re-Commerce: A New Paradigm for Innovation and Sustainability in CSET Education

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***Abstract*— Both Entrepreneurship and Sustainability are important concepts in Computer Science Engineering and Technology (CSET) education, and this paper illustrates a new pathway to link these two concepts. re-Commerce combines the waste management concepts of Reduce, Reuse, Recycle with the Icelandic *fullvinnsla* concept of full utilization to create a new paradigm, re-Commerce. re-Commerce is defined as the questioning of fundamental axioms in an industry in order to re-examine what we have assumed are constraints (either market, monetary or scientifically derived) to re-vision or revise an industry to fully utilize waste materials by re-tooling manufacturing processes, thereby re-inventing/re-structuring the commercial impact of the industry or product.**

The paradigm of re-Commerce has been used in Maine as a lens for examining the lobster industry. The New England Ocean Cluster (NEOC) is *re-examining* the waste in the lobster industry, *re-visioning* it as a valuable commodity, and working to *re-tool* manufacturing industries to take advantage of this commodity. The paradigm of re-Commerce may also be applied as a tool for CSET students to perform analyses of production or manufacturing processes, and in the way that educators approach team design based education. This work in process paper shows the development of the re-Commerce paradigm and its application in education among CSET students.

Keywords* — *re-commerce; team models; entrepreneurship education; sustainability; fullvinnsla

I. Introduction

There is a large body of knowledge, skills, and abilities necessary to create solutions to global problems, often described by proxy using the language of the Grand Challenges [1]. Many of these are already in our discipline research agenda and learning space thought patterns, such as: working inter-disciplinary teams [e.g. 2, 3], the importance of authentic learning experiences [e.g. 4, 5], entrepreneurship education [e.g. 6, 7], and designing for manufacturability [8] and sustainability [9]. While all of these, and more, are important, we often describe and implement them individually rather than holistically [10]. The concept of "re-Commerce" and the emerging educational model described in this work-in-process paper are one attempt to bridge together these evidence-based educational practices to create an economically stronger and less wasteful future. This paper briefly defines re-Commerce and the re-Commerce cycle, provides an example of emerging re-Commerce paradigm as a tool for students and a potential impact in using the paradigm to examine team learning.

II. re-Commerce – the Paradigm

Developed after the environmental turmoil of the 1970's [11], the concept of Reduce - Re-use - Recycle has been the mantra for moving to a more sustainable future for the environment. This concept derives from the theory of waste management [12]. As a result of the global banking crisis in 2007-2008 [13] Iceland adopted the idea of *fullvinnsla* or full utilization as part of their view on the industries at the heart of their economy. As a result, utilization of the cod fish and cod fish byproducts increased dramatically when new utilization methods were found for the skin, heads and viscera of the fish [14].

The State of Maine and the University of Southern Maine in particular have created an economic partnership with the Iceland Ocean Cluster House (a Scandinavian spin on a silicon valley-like incubator) called the New England Ocean Cluster (NEOC).

Combining the concepts of Reduce, Re-use, Recycle with *fullvinnsla* has resulted in the emergence of a new paradigm for viewing economic development, re-Commerce. As Figure 1 indicates, re-Commerce combines the traditional Reduce, Re-use, Recycle of waste management with the elements of *fullvinnsla*, Re-Examination, Re-Vision & Re-tool, turning pollution into solutions.

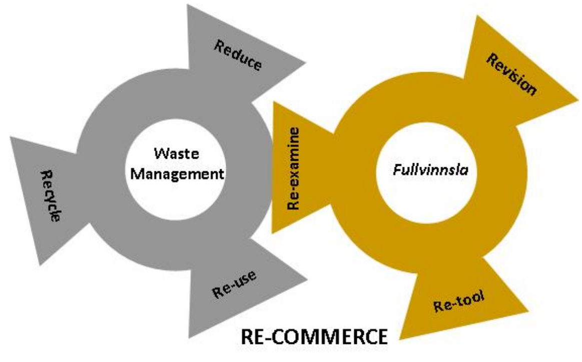

Figure 1. re-Commerce Cycle that Weds the Recycle and Fullvinnsla Cycles

NEOC's pilot example of *fullvinnsla* involves the lobster industry. Currently the fishing industry routinely discards

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approximately 8 billion pounds of waste annually (shells, viscera, blood, etc.) [15]. NEOC began by **re-examining** the assumption that there was no use for the shells and viscera of a lobster that form the majority of the waste product for this market item. Maine is the largest producer of lobsters in the US representing 85% of the overall catch [16]. The primary compound component in the shell of a lobster is chitin 66% [17]. Prior to the rise of petroleum-based plastics in the 1970's and 1980's, chitin was being developed as a way to produce durable, flexible materials. Plastic turned out to be much easier to synthesize as the purity of chitin has to be high to be most useful.

We now know the harms created by the petroleum and plastic industry worldwide (i.e. plastic filled oceans, oil spills, etc.) so as a first step, the previous assumption that chitin based products would be too expensive to produce was questioned. Chitin also has been discovered to have antimicrobial and antifungal properties [18] which have increased its potential use in the bio-manufacturing and bio-pharmaceutical industries [19].

Partnering with businesses in Iceland, NEOC is **re-visioning** the lobster "waste" exoskeletons as a new valuable resource and is examining ways to establish high-grade efficient methodologies for US-based chitin extraction. This will involve creating or **re-tooling** current manufacturing facilities and processes in the region based on the advanced manufacturing and processing techniques in use is Iceland and other parts of Scandinavia.

The result is **re-Commerce** which is defined as the questioning of fundamental axioms in an industry in order to re-examine what we have assumed are constraints (either market, monetary or scientifically derived) to re-vision or revise an industry to fully utilize waste materials by re-tooling manufacturing processes, thereby re-inventing/re-structuring the commercial impact of the industry or product.

III. RE-COMMERCE PARADIGM APPLIED TO CSET LEARNING EDUCATION MODELS

A. *re-Commerce Paradigm as a tool for CSET students*

At the heart of the re-Commerce paradigm is the idea that the founding axioms of many of today's engineering and technology solutions may no longer be axiomatic and that a critical component of training students is to give them a paradigm that they may use to test whether or not a founding axiom is still valid or to determine whether the constraints related to the axiom haves changed. [20]. The cheapest solution, though effective, may no longer be the best solution because it has higher societal costs associated with it.

For example, in the previous case of the extraction of chitin, the current manufacturing processes used to accomplish this task are hexane-based. It is a multi-step process that involves the use of petroleum-based products as well as potentially hazardous materials. Though hexane needs to be ingested or inhaled to produce toxic results, as the hexane is reused in succeeding processes it is believed that traces of it will eventually remain in the extracted material [21]. In addition, the most common method of extraction uses hydrochloric acid [22]. This is a circumstance where the application of the re-Commerce paradigm could produce very effective results.

One of the critical components of the re-Commerce paradigm is a shift in thinking from production-cost based decisions, to whole life-cycle cost based decisions [23] as well as incorporating sustainability and environmental impact as a component of cost determination and overall marketability of a product. Part of the value of this tool to CSET education is that it connects specific course work problems to broader societal issues and implementation concerns. re-Commerce by definition draws in societal, ethical, multi-disciplinary approaches to problem solving which directly aligns with ABET criterion 3 [24]. The re-Commerce paradigm may be used to examine greenfield (new) business problems as well as brownfield development (innovation and re-tooling in an existing business) problems [25].

B. *The re-Commerce Paradigm and Team Learning*

Team learning [26], team-based design, and team science [27, 28] are significant components of CSET education. Most CSET programs feature some sort of senior design or capstone program and it is our belief that the composition of teams being used in senior design projects needs to be **re-examined** and the often-used formulation of mixed-engineering disciplines in a team needs to be **re-visioned** to become multi-disciplined based teams [29]. The **re-tooled** teams could be composed of engineering, business, legal, science and humanities students; the members of the teams could be selected from both undergraduate and graduate programs. The science and engineering students can examine the technology being used; the legal students will focus on policy and regulatory constraints related to the process; the business students can look at market impact and business plan development and the humanities student will contribute insight into the human and societal factors related to the process under discussion and on the potential solution.

We expect that students participating in the revised team model created by applying the **re-Commerce** paradigm would gain enhanced skills in communication, leadership, change management and in being a representative of their field within a business environment. Further, many, if not all, of the professions represented in the teams have professional ethical standards. It is believed that the interdisciplinary teams will have a heightened awareness of the ethics of their professional as well as how their actions impact other team members and their clients.

These teams could be placed into the groups looking at the different manufacturing and business processes being explored in local businesses to create a real-world learning environment for the students. We know from the authentic learning model that students who have a chance to learn in a real-world environment (or an academic environment closely resembling a real world situation) have higher retention and knowledge acquisition [30]. We also know that students who experience entrepreneurship are more likely to become entrepreneurs themselves [31]. Therefore, one could intentionally **re-tool** how students are included in this process to increase their exposure to startups and new businesses and the hoped for result is a well trained workforce that brings a new perspective across all of the manufacturing industries, are more likely to promote sustainability and innovation, and go on to become entrepreneurs and innovators using the paradigm of re-Commerce as a means to change their respective fields .

C. Conclusions/Next Steps

re-commerce is an important new paradigm that can be used both as a tool for CSET students within the current CSET curricula, but also has the potential to impact the way we think about CSET education itself when applied to such concepts as team learning.

As the paradigm of re-Commerce spreads through the manufacturing industry it will require a work force versed in team solutions, cross-cutting technologies and experienced in working with people of diverse intellectual and experiential backgrounds. Not only will the new approach to the team-based student learning opportunities result in students who graduate from their respective program having experienced this new paradigm first hand, it will also provide them with a new tool or lenses for examining other problems that they face in the future.

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