, construction, fabrication and renewable resources.

In the second half of the semester we developed prototypes for local farmers' market structures. Through the act of developing an expandable/collapsible/portable system of display, shelter, attachment, layout, etc. for the vendors' goods that could be secured to the site, the students began to challenge familiar patterns of grocery store shopping, modes of production and delivery. After a two-part research phase including the examination of the existing Troy Waterfront Farmers' Market and documenting existing expandable displays, tents, connections, advertising, baskets/carrying devices, layouts etc. as precedents, the students generated full scale working prototypes for an actual day in the working market (see Figs 1, 3).

In this way they were able to address many aspects of their manufacturability as well as their appropriateness, usability and spatial consequences. We are undertaking collaborations linking students to non-profit and regional constituencies. The students consider radically new ways to design, build and revitalize products, buildings and the urban and environmental infrastructure. We explore the question asked by a Rensselaer colleague, Jesse Tatum, [4]: 'Can the insights central to the contemporary study of science, technology and society make us more responsible designers?' by full-scale intervention in specific communities. In this first project, the first-year mixed-major students began to challenge familiar patterns of consumption, modes of production and delivery, as exemplified by large supermarket shopping. By working alongside the farmers, interviewing clients and vendors, and examining the existing conditions, they were able to see alternatives to conventional mass marketing and determine whether and how products, especially mass-produced products, help this audience. Most significantly, they saw their own *a priori* assumptions and stereotypes fall away as engineering majors grappled with resistance to commodification and architecture and humanities majors wrestled with developing suitable processes for mass fabrication. Prompted by social scientists, engineering and architectural faculty, the students generated full-scale working prototypes for an actual day in the working market. Their own initial self-identifications (engineer, architect, student, etc.) dropped away as they developed a shared approach to tackling the complexities of and criteria for the unfolding problems.

As the content is developed, so are the methodology and models for delivery, accountability and access. Teamwork is the first step in alternative pedagogy. We are also challenging the semester system by developing consecutive studios to build on issues uncovered in the very first studio. As our social scientists note, when we move from single artifacts to entire technological systems, many possibilities emerge. Continuing our Farmers' Market intervention, and on the recommendation of Jesse Tatum, we are planning projects where technology, tax, land use policies favoring local community supported agriculture could lead to substantial shifts in agricultural practice and products. This will form the nucleus of an upper-level studio using alternative energy technologies for appropriate farmers' delivery vehicles, and short-range, low-performance vehicles for walk-to-shop needs. We have received more funding to investigate electronic access by our enthusiastic off-campus partners. Based on democratic access and project continuity, the curricular template now has parallel streams of social and technical inquiry into which students of any level, community, and discipline may join.

Deliberately joining town and gown in creative, accountable, technically and socially rigorous proposals for enhanced community addresses the changing academy with its reinvention across interdisciplinary lines, non-conventional students and delivery, and blurring boundaries between research, service and teaching.

Fig. 1.

Fig. 2.

In the year before, the students worked with a local camping gear manufacturer—Tough Traveler (TT)—to explore new uses for TT's existing technologies and to develop their product line. The students produced drawings and conceptual models, from which the seamstresses and structural form workers generated working prototypes (see Fig. 5). The Passive Exerciser uses existing bungee cords and straps to bind parts of the body. The straps are embedded with a chip rendering the straps 'smart'. These chips can be removed, sent to a physiotherapist to be analyzed and appropriate exercises appended to this 'passive' exercising can be supplemented for a complete physiological workout (see Fig. 4).

Product Design and Innovation 2

The new possibilities inherent in the interplay of the social and the technical received a more explicit focus in PDI 2. Edward Tenner's, 'How the Chair Conquered the World' [5] raised the questions of:

- How many of us in the USA have any awareness of what it means to be in a culture that does not typically have/use chairs?
- What happens when chairs are introduced, and gradually adopted throughout the culture?

Tenner tells us, for example, 'In Japan, where many households have maintained both tatami and Western rooms, younger people are finding it increasingly difficult to maintain traditional ground-level seating positions.' It also established an even larger 'generation gap' as the elders occupied the floor, and the younger generation the space above.

The major design project of PDI 2 became the design of a chair to be manufactured from cardboard (again, an obvious project for architects vis-à-vis Frank Gehry, in his study of materials and ergonomics through an investigation of layered corrugated cardboard). The students were presented with the Tenner article as well as other related articles. To bring out all the social and cultural aspects of this design experience, the students were presented with the basics of doing ethnographic research, particularly conducting interviews. Along with this social study of sitting, the students progressed through a series of (perhaps typical architectural) design explorations aimed at understanding how cardboard could be used as a building material. The intensity of the social study of sitting as well as the manufacturing and production of chairs challenged fundamental perceptions that could open up the material questions of:

- What was the effect of laminating it, of peeling it apart to form a new material, of wetting and forming it, or of weaving?

Fig. 3.

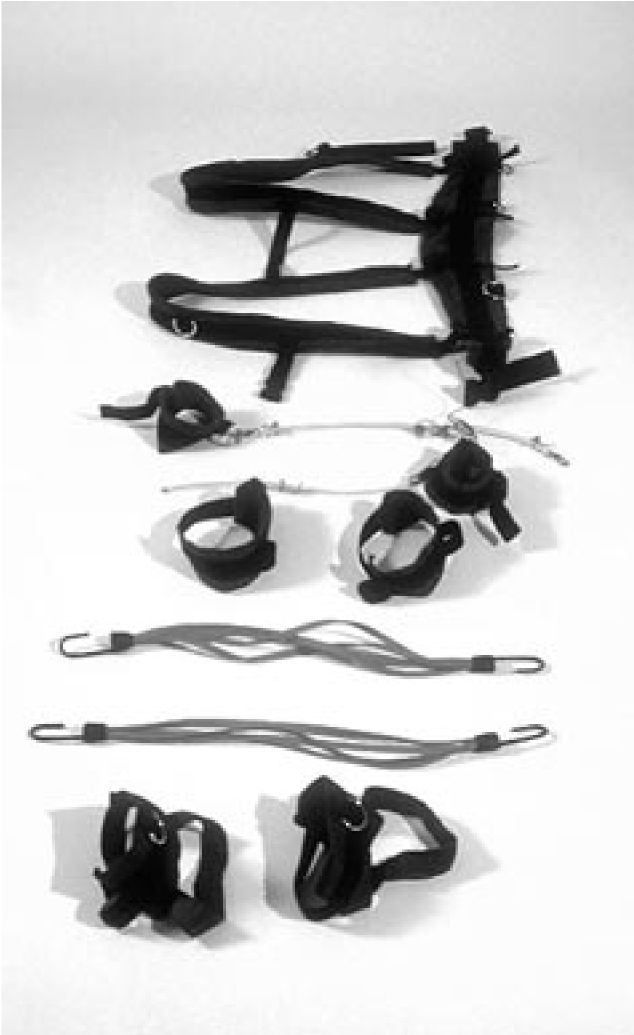

Fig. 4.

- How could it be joined to make new kinds of joints?
- What difference does the technical make to the social?

Product Design and Innovation 3

PDI 3 currently is working on designs located at the intersection between information technology and education. At the user end, the students are practicing ethnographic fieldwork in an under-funded school in the county. They are learning about the needs of these students through participant observation in the classroom, and reflecting on the possibilities for designs which would address the social issues which affect the students learning (e.g. race, class and gender) through PDI course readings and discussion (see Fig. 2). At the

Fig. 5.

technical end, the studio design exercises develop a series of analog and digital electronic circuits that allow students to understand how information technologies can both react to various environments and engage a wide variety of human sensory modalities. By understanding information transfers between different domains—e.g. how rhythms in sound can also be rhythms in image which can also be ratios in mathematics—students are provided with new tools for syncretic designs that blend the best of high technology and low-income community culture.

Product Design and Innovation 4

PDI 4 is an existing core-engineering studio that works across all engineering disciplines. They have, in the past, built devices for sports and recreation, working exhibits for demonstrating science and engineering, and devices for cleaning rooms as diverse as day care centers and large lecture halls.

Product Design and Innovation 5

PDI 5 is an industrial design (combined with architecture) studio devoted to exploring the relationship of abstract ideas and values, particularly esthetic, to industrial design and its presentation. The students take 'General Manufacturing Processes' along with this studio and creating a compelling coupling of the abstract and the produced.

Product Design and Innovation 6

The ethnographic approach envisaged for PDI is distinctly different from what is traditionally referred to as market research. Responding to this, PDI 6 addresses a specific goal of the program, which is to educate designers with a strong sense of advanced technology and the tools for employing new technologies into design. As new technologies emerge, new, unanticipated products often emerge as well. This design studio focuses on developing new product ideas that utilize emerging technologies that are being developed on campus. Students investigated the range of research efforts currently under way at RPI from nano-technology interventions, to polymer development, to optical simulation devices, selected technologies that hold particular interest for them, matched them to a particular societal need, and then developed a new product idea through a series of prototypes. Examples of projects include an evacuation system for guiding people out of a building in emergency conditions based on smart cell technology (cellular automata) and a camera device that helps drivers nosing out into an intersection.

Product Design and Innovation 7 and 8

Acknowledging that the program needs many real connections to industry, for good student placement, for realistic up-to-date and cutting edge manufacturing sensibility, pairs of industry person/theory person will be running particular studios (e.g. medical equipment designer and sociologist of medicine on a neonatal instrumentation). The interpolation between these radically different realms, and also towards material embodiment without relying on formal esthetic descriptors (i.e. most product designers) brings us to PDI 7 and 8 that are centered on the Multidisciplinary Design Lab. The students bring their STS and engineering backgrounds to bear on industry-sponsored design projects. They work as members of a multidisciplinary design team comprising different engineering and non-engineering disciplines in the solution of a design problem posed by an industry sponsor. Students pull from their backgrounds in engineering, building science and STS. It is in the demand to fulfill the sponsor's expectations and look at previously unconsidered conditions of social, political, cultural and economic frameworks that make this capstone significantly different from normative engineering curriculum industry-run projects. Numerous meetings, presentations and reports are required to document student findings. Topics include robotics, injection molding, computer numerical control, machines, metal-processing systems, nondestructive testing, and industrial safety. Both industry sponsors and theoretical analysts critique the prototypes. This provides a forum for corporate and academic interaction.

AMBIGUITIES IN BOUNDARY CROSSING

For engineers and other technologists we may need to begin in a way where we can see technology as a kind of social institution. For the arts-based designers we need to work in a way to have the technology embedded in the social from the very beginning. It is as difficult for our arts-oriented students to address this reciprocity between technology and culture or social institutions as it is for the engineers. Neither constituency has yet been involved in setting up alternative social contexts as initial conditions in their lives and it is very difficult for them to conceive of the technical penetrating every aspect of their 'creative' designs. Also, this was as complex for the faculty as the students. The engineering faculty, although intrigued by the breadth of architectural or industrial design proposals, sees our work as abstract and not resolved enough with respect to the fabrication or the implementation. The architects see the engineers as moving too quickly to analysis and preconceived solutions in order to get a fix on the completion of the project.

Our experience has taught us that successful multidisciplinary experiences for the students require a faculty that are themselves multidisciplinary and understand the associated issues. Unfortunately, these qualities are not always cultivated in a research university where accomplishments and recognition in one's own discipline is what is often most prized. We faced this issue in defining the PDI program, which began as an attempt to truly bridge the gap between the humanities, architecture and engineering to create a new kind of design education for our students. The program was developed by a core group of faculty who could see the value of a stronger connection between the disciplines. Our challenge became one of how to convince the other faculty.

Over this last summer we developed an exercise designed to involve faculty in a multidisciplinary design experience aimed at educating them on the benefits of this type of approach to design education. It was modeled after the architectural design charrette coupled with the 'Deep Dive' design exercises made popular at the design company, IDEO. When you lock eight faculty from diverse backgrounds in a room for a week and ask them to design something, as architects know, something incredible happens. In this case, the faculty designed a product for a 90-year-old senior housing resident who called her 40-year-old nephew on a regular basis to help her get stuff off the top shelf in her kitchen. At the start, social scientists brought to our attention that asking for specific help was more socially acceptable than nagging for a visit. Engineers looked at ease of access and adaptability and architects at how this fit into contemporary kitchens and whether the room itself should be re-evaluated. By the third day, the boundaries and areas of insight were not so clear and the groups became informed teams.

Although the PDI program was developed with the intention that by this point it would stand alone as a major, it has evolved along another course. Its dual major status attracts those students who have applied into mechanical engineering, are interested in design and recognize a winning combination—a four-year accredited engineering degree coupled with a humanities and social sciences degree and a full-blown design sequence (coming with a portfolio!). Few students are drawn by the content of the H&SS curriculum; the 'three-for-one' is still a principal magnet for engineers. So what we have is a deluxe engineering major that includes design, with a powerful depth in science, technology and society.

Discussions amongst the coordinators have raised a number of issues: How can our engineering dictum of 'knowledge and thoroughness' work together with, or better yet, reinforce creativity and invention? Is this a program that defines a new, twenty-first-century engineer, who not only has technical competence but also has a sense of design and knowledge of the social and political context of engineering design? Or does this program offer the design world a new model of designer, who has a more solid understanding of engineering and the social and political context of design? Although the latter possibility is powerful, it has not yet been feasible in our environment, where we have been unable to construct a more industrial design-oriented dual degree option because of a technical rule against combining the BS in STS with the B.Arch. degree. At some point the question may be answered as 'both,' but at present the program is principally attracting attention in engineering circles as training a new kind of well-rounded engineer who is capable of acting more competently and ethically in multidisciplinary problem-solving environments.

CONCLUSIONS

Preliminary assessment indicates that we are principally rerouting our existing mechanical engineers into a more multidisciplinary program, and just scratching the surface in attracting a new vein of students who are searching for a truly interdisciplinary curriculum, where the social, technical and aesthetic operate seamlessly. (Given the School of Architecture's own 20-year struggle with bridging the social, technical and aesthetic; it is a daunting task). We also wonder whether the design component suffers from an absence in formal design or visual studies, with no courses specifically addressing aesthetic-cultural production, theory, and history. Or is it liberated by its freedom from the constraints of normative design culture? The engineering program's ABET doesn't force us to pursue normative design accreditation schema such as NAAB (National Architectural Accreditation Board) or NASAD (National Association of Schools of Art and Design) to convince students and parents of its legitimacy. Accreditation constraints may, at the most mundane level, open up discussion about ways of measurements and its demand on design fundamentals, and at the highest level bring the program to the attention of the most creative students, practices and industry out there. On the other hand current institutional constraints on new degree programs may preclude any major transformation (not to mention the difficulty of interdisciplinary promotion and tenure). As the curriculum develops, it will likely establish itself through critically situating itself within or opposed to the arena of industrial and product design programs; winning national competition entries and publications; through research endeavors; and the launching of a world-class interdisciplinary graduate design program. A primary step has been taken by hiring a cross-disciplinary designer as director. Another critical measure will be the setting up of an advisory board that links industry, design practice, foundations and government, international firms and academies. These will form the basis to deliver leaders able to integrate diverse perspectives into creative design solutions.

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REFERENCES

1. J. Bordogna, *Engineering the Future: Making Choices,* Address at Oklahoma State University, Stillwater, Oklahoma: 1997. http://www.nsf.gov/od/lpa/forum/bordogna/jbosu2.htm.
2. J. Howard, *In Search of the Sweet Spot: Engineering, Arts, and Society in Design Curricula,* Department of Science and Technology Studies, Rensselaer Polytechnic Institute, 1997.
3. F. Bronet, G. Gabriele, J. Schumacher, *Product Design and Innovation,* NSF- CCLI Funding Submission, 1998. The text of this grant proposal forms a substantial part of the framework of this paper.
4. J. S. Tatum, *The Challenge of Responsible Design,* draft for Design Studios at Rensselaer, Department of Science and Technology Studies, Rensselaer Polytechnic Institute, July 2000.
5. E. Tenner, How the Chair Conquered the World, *Wilson Quarterly*, 64–70. Spring: 1997.

APPENDIX

The curriculum template for Product Design and Innovation: Mechanical Engineering and STS

First year

Fall	Credit hours	Spring	Credit hours
ARCH 2200 Design Studio I	4	ENGR 1960 Design Studio II[2]	4
STSH 1110 Introduction to STS (First-Year Studies)	4	ENGR 1100 Introduction to Engineering Analysis	4
MATH 1011 Calculus I	4	MATH 1020 Calculus II	4
ENGR 1500 Chemistry of Materials I	4	ENGR 1600 Chemistry of Materials II	4
ENGR 1200 Engineering Graphics and CAD[1]	1	ENGR 1300 Engineering Processes[1]	1

Second year

Fall	Credit hours	Spring	Credit hours
IHSS 2500 Design Studio III[3]	4	ENGR 2050 Introduction to Engineering Design	4
STSS 2960 Engineering and Society	4	ENGR 2530 Strength of Materials	4
MATH 2400 Introduction to Differential Equations	4	ENGR 2090 Engineering Dynamics	4
PHYS 1100 Physics 1 for Engineers	4	PHYS 1200 Physics II for Engineers	4
CSCI 1190 Programming	1		

Third year

Fall	Credit hours	Spring	Credit hours
ARCH 4960 Design Studio IV (Industrial Design)[2]	4	ENGR 496 Design Studio V	3
STSS 4xxx STS Advanced Option[4]	4	STSS 4xxx STS Advanced Option[4]	4
ENGR 2710 General Manufacturing Processes	3	ENGR 4050 Modeling and Control	4
ENGR 2350 Embedded Control	4	ENGR 2550 Thermo/Fluids Engineering I	4
ENGR 2600 Modeling and Analysis of Uncertainty	3	STSS 4800 Public Service Internship[6]	4

Fourth year

Fall	Credit hours
ENGR 4960 Design Studio V[5]	4
MEAE 4030 Elements of Mechanical Design	4
MEAE 4040 Mechanical Systems Lab	2
ENGR 4960 Capstone Design Studio [5]	4
STSS 4980 STS Senior Project[7]	4
MEAE 4020 Thermal and Fluids Engineering II	4
MEAE 4020 Thermal and Fluids Lab	2
ENGR 4300 Electronic Instrumentation	4

Notes:
1. These courses may be taken in any order.
2. PDI II, IV, V, and GMP satisfy the mechanical engineering requirement for the concentration electives in Product Design and Innovation.
3. For PDI students, Design Studio III can be used as a substitute for the second-year requirement in the STS area option.
4. Candidate courses include STSS 4350 Politics of Design; STSS 4960 History of Design; STSS 4960 Invention, Innovation, and

Design; STSH 4230 Engineering Ethics; STSS 4110 Social Effects of Science and Technology; STSS 4250 Human Dimensions of Biomedical Technologies; STSS 4310 Politics of Science and Technology; STSS 4560 Gender, Science, and Technology; and STSS 4650 History of American Technology.
5. It is recommended that the sequence of Design Studio V and Capstone Design Studio be taken as Multidisciplinary Design Lab 1 and 2.
6. This course satisfies the requirement for Professional Development II.
7. The STS Senior Project can be combined with the Capstone Design Studio to make an 8-credit capstone studio project. Coordination should be done with your PDI advisor.

PDI Curriculum in Building Science and STS

First year

Fall		Credit hours	Spring		Credit hours
ARCH-2210	Architectural Design 1	4	ARCH-2220	Architectural Design 2	6
MATH-1010	Calculus 1	4	STSH-1110	Introduction to STS	4
ARCH-2110	Building & Thinking of Arch. I	4	PHYS-1050	Physical Principles of Design	4
ARCH-xxxx	Design Studio 1	4	ARCH-2120	Building & Thinking of Arch. 2	2

Second year

Fall		Credit hours	Spring		Credit hours
IHSS-2500	Design Studio III[1]	4	ENGR-2050	Introduction to Eng. Design	4
STSS-2200	Engineering, Design, & Society	4	ARCH-2340	Environmental Systems	4
ARCH-2320	Structures & Construction Systems	4		Elective	4
ARCH-2130	Contemporary Design Approaches	2		Science Sequence II	4
	Science Sequence I[2]	4			

Third year

Fall		Credit hours	Spring		Credit hours
ARCH-4960	Design Studio V (Industrial Design)	4	ARCH-4960	Design Studio VI	4
STSS-4800	Public Service Internship	4	STSS-4xxx	STS Advanced Option[3]	4
ARCH-4700	Advanced Structures & Construction Systems	4	ARCH-4750	Advanced Environmental Systems	4
DSES-2010	Statistics	4	ARCH-xxxx	Concentration Elective	4

Fourth year

Fall		Credit hours	Spring		Credit hours
ARCH-4960	Design Studio VII	4	ARCH-4960	Capstone Design Studio with B.S. Final Project	4
STSS-4xxx	STS Advanced Option	4	STSS-4980	STS Senior Project[4]	4
ARCH-xxxx	Final Project	2		Elective	4
ARCH-4510	Construction Industry Seminar	2		Elective	4
	Elective	4			

Notes:
1. For PDI students, Design Studio III can substitute for the second STS concentration option.
2. The science sequence may be selected, with the assistance of the student's advisor, from among 1000-level introductory sequences in Biology, Chemistry, Geology, or Physics, including ERTH-1030, ERTH-1040 Natural Science I,II.
3. Candidate courses include STSS 4350 Politics of Design; STSS 4960 History of Design; STSS 4960 Invention, Innovation, and Design; STSH 4230 Engineering Ethics; STSS 4110 Social Effects of Science and Technology; STSS 4250 Human Dimensions of Biomedical Technologies; STSS 4310 Politics of Science and Technology; STSS 4560 Gender, Science, and Technology; and STSS 4650 History of American Technology.
4. The STS Senior Project is combined with the Capstone Design Studio to make an 8-credit capstone studio project.

Frances Bronet, Associate Professor of Architecture, **Ron Eglash**, Assistant Professor of Science and Technology Studies, **Gary Gabriele**, Dean of Undergraduate Education and Professor of Engineering, **David Hess**, Professor and Chair of the Department of Science and Technology Studies, and **Larry Kagan**, Professor of Arts and Associate Dean of Humanities and Social Sciences are faculty from Rensselaer Polytechnic Institute who have spent the past 13 years (in various timelines and partnerships) developing interdisciplinary courses, curricula and national dissemination models.