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Running Title

Product Design for Subsistence Marketplaces

Sustainable Product and Market Development for Subsistence Marketplaces: Creating Educational Initiatives in Radically Challenging Contexts

BIOGRAPHICAL SKETCHES

Madhu Viswanathan is Associate Professor of Marketing, at the University of Illinois, Urbana-Champaign, where he has been on the faculty since receiving a PhD in Business Administration from the University of Minnesota in 1990. He focuses on two programs of research; measurement and research methodology, and low-literate buyer and seller behavior. He wrote *Measurement Error and Research Design* (Sage, 2005). His research on low-literate buyer and seller behavior examines low-literate consumer behavior in the US and in India. This work has been supported by a grant from the National Science Foundation. His research has been published in journals in several disciplines; Computer, Speech, and Language, Journal of the Academy of Marketing Science, Journal of Applied Psychology, Journal of Consumer Psychology, Journal of Marketing, Journal of Marketing Research, Journal of Public Policy and Marketing, Marketing Letters, Personality and Social Psychology Bulletin, and Psychology and Marketing. His research on literacy is applied through the Marketplace Literacy Project (www.marketplaceliteracy.org), a not-for-profit organization that he founded and directs.

Ali Yassine is an assistant professor in the Department of Industrial and Enterprise Systems Engineering (*IESE*) at the University of Illinois at Urbana-Champaign (UIUC) and the director of the Product Development Research Laboratory. He teaches graduate courses in Systems and Entrepreneurial Engineering and Product & Market Development for Subsistence Marketplaces. His research involves managing the development process of complex engineering systems, design process modeling, design for development, and IT-enabled concurrent engineering. His research appeared in Management Science, European Journal of Operational Research, ASME Journal of Mechanical Design, Research in Engineering Design, IEEE Transactions on Engineering Management, and Systems Engineering Journal. Dr. Yassine received the B.E. degree in Mechanical Engineering in 1988 from the American University of Beirut. He received the M.S. and Ph.D. degrees in 1989 and 1994 in Industrial and Manufacturing Engineering from Wayne State University in Detroit, Michigan. He is a member of INFORMS, ASME and PDMA.

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John F. Clarke is Clinical Professor in Business Administration and Assistant Dean in the College of Business at the University of Illinois at Urbana-Champaign. John joined UIUC in 2004 bringing with him a diverse educational and professional background; he has a degree in engineering, a PhD in Physics, and an MBA. He spent over ten years as a management consultant working in North America, Europe, and Asia with large multinational companies. As a consultant he assisted companies with large scale change initiatives in order management, supply chain management, finance, and operations. At Illinois, John teaches undergraduates, graduates, and executives. He has developed and led more than eight international immersion experiences to India and China; these experiences enable participants to quickly gain a meaningful insight into developing marketplaces.

Sustainable Product and Market Development for Subsistence Marketplaces: Creating Educational Initiatives in Radically Challenging Contexts

Abstract

Developing products and business processes to serve subsistence marketplaces (or the roughly 4 billion poor around the world referred to as the bottom of the pyramid) is a significant challenge for businesses. But despite this obvious importance of subsistence marketplaces, most educational curricula have been based relatively resource-rich and literate consumers and markets. We teach an innovative year long course including an international field trip which covers the entire spectrum from understanding poverty, and consumer behavior, to product development and engineering design specifically for subsistence consumers. This unique course represents a pioneering effort to focus attention and create knowledge about product development, marketing, management, and engineering practices for subsistence marketplaces.

Introduction

In this paper, we describe our experience in teaching a unique course on sustainable product and market development for subsistence marketplaces. This course represents a pioneering effort to focus attention and create knowledge about business and engineering practices for subsistence marketplaces, or the roughly 4 billion poor around the world referred to as the bottom of the pyramid (Prahalad, 2005) or as subsistence marketplaces (Viswanathan and Rosa, 2007). Whereas the literature in the fields of business and engineering has resulted from an almost exclusive focus on resource-rich markets, this work extends across literacy and resource barriers to subsistence contexts where a large proportion of humanity resides and survives. A large proportion of such subsistence marketplaces can be described as being in the shadow of emerging markets.

The course stemmed from many years of research in subsistence marketplaces (as well as social initiatives in this arena) and structured approaches to product design. Therefore, a central aspect of this endeavor is the synergy between research, teaching, and public engagement that characterizes this work (Author et al., 2008). We begin with our motivation for developing this course. We then provide a description of the course and our experience in teaching it. We conclude with future directions and educational initiatives that are following from this course experience and implications for product development, marketing, management, and engineering education.

Motivation

Recent work has begun to provide broad insight into the role and nature of innovation targeted at the 4 billion living in poverty in the global marketplace, also referred to as the bottom of the pyramid (Prahalad, 2005) or as subsistence marketplaces (Viswanathan and Rosa, 2007). These subsistence marketplaces have been described in terms of their size and accessibility, with brand conscious, connected customers willing to accept new technology (Prahalad, 2005; Viswanathan and Rosa, 2007). The literature has emphasized the (market development imperative in terms of creation of the capacity to consume), the need for new goods and services, dignity and choice for the poor, and the importance of developing trust between buyer and seller. Several principles of innovation have been discussed including finding sustainable solutions, understanding functionality, innovating with process and deskilling work, educating low-literate consumers, designing for hostile infrastructure, and designing innovative distribution chains (Prahalad, 2005). With depleting opportunities in non-subsistence markets, subsistence marketplaces offer businesses the opportunity to seek out new markets while also contributing to poverty alleviation. The population across the world yet to enter the formal economy is estimated to be about 4 billion people, with a total household income of \$5 trillion a year.

Developing cost-effective solutions appropriate to local contexts meeting real needs requires innovative designs that can overcome harsh conditions and meet low-cost demands. Central to competing in these markets is the need for innovative product design and development, including the need for affordable, quality products that can function in hostile conditions, as chronicled in a number of case studies (Prahalad, 2005). Businesses need to design

products/services and implement ways for markets to bridge the “affordability gap”, reaching people in areas where ordinary business models do not work (Lodge, Wilson (2006).

Efforts to enable the large proportion of individuals living in subsistence to participate in the marketplace have to be guided by the need to find sustainable solutions that preserve natural resources for future generations. At an intuitive level, subsistence marketplaces are characterized by the extreme lack of resources where individuals live close to the environment without the buffers that typify non-subsistence settings. The need to conserve and do more with less is critical and natural instincts and traditions to preserve the environment are likely well developed. However, the impetus for survival in the near term can lead to unsustainable practices. There is much to learn from such settings on sustainable practices.

Despite the large proportion of humanity that survives in subsistence marketplaces, management and engineering research, teaching, and practice have focused largely on resource-rich, literate contexts. Our course based on research in subsistence marketplaces aims to open up a radically different context for students to study. Issues of importance to business and engineering research and education about the nature of product and market development for these distinctly different marketplaces are addressed in our course. We have a number of learning objectives in this regard: (a) to understand the radically different context of subsistence, (b) to generate new insights about business and engineering using this understanding and through comparison and contrast, (c) to understand product and market development for this context, and (d) to derive lessons for non-subsistence contexts.

Course Description

Our two-semester course sequence on sustainable product and market development for subsistence marketplaces combines in-class pedagogy with experiential learning, resulting in useful and marketable product concepts and prototypes. Graduate-level students in business, engineering, and industrial design jointly learn and use principles of business planning, marketing, cost accounting, project finance, engineering design, and manufacturing across two semesters to develop successful and profitable new products suitable for subsistence marketplaces. Students work over two semesters to identify an opportunity of general need, conduct field market research to better understand subsistence consumer needs and context through a field trip, develop a product concept, convert the concept to a workable prototype, and develop a manufacturing plan, marketing strategy, and overall business plan for the product. In the first two years, we partnered with multinational companies and a startup company for student projects and learning activities based on current business challenges in subsistence markets. Projects have focused on categories such as information technology, food and beverage.

The course is unique in its focus on developing products and services to serve the needs of those living in subsistence marketplaces. Overlaying the content in a typical new product development lab course is a separate module that develops contextual understanding of subsistence marketplaces. This type of immersion in the consumer context sets the stage for new product development. Travel to subsistence markets (our initial focus has been on India, the location of our research) for actual immersion in the context and to gather specific market information is a central aspect of the learning experience.

Many years of research on subsistence marketplaces as well as social initiatives stemming from the research) have enabled this educational innovation. The experimental

version of this course was introduced in 2006-07, cross-taught by business and engineering faculty. New product development lab courses are not new (e.g., Apple and Vanier, 1988; Eppinger and Kressy, 2002; Cardozo et al. (2002) present a review of educational resources), nor are courses with a multicultural or international perspective (e.g. Burton, 2005). However, what is new here is a course that focuses on developing sustainable goods and services to serve the needs of those living in subsistence marketplaces.

The pioneering nature of this course lends itself to some unique learning opportunities for students. Students have a full and first hand experience of applying principles of new product development in a radically different context. They learn innovative ways of conducting market research to learn the needs of a unique customer segment and then apply this knowledge and information to develop new products which that can function in a radically different context. It provides an opportunity to compare, contrast, and, therefore, sharpen product development, marketing, management and engineering skill sets for traditional marketplaces. Therefore this course is of great benefit to students who intend to work in any context as lessons learned for subsistence marketplaces can in turn be applied in other marketplaces. The course provides an opportunity to contribute to knowledge creation in this area. We expect project reports from students to form the basis for future learning material to be disseminated widely through publications. The course provides an opportunity to broaden one's perspective across cultural as well as literacy and resource barriers.

Detailed Description of Course Elements

Detailed description of course elements is provided below and an abridged course schedule is presented in Appendix 1. Students in business, engineering, and industrial design spend the first eleven weeks of the Fall session understanding subsistence marketplaces through

immersion in the context and through *emersion* of business principles. Five weeks of virtual immersion in subsistence contexts includes a poverty simulation, analysis of interviews of subsistence individuals, analysis of life circumstances in subsistence, development of conceptual models of poverty, low-literacy, and consequences, and development of conceptual models of needs, products, and marketplace interactions of subsistence individuals. The next six weeks are spent in emersion of principles using a rich set of cases (e.g., Prahalad, 2005), discussion of marketing and management topics, introduction to product design from an engineering perspective, and presentations with guest speakers ranging from social workers to technologists and entrepreneurs. In parallel, student groups are formed by the middle of the semester to balance technical and business skills and match interests with our company sponsors. During the second half of the semester, student groups generate and evaluate a long list of possible ideas based on interaction with company sponsors, and narrow them down to a smaller set. The final weeks of the semester are spent on designing market research to be conducted during a field trip. The class travels for actual immersion in the context and to conduct market research during part of the winter break. The field trip has been conducted in Chennai and Bangalore, India, where the goals of actual immersion and focused market research are accomplished.

Spring semester is spent converting concepts to workable prototypes, and developing manufacturing, marketing and business plans. Product design and development is a well researched and documented subject within the context of resource rich and formal economies (Pugh, 1990; Ulrich and Eppinger, 2007). However in subsistence contexts, it remains a highly unexplored and unstructured area of research and practice (Donaldson, 2006). Accordingly, the spring semester focuses on teaching a systematic and structured approach for developing products and services for subsistence marketplaces. This includes conceptual design, system

(architectural) design, detailed design, financial modeling, and prototyping methods. In addition, it includes writing project mission statements, business plans, and other related topics at the intersection of business and engineering. The main objectives of this module are to educate students on generic product development topics, while focusing on relevant issues for subsistence marketplaces such as: (a) design functionality and its fit to social and cultural needs or norms, (b) design affordability and cost-effectiveness, (c) design robustness and its ability to withstand harsh operating conditions, and (d) design manufacturability and local sourcing of materials, parts, and expertise. An overarching goal of this module, however, is to emphasize the importance of engaging subsistence marketplaces at every stage in the design and development process (whenever possible), and not solely treating them as end consumers (Murcott, 2007).

The course addresses a number of issues, a few of which are listed as exemplars: What are the characteristics of successful and unsuccessful products for subsistence marketplaces? How should products be designed for such marketplaces? How should market research be conducted throughout the new product development process?

Course Design and Class Enrollment

In our pilot effort, an application process was used in to build a class of diverse students who collectively combined a broad range of technical and business skills. Several information sessions were held on campus and faculty assistance was sought to build a class consisting of business, engineering, and industrial design students. The information was primarily targeted to graduate students. A key enrollment challenge was the two semester course and the field trip and associated expenses.

The information sessions were used to convey that student expenses for the course would be a certain maximum (say \$1000-\$1500), and that there would be no costs for text books for the

two semesters. Our goal was to apply for grants and seek company funding for the course. The two course commitment was needed for purposes of accomplishing the goals of a product prototype and a business plan, to allow for the field trip between the two courses for broader immersion and focused market research, as well as for planning purposes in terms of promising specific deliverables to companies. We strongly encouraged students to make a two course commitment, although allowing for some flexibility.

In our second execution of the course, we did not provide flexibility and asked for a two-course commitment from all the students. However, the two-course commitment does create reluctance on the part of students, as well as difficulties in enforcing such verbal commitments, suggesting an approach where a choice is made in mid-semester in Fall before group compositions are finalized.

Virtual Immersion in Subsistence

Five weeks of virtual immersion in subsistence contexts in the Fall semester includes a poverty simulation, analysis of interviews of subsistence individuals, analysis of life circumstances in subsistence through videos, development of conceptual models of poverty, low-literacy, and consequences, and development of conceptual models of needs, products, and market interactions of subsistence individuals. In this part of the course, a number of individual assignments are used. Before the first meeting, students are asked to read a book providing rich biographical accounts of living in poverty (e.g., *Nickel and Dimed* by Barbara Ehrenreich). In a subsequent assignment, students are asked to write about what they learned about poverty. The first meeting includes a poverty simulation conducted by the Cooperative Extension program at the university which serves a large population in the state living in poverty through nutrition education and other programs. In this simulation, students are assigned to specific roles in

families and asked to make financial decisions with limited amounts of money over a 4-week period. Each week is simulated in the course of about 15 minutes where students play their characters and interact with shops and government offices staffed by the organizers of the simulation. A number of needs, such as food, medicine, rent and so on, have to be met while paying for transportation and other services. Often, basic necessities have to be foregone in order to make ends meet. At the conclusion of the simulation, the organizers ask students assigned to each family to relate their experiences and then provide a summary of poverty in the state. This simulation of living in poverty in the US is effective in enabling students to consider life circumstances with severe resource constraints. Students are asked to complete an assignment where they describe the details of their experience in the poverty simulation, their own emotions and behaviors when participating in it, and broader lessons learned about living in poverty. This simulation enables students to think about poverty as well as the constraints that arise as a result. Often, students relate how they assumed that people chose in some way to live in poverty but in fact, it is very difficult to get out of the vicious cycle of poverty. They develop an appreciation for the economic, psychological and other factors that need to be overcome by those living in poverty. The simulation is also a participative exercise that enables students to be involved in the topic and serves as a very good starting point.

For the second week, students are asked to read 1-2 rich, in-depth interviews of buyers and sellers living in subsistence in India, selected from a larger set of interviews. These interviews were conducted as part of a research program on this topic (Author, 2007). Students are asked to write first-person narratives of the lives of individuals interviewed. The class discussion in the second week is wide-ranging and touches on various aspects of poverty as well as issues of literacy and culture. The class discussion is partially organized around specific

interviewees. Because students select from about half a dozen interviews, different interviewees are discussed in sequence. The discussion is not restricted to poverty in one country, but rather, students from different cultures and backgrounds are asked to make observations about poverty in their respective cultures. Such an approach enables a bottom-up, data-driven discussion of insights based on students' analysis of interviews.

In preparation for the third week, students are asked to read two more interviews, covering buyers and sellers across the total number of interviews they read. They are asked to develop a model of poverty covering antecedents and outcomes. The model can take a number of forms, such as a conventional causal diagram, or a collage that illustrates antecedents and outcomes. Students from engineering, industrial design, and business are very creative in this open-ended approach to understanding poverty. Class discussion in Week 3 is organized around presentations of poverty models by students. Videos of life circumstances in subsistence are also introduced to generate class discussion.

To summarize the first three weeks of immersion, using poverty simulations and interviews, students write first-person profiles of individuals in poverty, draw broader impressions about living in subsistence, and build conceptual models of poverty and related factors and behaviors. Noteworthy here is that the focus is on broader understanding of subsistence contexts. Such broader understanding of life circumstances forms the underpinning of the focus on the marketplace realm in the next weeks. In Week 4, students analyze additional interviews from the original pool, as well as videos to derive models of the set of needs, products, and markets for individuals living in subsistence. The class is organized around presentations by students about needs, products, and markets. In Week 5, we invite an expert in an area such as social work to talk to the class about broader impressions of poverty and pointers for conducting

research in subsistence. Week 5 is also used to summarize key issues about low literacy and poverty using research in the US and in India. As preparation, students are asked to summarize and critique two papers on these topics (Viswanathan et al., 2005; Viswanathan, 2007). It should be noted that we cover poverty in a variety of contexts and even eras, using comparison and contrast across different subsistence contexts or even across different strata of society to gain insights. Although our interviews from India are central, our discussion is wide-ranging and the US versus India comparison leads to discussion of other contexts as well. As mentioned, a diverse set of students speak about their own experiences and knowledge of different cultures and countries.

Emersion of Business, Design, and Engineering Principles for Subsistence Marketplaces

In this part of the course, the aim is one of emersion of principles for product development, marketing, management, and engineering, through comparison and contrast with principles for non-subsistence contexts. Groups of students are formed for case analyses, their responsibility being to distribute broad discussion questions and lead the discussion, with the other groups submitting write-ups. The write-ups as well as the class discussion assume thorough knowledge of the case and focus on analyzing the material and not on describing the facts available in the case. Cases are selected to cover a range of issues including product development, technology, engineering, distribution, promotion, and pricing. We have used 3-5 cases in our previous experiences including ITC-echoupal, Annapurna salt, and Jaipur Foot company (Prahalad, 2005), the aim being to cover different topics and subsistence contexts, although there is an overrepresentation of cases about India in the literature. The analysis of each case focuses on the following issues; needs and consumer behavior (specific need being served, relevant consumer behaviors, product and market context, larger context of life circumstances), market research

(examples of methods used, suggestions for methodological improvements, management and engineering issues, technology, products, distribution, promotion, pricing), recommendations for product and market development for subsistence marketplaces, and specific lessons learned for group projects.

Given the diverse backgrounds of students, a wide ranging set of readings in business is used, with specific topics being covered in depth in class discussion. The approach to date emphasizes marketing management, which covers topics such as the marketing philosophy, consumer behavior, marketing research, new product development, pricing, promotion, and distribution. The topic of marketing research is covered in some depth in preparation for designing research methods for group projects to be executed during the field trip. The topic of product design is covered in a separate session by the engineering faculty responsible for teaching in the spring semester, providing students with an introduction to the topic to enable idea generation and screening and to anticipate the direction of the project in the spring semester. We also invite a number of guest speakers during the emersion part of the course, ranging from technologists to commercial and social entrepreneurs, to discuss their experiences in subsistence marketplaces.

Group project

Based on functional skills and interest in potential project topics, groups are formed in the middle of the first semester. Through interactions with company sponsors, the breadth of the project is determined in terms of the range of product categories to consider. Groups then work to generate a wide range of ideas, essentially erring on the side of inclusion. Brainstorming sessions and focused meetings to which students bring a set of ideas are suggested approaches. This stage can be facilitated by reviewing video and interview based material to

consider needs and ways to address them, a market based approach. Alternatively, technologies can be considered that could lead to innovative product ideas. Groups are asked to summarize their discussions to the rest of the class. In the next stage, the list of ideas is narrowed carefully to a smaller family of topics. Each idea is carefully considered and the group decides on a smaller set at the end of this process. The aim is not to reduce to a single idea but rather to have a manageable set of ideas as a basis for designing qualitative research. Groups will be asked to summarize their discussions to the rest of the class. In the next stage, qualitative market research instruments are readied for use during the field trip. Students are encouraged to develop visual material representing product ideas that will facilitate the data collection process.

Field Trip

The class travels for immersion in the context and to conduct market research during part of the winter break. The field trip has been conducted in Chennai and Bangalore, India, in January. Students observe households in urban and rural subsistence contexts, as well as retail and wholesale outlets. Students interview low-literate, low-income individuals in urban and rural settings to conduct market research for their group projects. Students also visit educational institutions and corporations engaged in the development of innovative technologies for subsistence contexts, and social enterprises providing services.

The field trip has been a central and transformative experience in the larger context of the course. The preparation for the field trip takes a number of directions ranging from an orientation for students to many months of planning. The nature of the field trip in terms of interacting with individuals and communities in urban and rural areas requires careful planning and rehearsal and the cooperation of a number of organizations and individuals. Many of the amenities and facilities that are taken for granted in field visits to corporations or in other field

trips in middle-class settings cannot be assumed here. For instance, careful planning is required to select villages to visit, to ensure that individuals are willing to be interviewed, to ensure that facilities are available to conduct interviews and so on. Our ability to organize the field trip is greatly facilitated by a core team of individuals from the very contexts we studied who have been central to our research, teaching and social initiatives. We draw on the cooperation of a number of community-based organizations and self-help groups as well as educational institutions and companies.

A number of immersion aspects of the trip are central to the learning experience. Students spend long days with many interactions with subsistence individuals and contexts. These interactions are not scripted and allow students to engage in a discovery process in a radically different context. They are encouraged to reflect on what they are observing by maintaining diaries and through debriefing sessions. The field trip has been a transformative experience for students.

Product Design and Development

Overview

Product design and development is a well researched and documented subject within the context of resource rich and formal economies (Pugh, 1990; Ulrich and Eppinger, 2007). As discussed, subsistence contexts represent a highly unexplored and unstructured area of research and practice (Donaldson, 2006). At the same time, multinational commercial enterprises are struggling to morph their existing products and development processes to launch products that meet the expectations of subsistence marketplaces. The spring semester focuses on teaching a systematic and structured approach for developing products and services for subsistence marketplaces including conceptual design, system (architectural) design, detailed design,

financial modeling, and prototyping methods, project mission statements, business plans, and other related topics at the intersection of business and engineering. The main objective of this module is to educate students on generic product development topics customized to subsistence marketplaces.

Details

This part of the course commences with a trip brief, based on the field trip that takes place over winter break. The briefs usually take a “show-and-tell” format where each team prepares a set of slides that often include photographs and videos taken during the trip and present their observations and experiences. Students cover specific conversations they had with individuals, observations regarding communities visited, and generalizations based on the overall trip experience. The team concludes the brief by presenting one or a few perceived market opportunities. The rest of the class time is used to discuss business planning, and project and team management issues. We begin the class discussion by describing what a “mission statement” is and study statements from various organizations (e.g. profit and non-profit) to allow each team to capture a preliminary mission statement for their own project. Then, we move to describing the anatomy of a “business plan” and learn how to write a “good” one-page business plan using several documented cases (Horan, 2004; Sahlman, 1997). In the last part of this class, we focus discussion on project and team management. A quick overview of Gantt charts and project scheduling is provided and then a laundry list of “Do’s” & “Don’ts” for effective team communication and workload sharing and distribution is discussed.

In the second week, we cover three topics: state of design practices in developing countries, importance of proper needs assessment in subsistence contexts, and appropriate technologies. First, we discuss the various design strategies and processes observed in

developing countries to identify design opportunities and constraints (Donaldson, 2006; Tybout, 2000). The focus of discussion here is to highlight the notion that design practices and processes must be consistent with local conditions in order to support sustainable economic development. Next, we discuss the importance of improved contextual understanding as a necessary precursor to any engineering design endeavor; particularly in a subsistence context. A contextual needs assessment method based on recent research is described in detail and discussed in class to discover and document the "how," "where," and "who" factors of the design context (Green et al., 2006, Rodriguez et al. 2006).

The last topic discussed in Week 2 is intermediate or appropriate technology. As the name suggests, such technology can be understood as a middle ground between the highly expensive and advanced technologies of the 'West', driven by large scale production and profit, and the traditional subsistence technologies of developing countries (Schumacher, 1973). Discussion of this topic serves as a good yardstick for the class teams when evaluating whether technologies are suitable for subsistence marketplaces (Hammond and Prahalad, 2002). An important discussion point during this class is that appropriate technology does not necessarily mean primitive or less advanced. However, in many situations this approach may require a quantum leap in technology thinking (compared to existing high-tech solutions found in industrialized economies).

In preparation for the third and fourth weeks, the students are asked to read three articles concerning QFD, innovation, and design decomposition (Hauser and Clausing, 1988; Hargadon and Sutton, 2000, Stone et al., 2000). Our objective in these weeks is to teach students a way of mapping customer requirements (i.e. needs and wants) that were developed during the Fall semester and the field trip into a meaningful and measurable engineering criteria or

specifications. Once these quantifiable and measurable attributes are defined, the students have a documented list of measurable attributes that their designs should adhere to in preparation for the next stage of development that concerns concept generation and selection. During concept generation, brainstorming techniques, design decomposition (function diagrams), morphological analysis, and voting techniques are covered. Students are then asked to go through several (typically two or three) rounds of exercises focused on finding design solutions for subsistence marketplaces (usually, we chose arenas where a product already exists but the students are not likely to be aware of it). Design examples are presented in Appendix 2. Sources of design examples for subsistence marketplaces are available on the web and a shortlist of cases is compiled in the Appendix for illustrative purposes.

Decomposing a black-box model of the overall desired product functionality into sub-problems and sub-functions that collectively deliver the intended or desired overall product functionality is an approach to enable modular concept generation. This is done by identifying subsistence functions that can be grouped together and implemented through a single subsystem or module (Stone et al., 2000). A key advantage of identifying the modules that cater best to critical subsistence needs is the ability to generate solution concepts for modules that simultaneously encapsulate subsistence specific requirements and allow for product adjustability (and upgradeability) by consumers. This proposed approach allows the development team to address the important sub-functions that require special attention in subsistence marketplaces.

During concept generation, industrial design students play a central role, using sketching capabilities gained from their disciplinary background in translating various verbal conceptual solutions into lively and informative sketches. Another aspect of concept generation for subsistence marketplaces which we found very helpful was to ask the students teams to search

the Internet for products designed for unfamiliar contexts. These types of products are helpful in at least two respects: to study how customer needs were elicited in such contexts (Hannukainen and Holtta-Otto, 2006), and as a source of innovation to use in subsistence marketplaces (Geschka, 1986). Such design contexts include products for extreme situations, such as assistive products for elderly and disabled customers, or for emergency and catastrophe environments. For example, the freeplay radio, which was originally designed and marketed for emergency applications, turned out to be a good solution to educate and broadcast information to entire villages that lack electrical power and for whom batteries are too expensive to purchase (Chick, 1997). Children's toys are another useful source of innovation considering their ruggedness, simple and intuitive user interfaces, simplistic designs, and inexpensive materials¹.

During concept screening and selection, we propose a rating matrix (to choose a single concept for further development from the various solution concepts brainstormed) based on a Pugh rating chart (Pugh, 1990). A subsistence Pugh chart is similar to a traditional Pugh chart, where the alternative solution concepts are listed in the columns of the selection matrix and selection criteria are listed in the rows of the matrix. However, special attention is devoted to the selection criteria used in the chart. In this task we develop a set of subsistence specific selection criteria based on the type of product developed and the subsistence context addressed. Also, in this class, the students learn about the various prototyping techniques including a thorough discussion of strengths and weakness of each technique for subsistence contexts.

In the fifth week, the students are exposed to various traditional material removal and forming processes and particularly plastics injection molding, using short instructional videos (SME, 2003; SME, 2004). They are also introduced to the world of materials and their general

¹ A practical product that was designed after a children toy is the Kinkajou overhead projector (<http://designthatmatters.org>).

properties (Ashby and Johnson, 2003). Our main focus here is on manufacturing strategies and material sourcing decisions as they relate to a particular subsistence context. Local manufacturing is beneficial to both the enterprise and local community as it is cost effective, and imparts new skills to local people. Local parts and materials can be sourced and local manufacturing provides new employment opportunities to the community. In addition to the product design, it is also essential to consider the servicing and maintenance issues that could potentially arise from new products. Issues in providing reliable maintenance of the products that become an integral part of subsistence individuals' lives include localized provision of service and supply of specific parts.

Our final week of the module focuses on the financial side of product development and production economics. We use a hands-on example of an Excel-based model for performing financial analysis and determining the financial and social return on investment for the project. In this week, the students are exposed to Taguchi's robust design methodology (Taguchi and Clausing, 1990) in order to enable them to consider robustness in general as a philosophy and not necessarily apply the complete statistical details behind it. For instance, at the concept development stage, students can question whether their concept is robust and whether it will work in a variety of environments, for a variety of customers, and under conditions with variation anticipated in a particular subsistence context.

Case studies

Throughout the first part of this semester, the focus is to equip students with various required competencies and tools that can be applied to their projects. The second part of the semester focuses on analyzing case studies on design for subsistence marketplaces in more detail. Through the use of these case studies (Appendix), each student team addresses the following:

needs assessment (specific need being served, and relevant consumer behavior), technology appropriateness (including functionality and improvements), engineering issues, product design, industrial design, manufacturing technology, recommendations for design & development for subsistence marketplaces, and specific lessons learned for group projects. Finally, in this part of the course a series of guest lectures are scheduled. Various consultation sessions, project deliverables, and design briefs are scheduled through the Spring semester as detailed in the syllabus (see Appendix). Elements of a business plan are also covered in depth, while revisiting topics in marketing and management based on student requests.

Future Directions

Our educational initiative provides a basis for a number of future initiatives. Our extended 2-course sequence now provides the basis for creating a number of educational modules. For illustrative purposes, we describe a just completed a pilot effort for a freshmen business course with a module on sustainable businesses for subsistence marketplaces. This 5-week module for first semester undergraduate students involved understanding subsistence marketplaces, generating and choosing sustainable product ideas, developing and presenting a brief business plan and presenting the project in a poster session. The module was developed by drawing from the experience of the year-long course. Current plans are to scale the module as part of the entire course to 300 and then all 600 incoming business students by training juniors and seniors to teach the materials. At a curriculum level, our approach is to introduce this topic broadly through an early module or course and then to provide a capstone integrative experience for interested students.

We have also introduced a 7 week course for MBA students on sustainable marketing enterprises. Our approach here was to use insights from subsistence marketplaces as a starting point to consider sustainable consumer behavior, product design, promotion, distribution and pricing in all contexts. The intersection of sustainability and subsistence offers a number of insights that can form the foundation for thinking about sustainable enterprises in general.

Immediate plans also include modularizing the key elements of the course into day-long or two-day long learning experiences for students, managers, and social entrepreneurs. Such learning modules can be customized to emphasize a number of themes. For example, such an approach could be used to develop a learning module on professional responsibility that combines the twin issues of sustainability and poverty alleviation organized around a central, interdisciplinary business function, i.e., product development. At the heart of professional responsibility for the 21st century is the need to appreciate diverse perspectives across the globe and imagine circumstances beyond one's immediate experience, while working toward a better world. Such a learning module provides exposure to radically different contexts that most students would not have experienced, such as extreme poverty and low levels of literacy and different cultures. Such exposure in itself challenges conventional wisdom and stretches the imagination, while stimulating self-enquiry about the things that are taken for granted in relatively-resource rich settings. It also stimulates thinking about one's responsibility in a professional capacity to address issues that a majority of humanity faces. The use of settings from across the world brings in the all-important global dimension. Such solutions are inherently inter-disciplinary, again exposing students to a variety of perspectives that are brought to bear on. Also unique to our approach is the intertwining of actual business functions with

professional responsibility issues rather than using scenarios or exercises that are relatively abstract or removed from actual, day-to-day business activities.

At the broadest level, our focus is on presenting radically challenging contexts in which transformative education experiences can take place. Our course is at the confluence of subsistence and sustainability, representing two of the most important issues facing humanity. Such a radically different context where there is much potential for social good strikes a chord with students. Intertwined with our course is the need for interdisciplinary solutions and a global perspective. In summary, we believe that such educational initiatives provide a challenging learning ground in preparing students for the unique demands of the 21st century that have to be collectively confronted by humanity.

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Appendix 1 – Course Outline

Fall Course Schedule Monday – 5:00 - 8:00 pm

Part 1 – Immersion

The aim of this part of the course will be to provide an opportunity for students to immerse themselves in the context of subsistence marketplaces through cases and findings from research. Whereas the field trip will provide an opportunity for actual immersion, the first 5 weeks of the course will attempt to create a learning environment to simulate such immersion.

Week 1	Orientation/Introduction to the Course Group Formation Exercises Poverty Simulation – Robin Orr, Cooperative Extension, University of Illinois
Week 2	Understanding the Subsistence Context – Individuals, Groups, and Society Analysis and Profile of Interviews and Videos
Week 3	Understanding the Subsistence Context – Individuals, Groups, and Society Analysis and Profile of Interviews and Videos Developing Conceptual Models of Poverty
Week 4	Understanding the Subsistence Context – Products and Markets Analysis of Interviews and Videos Developing Models of Needs, Products, and Markets Group Formation
Week 5	Understanding the Subsistence Context - Summary Comparisons and Contrast of Literacy and Poverty in the US versus India Guest speaker – Poverty and Culture Group Projects – Introduction to Idea Generation Readings: Viswanathan (2007) and Viswanathan et al. (2005)

Part 2 – Emersion

The aim of this part of the course is to extract general principles on buyer and seller behavior, market research, and the marketing mix elements for subsistence marketplaces while contrasting them with traditional marketplaces.

Week 6	Product Design Primer Group Projects – Idea Generation
Week 7	Technology Assignment - Case – ITC e-Choupal Guest Speaker – Running an Enterprise in Subsistence Marketplace Group Projects – Idea Generation
Week 8	Products and Distribution Assignment - Case – Annapurna Salt Understanding the Subsistence Context - Implications for Market Research Guest Speaker – Product Design in Subsistence Marketplaces Group Projects – Idea Generation
Week 9	Promotion and Pricing Assignment - Case - Lifebuoy Soap Group presentation of ideas Group Projects – Idea Screening and Evaluation
Week 10	Marketing and Market Research Group Projects – Idea Screening and Evaluation
Week 11	Marketing and Market Research Group presentation of idea screening and evaluation Group Projects - Idea Screening and Evaluation and Development of Market Research Instruments
Week 12	Marketing and Market Research Group presentation of market research plans Group Projects – Idea Screening and Evaluation and Development of Market Research Instruments
Week 13	Field Trip Planning and Orientation Group Projects - Development of Market Research Instruments

Parts 1 and 2, immersion and emersion, will lay the foundation for students to embark on specific product and market development research projects.

Field Trip – December 31 – January 11 (approximately)

Trip Objectives and Plans

Immersion in subsistence marketplaces through first hand observation of the influences of poverty, literacy, and culture

- Individual and group interactions in urban and rural settings
- Observations in urban and rural settings

Learning about a diverse set of organizations and their initiatives in subsistence marketplaces

- Field trips to observe profit and non-profit organizations

Market research for projects

- Individual and group interviews in rural and urban settings
- Discussions with company sponsors regarding projects

Spring Course Schedule
Monday – 5:00-8:00 pm

Part 3 – Product Design & Development Basics

The aim of this part of the course is to learn a systematic and structured approach for developing products and services for subsistence marketplaces. This will include conceptual design, system (architectural) design, detailed design, cost modeling, and testing and prototyping methods. In addition, it includes developing project mission statements and business plans, and covering other related topics at the intersection of business and engineering.

Week 1	Introduction to the course Trip Brief Mission Statements & Business Plans Project & Team Management Deep Dive Video (ABC News Special Report) Reading assignment: How to Write a Great Business Plan, HBR article
Week 2	Product Design Processes for Subsistence Marketplaces Deep Listening Methodologies Appropriate technology Reading assignments: Donaldson, K., "Product Design in Less Industrialized Economies: Constraints & opportunities in Kenya," Res. Eng. Design, 2006. Green et al. "Frontier Design: A product usage context method, Proceedings of the ASME. DETC/DFM 2006-99608. Philadelphia, PA., Sept. 10-13, 2006. Rodriguez et al. (2006), "Gaining insight into unfamiliar contexts : A design toolbox as input for using role-play techniques," Interacting with Computers, 18(2006) pp. 956-976.
Week 3	Establishing Engineering Specifications Concept Generation & Selection Prototyping Methods 1-page Business Plan & Project Schedule Due Reading assignments: Hauser, J., Clausing, D. (1988), "The House of Quality," Harvard Business Review, May-Jun. 1988. Hargadon, A., Sutton, R. (2000), "Building and Innovation Factory," Harvard Business Review, May-Jun 2000. pp. 157-166. Stone, R., Wood, K., Crawford, R. (2000), "A heuristic method for identifying modules for product architectures," Design Studies, 21(1), 200, pp. 5-31.

Week 4	Design exercises for subsistence marketplaces Faculty Consulting & Team Meeting
Week 5	Material Selection & Manufacturing Processes & DFMA Conceptual Design Due Reading assignment: Ashby, M. Johnson, K. (2003), "The Art of Materials Selection," Materials Today, December 2003. DFMA - chapter 11, Ulrich & Eppinger, 2007.
Week 6	Financial Modeling Robust Design Reading assignment: Taguchi, J., Clausing, D. (1990), "Robust Quality," Harvard Business Review, Jan-Feb 1990. Handouts Faculty Consulting & Team Meeting

Part 4 – Product Design & Development –Case Studies

The aim of this module is to enforce the basics learned in Part 3 with design case studies in various subsistence contexts. In addition, several guest speakers will share their views and design experiences for product development for subsistence marketplaces. Finally, a major portion of class time will be used to assist students on their team projects.

Week 7	Guest speaker 1- TBD Assignment - Case 1 – ApproTEC Kenya Faculty Consulting & Team Meeting
Week 8	Midterm Presentations Faculty Consulting & Team Meeting Detailed Design Due – PowerPoint presentation and a written report
Week 9	Guest speaker 2 - TBD Assignment - Case 2 – Jaipur foot Faculty Consulting & Team Meeting
Week 10	Guest speaker 3- TBD Assignment - Case 3 – Kinkajou Project Faculty Consulting & Team Meeting
Week 11	Case 4 – Discare Faculty Consulting & Team Meeting Financial Modeling & Manufacturing Plan Due - PowerPoint presentation

Week 12	Cases 5 – Sugarcane Charcoal in Haiti Faculty Consulting & Team Meeting
Week 13	Wrap up Faculty Consulting & Team Meeting Peer Evaluation
Week 14	Final Presentations Final Reports, Prototypes, Business & Manufacturing Plans Due

Group Projects deliverables and deadlines

Mission Statements, Business Plan & project Schedule

At this stage, the project team delivers its missions statement and preliminary business plan. This includes figuring out the purpose of their existence as a start-up company, identifying major stakeholders, target markets, and milestones.

Week 3 - Group Projects – 1-page Business Plan & Schedule Due

Conceptual Design

The aim of this stage is to develop sketches of the one or two most promising alternative solution concepts.

Week 5 - Group Projects – Conceptual Design Due – a PowerPoint presentation only

Detailed Design

In this stage, the conceptual design should be developed by providing detailed drawings, engineering specifications, material selection, and preliminary cost analysis.

Week 8 - Group Projects – Detailed Design Due – a PowerPoint presentation and a written report

Week 8 - Group Projects – Group Presentations & Review

Financial Modeling & Manufacturing Plan

Week 11 - Group Projects – Financial Model & Mfg Plan Due – a PowerPoint presentation only

Development of Prototype & Business Plan

Week 14 - Group Projects – Final Presentations

Week 14 - Group Projects – Final Report, Prototypes, Business & Manufacturing Plans Due

Appendix 2 - Design Examples For Class Assignments

Imagine waking up long before sunrise and then walking for more than two hours to the nearest river or borehole and then carrying a bucket full of water on your head all the way home! Now imagine you are a woman or a young child and it is your responsibility to carry this heavy bucket of water every day of your life! Traditional methods of collecting water include the use of 20-liter (5-gallon) buckets, which are laboriously carried on the head. Extensive suffering occurs in the process. This method is very time and energy consuming and is also the cause of many serious health problems.



Exhibit

Solution: Hippo Water Roller: <http://www.hipporoller.org/>

The Hippo Water Roller was specifically designed to alleviate the suffering caused by a lack of access to water. The Hippo Water Roller is a barrel-shaped container designed to transport 90 liters (20 gallons) of water. It comprises of a drum with a large screw-on cap and a clip-on steel handle.

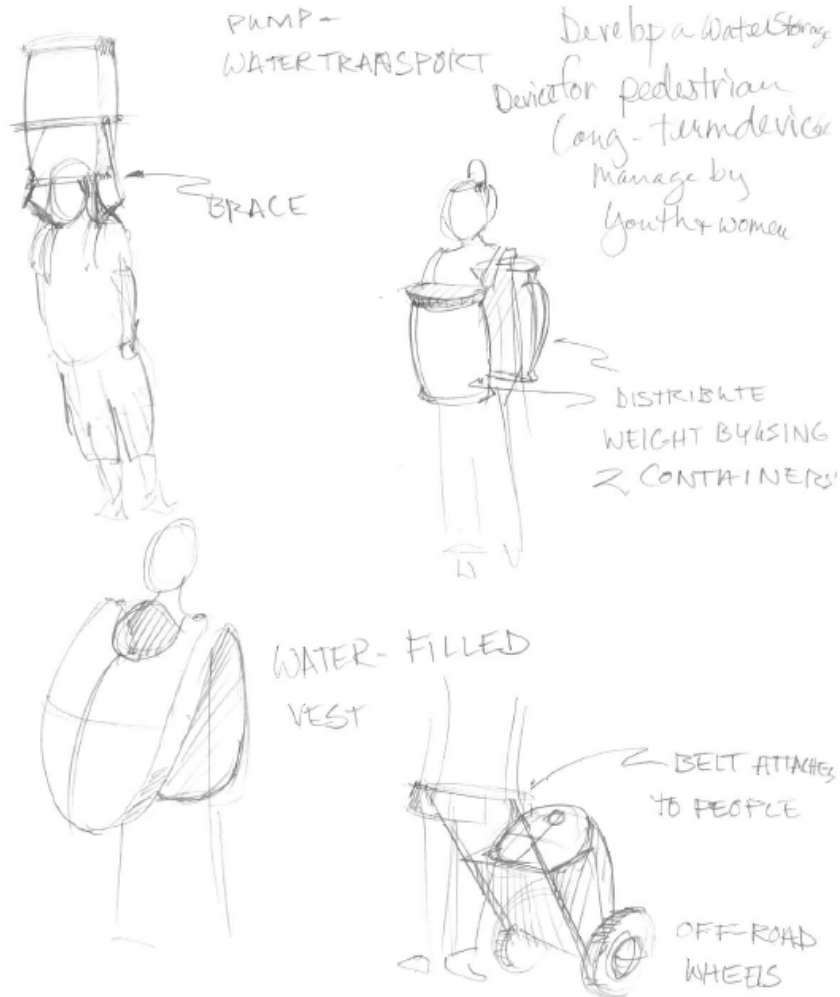


Exhibit

The drum is manufactured from UV stabilized Polyethylene and has been designed to withstand typical rural conditions such as uneven footpaths, rocks and even broken bottles. The large opening (135 mm / 5.3 inch diameter) allows for easy filling and cleaning of the interior. The sealed lid ensures hygienic storage of water and the steel handle provides firm control over difficult terrain while pushing or pulling the roller.

The innovative design allows water to be placed inside the "wheel" rather than carried above the wheel. The 90kg (200 pound) weight of water is borne on the ground resulting in an effective weight of just 10kg (22 pounds) on level ground. Children and the elderly can easily manage a full roller over most types of terrain. Extensive field tests over many years and various

awards have proven the effectiveness of the Hippo Water Roller. Approximately five times the normal amount of water can now be collected in less time with far less effort.



Exhibit

Web sources for design examples that could serve as assignments:

Specific product examples:

Hippo Water Roller: <http://www.hipporoller.org/>

Xaccess Bicycles: <http://www.xaccess.org/projects/biggaboda/overview.htm>

Hippo Water Roller: <http://www.hipporoller.org>

Rat Catchers: <http://www.cddponline.org/Photographs.htm>

Nepali Wire Bridges: <http://www.ecosystemsnepal.com>

Several project examples to choose from:

<http://designfordevelopment.org>

<http://www.itdg.org>

<http://www.iicd.org>

<http://www.tfsr.org>

<http://www.solarafrica.org/index.htm>

<http://www.thinkcycle.org>

<http://web.mit.edu/d-lab/>

A short list of potential case studies for use in this class

Kasturi Rangan, V. (2003), “ApprocTEC Kenya: technologies to fight poverty and create wealth,” Harvard Business School case, 9-503-007.

Macke, S., Misra, R., Sharma, A. (2003), “Jaipur Foot: Challenging Convention,” Michigan Business School case.

Figueredo, S. (2003), The Kinkajou Project: Product Design of Low Cost Microfilm Projector, MIT Department of Mechanical Engineering, undergraduate B.S. thesis, June 2003.

Kornbulth, K., Osafo-Kwaako, P. (2004), “Wheelchairs in Zambia: Project Appraisal of the DISACARE Wheelchair Center in Lusaka, Zambia,” An MIT D-Lab Report.

<http://web.mit.edu/d-lab/>.

Smith, A., Frayne, S. (2004), “Fuel from the Fields: A Case Study of Sugarcane Charcoal Technology in Haiti,” An MIT D-Lab Report. <http://web.mit.edu/d-lab/>.