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SYSTEMS THINKING COURSES IN THE MASTER'S PROGRAMME ON CREATIVE SUSTAINABILITY AT AALTO UNIVERSITY: REFLECTIONS ON DESIGN AND DELIVERY OF THE 2010-2011 SESSIONS

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ABSTRACT

In fall 2010 and winter 2011, two new courses in systems thinking were initiated as core curriculum in the master's programme in Creative Sustainability at Aalto University in Finland. As intensive courses, each was to be conducted as three full days of lectures over eight days, with students fulfilling credit hour requirements both independently and in group activities over a two-to-three month period. To complement the teaching staff at the university, a researcher active in the systems science community was brought in from abroad as a subject matter expert for the two courses.

In the summer preceding the first session, a reading list for the courses was drawn from current leading sources in the systems sciences, starting from 2010 and linking back to prior references of relevance. Lectures were prepared as minimal critical specifications, with concepts mapped into clusters of references, with the majority of sources available electronically over the Internet. On each set of the three lecture days, the courses were delivered in a face-to-face classroom setting, coupled with group activities designed in the style of Singerian inquiring systems. Coordinating artifacts from the instructors evolved and were incrementally updated on a publicly-accessible web site, and students followed the social media style of posting their reflections on publicly-visible weblogs linked with notifications on an activity stream at a systems community hub.

Supplementing the chronological recollections of development and learning during the courses sessions, theoretical reflections constructed in hindsight may serve to inform the form and content of similar educational opportunities in other contexts.

Preparations are underway as the courses are being naturally evolved for a second cohort of students in fall 2011. The completion of one cycle of two courses presents an opportunity for reflections on the approach employed in the innovation/startup cycle, with considerations for improvements and/or replication for similar programs in the future.

Keywords: systems thinking, education, sustainability, resilience, dialogue

1. INTRODUCTION: SYSTEM THINKING COURSES WITHOUT A LEGACY WERE DESIGNED AND DELIVERED FOR A NEW MASTER'S PROGRAM WITHOUT A LEGACY

In the absence of a legacy, how should a course on systems thinking be designed and delivered with relevance to students in a new master's program in Creative Sustainability at Aalto University in Finland? This was the challenge and opportunity presented in spring 2010 for courses to be offered that fall.

In section 2, the context leading to engagement in the courses is outlined. In section 3, the design of the courses to minimum critical specifications is described. The content and mutual learning of the fall course is reviewed in section 4, and of the spring course in section 5. Section 6 reviews the future prospects for the course, not only in Finland, but also for replicability in other contexts. Each of the sections concludes with theoretical reflections on implicit considerations of the systems practice applied reflexively.

2. CONTEXT: BY SPRING 2010, COURSES ON SYSTEMS THINKING HAD BEEN SLOTTED FOR THE CREATIVE SUSTAINABILITY PROGRAM

The courses in systems thinking for fall 2010 and spring 2011 should be viewed in the larger contexts of the containing master's program, and transformation of the sponsoring university system in Finland. Subsection 2.1 follows, with a summarization of the Creative Sustainability program placed in the larger context of the formation of Aalto University. The systems thinking courses are foundations in the master's degree program, described in subsection 2.2. Based on engagement of the content lead, the body of knowledge was provided as a list of references, outlined in subsection 2.3. The circumstances are retrospectively framed in a theoretical reflection in subsection 2.4.

2.1 The Master's Program in Creative Sustainability was in planning during the transition into three Finnish universities merging

Aalto University was created from the merger of three leading Finnish universities, on January 1, 2010: the Helsinki University of Technology (founded 1849, known as TKK), the University of Art and Design Finland (founded 1871, known as TAIK), and the Helsinki School of Economics (founded 1911, known as HSE). This new institution "aims to make a change through top-quality and interdisciplinary research, pioneering education and by boldly surpassing traditional boundaries" (Aalto University 2011). The Charter of Foundation was signed in June 2008 with an endowment from the Finnish government, with a seven-member board appointed in August 2008.

During the formation of Aalto University, the Creative Sustainability program was under development, as …

> a joint teaching platform of the Aalto University on sustainable design and business. It is built on a number of disciplines: real estate, urban planning, landscape planning, building design and industrial design, as well as the discipline of management. Each student will gain thorough knowledge of his/her own discipline. In addition, the

> interdisciplinary structure of the program enhances the understanding of the work practices of sustainability experts from different fields as well the skills of communication about sustainability (Aalto University 2010).

In 2009, the Creative Sustainability program accepted applications for "a new cross-disciplinary Master's minor study programme on sustainable design … starting in autumn 2009". At that time, the objective was "to open an international master's degree programme in 2010 and a postgraduate programme in 2012" (University of Art and Design Helsinki (TAIK) 2009). In fall 2010, the Creative Sustainability program had 24 students from 15 countries enrolled in the major, and 25 studies enrolled in the minor (Laurila 2011). The major program is a 120 ECTS (European Credit Transfer System) entity over two academic years, with 46 ECTS credits as joint compulsory studies. Two courses, Systems Thinking of Sustainable Communities (CS0004) and Systems Thinking for Planners and Designers (CS0005) are offered by the School of Art and Design as compulsory courses at 2 ECTS credits each.

2.2 As the scope expanded from a degree minor to a major, a content lead on systems thinking was sought to collaborate with instructors from architecture and design

In the 2009-2010 minor program, the systems thinking courses were based on content from the Systems Thinking and Decision Making (Systeemiajattelu ja päätöksenteko) course at the Helsinki University of Technology, taught by Jukka Luoma. Materials were adapted from the technical/mathematical engineering orientation and Finnish language into initial course offerings by Katri-Liisa Pulkkinen and Aija Staffans, including practical experiences from their work in the Department of Architecture. For the 2010-2011 major program, content (i) more directly applicable to sustainable design and business and (ii) deeper in scientific content were sought. Through Jukka Luoma, the course leaders – Aija Staffans and Katri-Liisa Pulkkinen – contacted David Ing, who had held roles as a vice-president in the International Society for the Systems Sciences, and had experience as both an instructor and doctoral student in the Finnish systems of universities and polytechnics since 2003.

The dates were set for three days of lectures each: Systemic Thinking for Sustainable Communities (CS0004) in October 2010 and Systemic Thinking for Planners and Designers (CS0005) in February 2011. The arrangements were made over e-mail exchanges, and personal contact would not occur until late September, just a week before the course. The most complete resource for the course was the program information provided at http://www.creativesustainability.info/ .

2.3 In late summer, a proposed list of current references suitable for Finnish master's students was proposed

While the planning for this course would be considered loose – at minimum – by North American standards, it was not atypical of Finnish graduate university programs. Intensive courses, with class meetings conducted as full-day sessions over a timeline of two weeks, enable (i) international scholars to visit Finland and lead or contribute subject matter knowledge in person, and (ii) students who may not be able to commit a quarter or

semester to topic to gain an exposure to a broad and deep body of literature. At the master's and doctoral level, seminars can be more participative, with instructors and students collaborating both to make sense of published research and cocreating new research. The interest in current practices internationally is balanced with an appreciation of strong theoretical research with depth.

As an example, in prior teaching in the master's program in industrial management, suggested articles from Harvard Business Review and Sloan Management Review were criticized as too simplistic. Articles from Strategic Management Journal and Journal of Marketing Research were acceptable, and students did not balk at publications that were either quantitative or philosophical in nature.

With this background, David Ing developed a list of academic references based in the theories rooted in the systems sciences, supplemented by methods and techniques explicitly and implicitly employing the art of systems thinking. The reading list was accumulated from journal articles published in 2010, working back in time to citations of relevant works. For the domain of systems thinking, the journals of *Systems Research and Behavioral Sciences*, *Systemic Practice and Action Research*, and *Kybernetes* provided a core of concepts with pointers to related research of relevance. For the domain of sustainability, the journals of *Ecology and Society*, *Futures*, *Ecosystems* and *Ecological Complexity* opened up the network of authors with associations and connections to researchers in the systems sciences. Electronic alternatives to printed books were preferred, when available. Web pages, web videos and weblogs were included, as easier-to-access resources, keeping in mind that many (if not most) students would be speaking, reading and writing in English as a second language. The references were organized in electronic form using Zotero, and published as web pages at http://coevolving.com/aalto , including web links and DOI (Digital Object Identifier) redirection addresses when available.

The reference list was intended neither to be exhaustive, nor a mandatory list to be covered by the instructors and/or the students. The two systems thinking courses are compulsory in the Creative Sustainability program, as foundational. The breakdown of alternative degrees with course distribution credits for the year 2011-2012 is shown in Table 1.

Table 1: Structure of the Master's Degree Programme in Creative Sustainability (Laurila (2011))

MA (Design) MSc (Business, Arch. or Real Estate)	Compulsory Joint Studies / ECTS	Compulsory studies at own school / ECTS	Elective sustainability studies / ECTS	Optional studies or Minor studies / ECTS	Master Thesis / ECTS
TAIK / Design	10	32	18	20	40
ECON / Economics	6	48	12	24	30
ENG / Arch. Building Design	10	50	30	-	30
ENG / Arch. Urban Planning and Design	10	50	30	-	30
ENG / Real Estate	10	40	20	20	30

To qualify for a Master's in Creative Sustainability, students must complete 120 ECTS credits in total, with each home school varying in required numbers of compulsory CS joint studies, compulsory studies at the home school, elective sustainability studies, optional studies, and the master's thesis. The two ECTS credits in each of the systems thinking courses are included in the required 6 to 10 ECTS credits compulsory joint studies offered by the CS program. These compulsory joint studies courses are added to the compulsory studies each student's home school. Thus, for an M.A. in Design, students should complete compulsory studies of 32 ECTS credits from the legacy TAIK; for an M.Sc. in Business, students should complete compulsory studies of 48 ECTS credits from the legacy HSE; for an M.Sc. in Engineering (either in architectural building design or in urban planning and design), students should complete compulsory studies of 50 ECTS credits (from the heritage TKK); and for an M.Sc. in Real Estate, students should complete compulsory studies of 40 ECTS credits (from the heritage TKK) (Laurila 2011). From the broad and deep list of systems references, the frame would be for students to each draw upon the readings and content most relevant to their disciplines, while retaining an appreciation for the systems sciences as a bridge to other disciplines and interests.

2.4 Reflection: In the adaptive phase of passive capital and low connectedness, the opportunity for reorganization of systems content presented itself

The structure of this new master's degree program is not unlike the structure of the systems movement. While some would like the systems sciences to become a unified discipline, the systems movement was founded as a multidisciplinary ecology of knowledge. The founders of the Society for General Systems Research – the original name for the current International Society for the Systems Sciences – were a diverse group of researchers seeking isomorphies: Ludwig von Bertalanffy (from biology), Ralph Gerald (from neurophysiology), Anatol Rapoport (from mathematical psychology), James Grier Miller (from clinical psychology) and Kenneth Boulding (from economics) (Hammond 2003). The Creative Sustainability programme is available to graduate students seeking a Master of Arts degree in design, or a Master of Science degree in business, architecture or real estate. Systems thinking is embedded within the legacy of development in the bodies of knowledge for design, business, architecture and real estate. The choice of paths for these new compulsory systems thinking courses were (i) to anchor on the legacy of systems theory that has become embedded in the disciplines and applications of contemporary practice, or (ii) to set a new milestone at the current level of systems theory onto which the Creative Sustainability program might find new linkages.

On the first path, the advantage of following the legacy of systems theory is a strong body of methods and frameworks that have proven successful for practitioners with continuous improvement and refinement over decades. Thus, techniques such as Soft Systems Methodology (Checkland and Poulter 2010), Idealized Design (Ackoff 2001) and frameworks such as the Viable Systems Model (Beer 1984) and Living Systems Theory (Miller 1978) are well known to systemicists and have been applied in varied circumstances.

There are downsides associated with following the legacy of systems theory.

Firstly is the challenge of incomplete assimilation of contemporary research. Many of the experiences, methods and techniques have roots in research conducted the 1970s, further refined into the 1980s, gradually becoming embedded into disciplines. As one example in the field of management, research from the Tavistock Institute for Human Relations such as studies on longwall coal mining (Trist and Bamforth 1951) would have been on standard master's level reading lists in the 1960s and 1970s, discussed in master's level organizational behaviour courses in the 1980s, and has since become a foundational concept in the discipline of organization science with the ties to systems science lost.

A second challenge is that disciplinary knowledge further tends to reduce to subdisciplinary schools so that the more dialectical forms of inquiry (i.e. Hegelian and Singerian inquiring systems, (Mitroff and Linstone 1993; Churchman 1971)) become uncommon forms of engagement. As an example within the field of management, a shared appreciation of the systems sciences with mutual respect for differing perspectives was reflected in exchanges such as Stafford Beer poking fun at "suicidal rabbits" while enjoying "the friendship of Russell Ackoff for over 30 years" with "a proneness to disagree about almost everything" (Beer 1990). As an example from landscape architecture in dialogue with ecosystem ecology, John T. Lyle developed his ideas on land use based on research by Howard T. Odum and Gregory Bateson (Lyle 1996). With many of the original systems sciences luminaries having passed away in the 1990s and 2000s, the interdisciplinary exchanges founded on a common interest in a general theory of systems has been silenced.

A third challenge in blindly following the legacy of systems theory is a question as to contemporary relevance. The systems movement was formed in a post-war 1950-1960s era first generation of researchers (e.g. James Grier Miller, Kenneth Boulding, Anatol Rapoport, Ralph Gerard). A second generation of 1970s-1980s researchers (e.g. Stafford Beer, Heinz von Foerster, Robert Rosen, Peter Checkland, C. West Churchman, Russell Ackoff) would have seen the rise of color television, jet travel and mainframe computers. These progenitors may have dreamed about the post-industrial world after the millennial year 2000, but would not have had sufficient experience to incorporate this knowledge into their legacies. The practices adopted by today's generation – at the cohort of great-grandchildren or later! – with technologies such as the Internet, mobile telephony and social media would be problematic for the elder to assimilate. In concert with current day concerns on climate change and globalization, advances in fields such as ecology and service systems present opportunities for further advances in knowledge through the systems sciences.

The new master's programme in Creative Sustainability presented an opportunity for a fresh start. The current state of the systems movement can be considered in the frame of the adaptive cycle of dynamic hierarchy (Holling 2001), placed in one of four phases: growth (r), conservation (K), release (Ω), or reorganization (α). This frame leads to three properties by which the current state can be analyzed: potential (as passive wealth or active capital); connectedness (as weak or strong controllability), and adaptive capacity, as low or high resilience.

> Potential, or wealth, sets limits for what is possible – it determines the number of alternative options for the future. Connectedness, or controllability, determines the degree to which a system can control its own destiny, as distinct from being caught by the whims of external variability. Resilience, as achieved by adaptive capacity, determines how vulnerable the system is to unexpected disturbances and surprises that can exceed or break that control (Holling 2001, 394).

The capital of systems theory – as knowledge that might be deployed in situational applications -- is currently more passive in disciplinary foundations than active in interdisciplinary integration. The connectedness of systems theory – in setting its own destiny as compared to following the direction of other interests – reflects low controllability with a variety of schools each claiming and branding distinct positions. The combination of high potential and low connectedness currently positions systems theory in an adaptive capacity of low resilience, beyond the release (Ω) phase and prime for reorganization (α).

On the second path for the systems thinking courses, the Creative Sustainability programme itself could be described as in a reorganization (α) phase, as a new master's degree in a newly merged university. Taking the opportunity for change and renewal, the systems courses could serve as opportunity to "remember" the prior foundations in systems theory as a cross-scale interaction, drawing on "the accumulated wisdom and experiences of maturity" (Holling 2001, 398). This path would lead to an approach based on depth across the domain of systems sciences, rather than depth in just a few frameworks and techniques.

Thus, to position for future growth for the systems sciences, the second path of setting a new milestone for the systems movement was taken.

3. DESIGN: TWO INTENSIVE COURSES WERE CONSTRUCTED TO MINIMUM CRITICAL SPECIFICATIONS

With only the two lists of proposed references as an outline, the instruction team met face-to-face for the first time on September 29, 2010, two days before the first lecture was to be convened. About 24 students had signed up for the course. In that meeting, three major design decisions were made. The mixing of lecture with group exercises to facilitate sensemaking amongst students is described in subsection 3.1. To guide the content, the courseware would be released on a publicly accessible website, and continually updated, as outlined in subsection 3.2. Continuing with the theme of open collaboration, students would be encouraged to post reflections and final reports on publicly accessible websites, linked to an activity stream in an open systems community web site, detailed in subsection 3.3. In reflection, this minimal critical specification approach to course development was consistent with the spirit of joint action learning, following conditions appropriate for contextural action research, as described in subsection 3.4.

3.1 On three lecture days over two weeks, content orientation was interspersed with group exercises to facilitate sensemaking

With each course scheduled as three days, the limits of human attention led to structuring the proposed reference lists into six clusters, roughly one cluster for each morning and afternoon. As an overview course, students were not expected to have read articles before coming to class, as the relevance of the content to their interests would yet emerge. Since the body of knowledge on systems thinking is so wide and deep, the reading of the complete list of reading lectures by any individual student within the course period was impractical. As a guide to the literature, lectures included time slots to walk the group through highlights and backgrounds on the topics and authors in the reference list. With these highlights in mind, students could then be encouraged to quickly read the electronic version of articles to get a sense of their personal relevance and resonance, and then choose to either read more deeply or to move on to another topic and/or source. Since the probability that any two students would choose exactly the same list of references was low, bringing students together – both in person, and electronically – would aid learning by the group covering and sharing more content than could be covered independently.

In the October 2010 CS0004 session, the master's students did not have equal facility with accessing journal articles electronically in the TAIK/Aalto library transition, thus requiring some rudimentary coaching during the course period. By the February 2011 CS0005 course, students had become sufficiently familiar with the instructional style that some took the initiative in advance of the class meeting to recommended web video clips.

Peer-to-peer sensemaking was encouraged through the formulation of dialectics – sometimes dilemmas – in the style of a Singerian inquiring system (i.e. a multiple perspectives variant of a Hegelian dialectic (Mitroff and Linstone 1993; Churchman 1971)). In the October 2010 CS0004 session, students self-organized into cells of 2 to 3 people, with each cell then placed in opposition to another cell in a dialectic group. Each cell was initially asked to preparation a position, independent of the other opposing cell. As an example, one cell took a position of endorsing "organic farming", while the opposing cell endorsed "locavore agriculture" (colloquially known as the 100-mile diet). In another example, one cell endorsed a position of "urban densification", while the opposing cell endorsed "back to the land". After meeting three times in cells to refine their positions – based on concepts learned in the lectures – the dialectic groups came together to discuss their positions. The engagement from that first joint dialectic group meeting was – as expected – inductive-consensual (i.e. an inquiry resulting the "first way of knowing"), with students thinking that a systemic answer was "both" positions. Student were then debriefed of the practical infeasibility of "both" solutions. In the northern soils of Finland, either organic farming OR locavore agriculture might be possible, but the requirement of both would likely drive food prices so high as to result in a system collapse. Political and economic policies could either encourage people to move to the city for urban densification, OR to rural areas as a "back to the land" movement, but funding both would likely be unsustainable as well as incoherent. Based on this correction, the students then met once again as separate cells, and then as a combined dialectic group to complete the exercise in seeking new creative solutions.

In the February 2011 CS0005 session, an attempt was made to couple the dialectical approach with concurrent studies, as about half of the students were enrolled in an Sustainable Urban Design course. From the perspective of maintaining integrity in the inquiring system, this coordination was not successful in effectively constructing a creative context. Since CS0005 is an intensive course with a lecture period over two weeks, and the Sustainable Urban Design course is a regular course spanning an entire term, the quality of cell and dialectic group discussions was hampered by timing (i.e. CS0005 came before the data collection activities in the other course) and topicality (i.e. students not taking the concurrent course had to unduly rely on their peers to bring them up to speed). In the larger context of learning, beyond the CS0005 course period, some aspects of the dialectic approach were evident in the final works of the Sustainable Urban Design course presentations at the end of spring term.

The orientation taken in CS0004 and CS0005 to cover a breadth of systems thinking content is in contrast to other programs that emphasize artifacts and techniques to a greater extent. The choices are (i) to learn a little bit about a variety of perspectives (e.g. ranging from inquiring systems to ecological resilience), or (ii) learn a lot about a specific technique that might be employed within a specific context (e.g. Soft Systems Methodology or Interactive Planning). For the needs of the Creative Sustainability program, the direction was taken to encourage systems thinkers with an exposure to the system sciences, without necessarily creating systems scientists. Authenticating true systems thinkers can be a challenge, as many who espouse to be systems thinkers quickly reveal a reductive orientation counter to the expansive spirit. Systems thinking is largely exhibited through an recognition of expansionism, where synthesis precedes analysis.

> In the systems approach, there are … three steps:
>
> 1. Identify a containing whole (system) of which the thing to be explained is a part.
> 2. Explain the behavior or properties of the containing whole
> 3. Then explain the behavior or properties of the thing to be explained in terms of its *role(s)* or *function(s)* within it containing whole.
>
> Note that in this sequence, synthesis precedes analysis (Ackoff 1981, 16).

This definition of systems thinking was explicitly given at the beginning of CS0004, and then reiterated in CS0005. In the time between the fall and spring sessions, the students (or co-instructors) grew to appreciate the containing systems (i.e. supersystem contexts) in which systems of interest are discussed, rather than just the subsystems conceptually defined within the system. While students were exposed to a large body of literature in the systems sciences, the implicit principle objective within the two courses was to develop the intuition that systems thinker innately share. Successful education should eventually lead to reflective practitioners prepared to select and apply systems frameworks and techniques guided by their intuitive appreciation of conditions, rather than slavishly adhering to methods as in following a cookbook.

3.2 All lecture content was provided as open courseware, with the caution that materials would continually evolve during the course sessions

Lectures were designed specifically for in-person delivery, assuming full attention by 20 to 30 master's level students. The principal lecture artifacts were made available as public web pages of text and diagrams. Paperless delivery enabled continuous updating of the course content, with students advised to be on alert to check revision dates. For expediency, the lecture materials were hosted on the personal web site of the lecturer at http://coevolving.com/aalto under a Creative Commons license, obviating questions and bureaucracy that might arise from hosting on an institutional web site.

Text web pages were written in as XHTML with the Amaya editor (World Wide Web Consortium (W3C) 2010) to ensure formatting consistent with browsers complying to standards. For simplicity, the text XHTML files were uploaded directly on the web site, rather than being managed through a Content Management System.

Diagrams were also uploaded as web pages. As an alternative to slides presented sequentially (e.g. Powerpoint), the flow of each lecture generally followed a concept map constructed using open source Visual Understanding Environment (VUE) software (Tufts University 2008). VUE was selected due to its features enabling network diagrams (c.f. hierarchical tree structures as in Freemind), cross-platform portability (i.e. Windows, Mac, Linux) and adherence to web standards (i.e. generation of XHTML and SVG). Bitmap graphics were embedded in the VUE diagrams in either PNG or JPEG format.

With the responsibility for course content resting on only of the three instructors, the text web pages and diagrams were delivered under single author control rather than as evolving collaborative revisions. All of the original source files have been retained on the web site as at the end of the lecture sessions, for revision and adaptation in subsequent courses.

Lectures were delivered in a classroom with a large screen projector with network access to the Internet so that students could follow along with the text and diagrams. The lecture talk was semi-structured to correspond with the content posted on the Internet, with digressions and explanations occurring extemporaneously. The context maps served as a visual aid and navigational device to aid students in identifying and retaining key concepts and points. Lecture content was revised up to the date preceding the lecture.

3.3 Open collaboration was encouraged for students blogging in public, with pointers noted on the activity stream on a public social media site

Following the spirit of open collaboration using social media, students were each encouraged to independently maintain learning logs on their reflections on readings selected from the reference list, as public weblogs. The lecturer set a strong professional example with his personal blog that includes academic references, saying that assignments handed in to be read only by a grader was wasted social capital. On a quick poll within the class, practically none of the students had previously written a blog, while almost all were active on Facebook. Students were asked to create a blog on a shared public platform is free (e.g. Wordpress.com is free, and has an active support

community), as an alternative to the registration procedures on the university-provided system. Students needed help with information technologies were directed to refer to peers within their cells or groups with greater proficiency.

Students were also asked to create a persona on Systems Community of Inquiry web site at http://syscoi.com. For each day, the lecturer created a thread onto which students could leave comments. Upon completing a post on his or her personal blog, each student would then place a status update on this hub web site. These update accumulated as a series of notifications time-stamped in sequence. The instructor responded to linked blog posts on the hub web site, and also referred contemporary researchers in the systems community internationally to weigh in with comments.

Most of the students wrote reflections on their weblogs between lectures, providing the opportunity for general trends and themes to be discussed at the beginning of the second and third meetings. With some of the readings more challenging than others, student could be assured about whether their interpretations were in the right direction, and/or other sources might be better for their interests. After the completion of lectures, students had the option to blog interim versions of their culminating essays, with the alternatives of publishing the completed work in public on their web sites, or handing them in to the instructors in the more traditional way.

3.4 Theoretical reflection: Instructors and students collaborated on joint action learning in a contextural style, where the relevance of schools of systems thinking was balanced with students' backgrounds and interests

These systems thinking courses, and the Creative Sustainability programme itself, can be placed with the larger context of education policies for building the Finnish education system in place since the 1980s:

> *Flexible and loose standards*: Building on existing good practices and innovations in school-based curriculum development, setting of learning targets and networking through steering by information and support.
>
> *Broad learning combined with creativity*: Teaching and learning focus on deep and broad learning giving equal value to all aspects of an individual's growth of personality, moral, creativity, knowledge and skills.
>
> *Intelligent accountability with trust-based professionalism*: Adoption of intelligent accountability policies and gradual building of a culture of trust within the education system that values teachers' and headmasters' professionalism in judging what is best for students and in reporting their learning progress. (Sahlberg 2007, 152)

The policies can be seen as counter to typical global education reform trends: (i) flexible and loose standards, rather than *standardization*, as setting clear, high, and centrally prescribed performance standards for schools, teachers and students to improve the quality of outcomes; (ii) broad learning combined with creativity, rather than a *focus on literacy and numeracy*, as basic knowledge in skills in reading, writing, mathematics and natural sciences as prime targets of education reform; and (iii) intelligent accountability with trust-based professionalism, rather than *consequential accountability*, as school

performance and raising student achievement closely tied to the processes of promotion, inspection, and ultimately reward or punishing schools and teachers based on accountability measures, especially with standardized testing as the main criteria for success (Sahlberg 2007, 152). Towards the design of new courses on systems thinking, this embedded context supported innovation in the educational approach.

In reflection, the first offerings of the two courses presented the problematique of educating students on the orientation and usefulness of systems thinking relevant to the Creative Sustainability programme. With the contemporary body of research in system sciences calling for a refresh of the literature and the specifics of the new master's programme continuing to evolve, the problematique could be framed as an action learning challenge: what to study, and how the content should be approached was negotiable. Action learning would proceed on two horizons: (i) collaborative learning on finding appropriate and productive uses of the allotted course time and resources, by course instructors and students collectively; and (ii) experiential learning to develop competences for potential future action learning activities through the disclosing of ignorances (Ing, Takala, and Simmonds 2003).

In these courses, the learners included both the Creative Sustainability students and instructors assigned to lead the course. Action learning is related to, but different from action research.

> Because action learning can be regarded as a natural extension of action research, comparisons between the two are useful. The basic characteristic common to both is the focus on collaboration between the "outsider" (researcher, consultant, scientist, facilitator, advocate, etc.) and the "insider" (participant, stakeholder, practitioner). A critical difference between action research and action learning in relation to insider/outsider relations is reflected in their titles.
>
> In applications of action *research*, the distinction between the output of the insiders (action) and that of the outsiders (research remains clear and strong. The goals of social science and the professional responsibility are important and must be addressed.
>
> In action-*learning* settings, the output is an integrated one – mutual learning on the part of insiders and outsiders. [….]
>
> In action research, the expertise of the outsider remains as a critical determining force. In action learning, there is an explicit recognition of the distinctive and different experiences, knowledge and skills that are possessed by insiders and outsiders (Morley 1989, 180).

The systems thinking courses followed four principles of holographic design: (i) redundancy of functions, (ii) requisite variety, (iii) minimal critical specification, and (iv) learning to learn (Morgan 1986).

Redundancy of functions was evident in having three instructors co-lead the systems thinking courses.

> Australian systems theorist Fred Emery has suggested that there are two methods for designing redundancy in a system. The first involves redundancy of parts, where each part is is precisely designed to perform a specific function, special parts are added to the systems for the purpose of control and to back up or replace operating parts wherever they fail. […]
>
> The second design method incorporates a redundancy of functions. Instead of spare parts being added to a system, extra functions are added to each of the operating parts, so that each part is able to engage in a range of functions rather than just perform a single specialized activity (Morgan 1986, 98-99).

While systems thinking courses might have delivered by any one of the three instructors, the combination of their experiences resulted in a richer education condition that any one could have produced independently.

Requisite variety was supported in covering a broad range of topics in systems thinking, allowing students to find they own way.

> … *requisite variety* … suggests that the internal diversity of any self-regulating system must match the variety and complexity of its environment if it is to deal with the challenges of that environment. [… All] of the elements of an organization should embody critical dimension of the environment with which they have to deal, so that they can self-organize to cope with the demands they are likely to face (Morgan 1986, 100).

As emerging future roles in sustainable design and business endeavours are yet to be established, students pursuing the variety of degrees pursued in the Creative Sustainability program benefited by breadth that could be deepened as needed.

Minimal critical specification was preserved in consciously not overplanning the course.

> The principle of critical minimum specification suggests that managers and organizational designers should primarily adopt a facilitating or orchestrating role, creating "enabling conditions" that allow a system to find its own form. [….] The principle of minimum critical specification attempts to preserve flexibility by suggesting that, in general, one should specify no more than is absolutely necessary for a particular activity to occur (Morgan 1986, 101).

Gaining comfort with the ambiguous was one of the implicit features of participating in these systems thinking courses. The learning emerged for each student, as each individually made sense of concepts for his or her own application.

Learning to learn about systems thinking was a journey of uncovering ignorances.

> … a system's capacity for coherent self-regulation and control depends on its ability to engage in processes of single- and double-loop learning. These allow a system to guide itself with reference to a set of coherent values or norms, while questioning whether these norms provide an appropriate basis of guiding behavior (Morgan 1986, 102).

Early in CS0004, the design of inquiring systems – particularly on topics of dialectic and multiple perspectives – were explained in a lecture. A short while later, as cells came together into groups, the mental trap of inductive-consensual behaviour became a poignant lesson.

As a post-evaluation of the practice of action learning, six components -- as four inputs, a process, and an output – have been described as an ethical standard (Johnson 2010):

(1) Bedrock in an epistemology founded by Rev Revans;

(2) Nature of the inquiry as (i) important to participants, (ii) centered on a problem, issues change or opportunity, (iii) relevant, and (iv) studied as a system from an inside viewpoint;

(3) Role of the facilitator, as (i) starting in a *hierarchical* mode of directing, leading from the front, structuring; (ii) moving through a *co-operative* mode of sharing power over the learning process, enabling and guiding the group to be self-directing; (iii) aiming for an *autonomous* mode, giving the group freedom to find their own way;

(4) Group characteristics as (i) about 6 to 8 participants in the rhythm of the workplace, (ii) action on real tasks or problems, (iii) induction into expectations allowing participants to deselect themselves, (iv) voluntary participation, egalitarian participation, and (v) privileged information during a meeting remaining private;

(5) Process with fecundity as a confluence of (i) questioning insight, (ii) critical thinking, and (iii) dialogue; and

(6) Outcome of the action learning programme that includes (i) self-development of individual participants, (ii) an amelioration or improved situation, and (iii) learning as demonstrated.

From the breadth of reference materials brought to the course, one student commented that she hadn't anticipated covering the complete domain of systems thinking in three days. This led to the lecturer's remark that the time frame was actually six days(!), over two courses, and that the goal was to expose students to the breadth of knowledge in systems thinking, resulting in an appreciation that could be deepened according to each individual's needs and interests.

On (1) bedrock epistemology, the origins of action learning comes from the study of managers in the British coalmining industry in the 1940s by Reg Revans and Eric Trist. As an alternative to lecturers and "experts without responsibility for running a real pit sent out from headquarters to tell the real managers how to solve their problems", managers and workers on the ground met at local sites, discussed what they saw, and made suggestions as to what might be tried out before a next meeting.

> Action learning differs from normal training (education, development) in that its primary objective is to learn how to ask questions in conditions of risk, rather than to find the answers to questions that have been precisely defined by others – and that do

> not allow of ambiguous responses because the examiners have all the approved answers (Revans 1982, 65).

Since students, as well as members of the instructional team, have not previously had the benefit of education in systems thinking, they did not know what they did not know. The circumstances of the course could be described as turbulent (Emery and Trist 1965) both within the university and towards the larger world challenges towards which the Creative Sustainability programme aspires to contribute.

On (2) nature of the inquiry, all participants in the systems thinking courses had already become insiders to the challenges of Creative Sustainability by joining the programme. As a new multidisciplinary program, the value of systems thinking would be to bring together a variety of domains into contextural approach.

> The word contexture means the weaving together of parts into a whole. A contextural approach implies an awareness that the phenomena under study are determined by the relationships and interactions of the several systems of which they are composed. As such, their behaviour cannot be understood, anticipated, or changed by dealing with isolated fragments. Also, each problem or issue is viewed as a dynamic entity with its own individual history including a genesis, an evolutionary path, and a contemporary context. The essence of contexturalism is the deliberate interconnecting or weaving of parts within complex systems undergoing change. (Franklin 1998, 9)

The function of the systems thinking course is not to duplicate the body of knowledge in each of the core fields of study in architecture, business, design, landscape planning, real estate and urban planning. Its function is to increase the understanding across the disciplines and enable holistic approaches.

On (3) role(s) of the facilitator(s), three instructors co-led the two systems courses, with responsibilities including (i) course content development and delivery, (ii) course administration and evaluation, and (iii) course coordination with other Creative Sustainability courses and Aalto University programs at large. The style was participative and organic, both amongst the three instructors and with students enrolled in the class. Some decisions on course management (e.g. deadlines for the culminating essays, time slots for group work, scheduling of an optional lecture in CS0005) were worked out as a group in the moment. Students were allowed to gravitate towards natural interests in particular topics or authors in the systems research, leading to independent and unique personal perspectives on what systems thinking means for each of them.

On (4) group characteristics, students self-organized into cells of two to three, that were then paired into dialectic groups adding up to about 6 people. Students generally sought out guidance when they became puzzled, and interpersonal conflict was not evident. The group activities seemed to have been successful on a list of seven qualities for learning: (i) being democratic and heterarchical; (ii) being pluralistic; (iii) being proactive and empowering; (iv) linking individual and social transformation; (v) striving to integrate different kinds and levels of understanding; (vi) striving to create conditions that are always evolving and open-ended; and (vi) striving to demonstrate its worth in terms of the capacities it creates for intelligent action rather than terms of its contribution to

formal knowledge (Morgan and Ramirez 1984, 17-22). While the instructors provided the context for learning, much of the sensemaking about concepts and ideas were worked out by students with their peers.

On (5) process, course interactions were conducted as dialogic conversations, both in face-to-face lectures and through social media over the Internet. The principle of minimal critical specification was followed.

> [It] is important that there be no more predesign of the process than is absolutely necessary for learning to occur. The more that one designs the process in advance, the less opportunity for self-organization according to the insights which emerge. [….] Those organizing or facilitating the action-learning process should strive to create "enabling conditions" in terms of appropriate resources and inputs, and provide help and guidance for the action-learning group to design its own future. Ideally, the aim of the organizer or facilitator should be to make his or her role obsolete, by helping to develop appropriate skills, knowledge, and functions *within* the members of the learning community (Morgan and Ramirez 1984, 16-17).

The predesign of the two courses was minimal, with (i) the dates set in advance according to normal university procedures, (ii) the content selected and refined during the lecture weeks, (iii) loosely coupled technology support in public web sites. The writings on public weblogs by the 2010-2011 cohort of students adds to the body of knowledge on which future students and instructors can draw.

The combination of verbal exchanges during classroom time and written exchanges between meetings in-classroom probing and online encouraged questioning insight, i.e. the realization by individuals that solutions might be unknown, but through which learning might be gained by asking fresh questions unburdened by assumptions and old ways of thinking.

Questioning insight – learning through asking fresh questions unburdened by assumptions and old ways of thinking – occurred through the combination of verbal exchanges during classroom time and written exchanges online between meetings. Critical thinking skills were developed not only through dialogic exchanges tying together complementary ideas and authors in systems thinking, but also in dialectical inquiry in the positioning of cells of 2 to 3 students paired in opposition to another in a group. Dialogue, towards establishing an implicit appreciation of the systems of interests, naturally came in instructor-student engagements, with richer opportunities in the student-to-student peer discussions during group activity periods.

On (6) outcomes from an action learning programme, all participants seemed satisfied that the time spent on the systems thinking courses was worthwhile. Self-development of the students was evident by the systems vocabulary and appropriate use of concepts written in the blogs. Further, self-development of the instructors was demonstrated with an expanded knowledge set as students swept in additional readings and applied personal experiences.

Signs of an improved situation and of learning as demonstrated were observed in the immediate context, and would require longitudinal tracking to validate in the larger context. The immediate context by the end of the spring 2011 term included a baseline of artifacts and experiences on a new pair of systems thinking courses that may be critically evaluated and evolved for improvement. Students have an appreciation for concepts that they know they did not know before engaging in the courses. In the larger context, the integration of a systems thinking approach into the Creative Sustainability programme at large, and demonstrations of learning by students in other course work are points that could be assessed at a later date.

4. SUSTAINABLE COMMUNITIES EMPHASIS: THE OCTOBER 2010 SECTION ORIENTED TOWARDS LEARNING IN AN ERA OF POSTNORMAL SCIENCE AND DIALOGUE

With the Creative Sustainability programme requiring two courses on systems thinking, the October 2010 section on Systemic Thinking of Sustainable Communities was oriented toward emphasizing the engagement and enablement of voices by those directly impacting and/or indirectly influencing changes in a system design.

The body of content for the October 2010 session of CS0004 is listed at a high level in subsection 4.1. Further details are readily accessible for the interested reader at http://coevolving.com/aalto/201010-cs0004/.

Lessons gained during the course period are described in subsection 4.2. The orientation towards designing engagements or designing coversations proved to be more challenging than originally expected.

4.1 Body of content: The course on *Systemic Thinking for Sustainable Communities* emphasized designing community engagement for mutual appreciation of ways that social and ecological systems might establish resilience

The success of a community pursuing sustainability rests with the ability of its constituents (re-)design future systems while having their points of views acknowledged, their interests expressed (either directly or via representatives) and their voices heard. In democratic forms of governance, the "wisdom of crowds" can prevail over "experts" who espouse superior credentials and specialized knowledge. Dilemmas, problematiques (i.e. systems of problems, also know as messes) and wicked problems are likely to be encountered. For this challenge, Creative Sustainability students can be educated on ways in which systems thinking can guide better futures. The course content was bundled into six clusters, described below.

4.1.1 Cluster 1: Foundations for a systems approach -- *How is a systems approach different?*

To satisfy initial questions on "what is a system?" and what is systems thinking?", definitions by Russell Ackoff and Jamshid Gharajedaghi were provided – not necessarily as the best or complete descriptions, but as accessible and useful references. To draw

attention to the (co)evolution of systems over time, the shearing layers (pacing layers) description by Stewart Brand was easily digestible in its depiction of a building, and well complemented by a BBC series now accessible for viewing over the Internet.

4.1.2 Cluster 2: Boundary, inquiry, perspectives -- *How do we ensure that we have appropriate levels of community engagement and participation?*
The definition of system boundaries was subtlety drawn into the human perspective, with the introduction of boundary judgements described by Werner Ulrich. The issue of "how do people know?" was framed in a discussion on the design of inquiring systems, combining the writings of Ian Mitroff and Harold Linstone with the original philosophy of West Churchman. To assist students dealing with the conceptual through concrete levels of thinking, the abstraction ladder of S. I. Hayakawa was included.

4.1.3 Cluster 3: Learning categories, postnormal science, ignorance -- *How do we understand and approach ecologies (both natural and social)?*
Learning, as a systems concept, was clarified by the five logical categories developed by Gregory Bateson. The challenge of having to make decisions in absence of established mainstream science led to the post-normal approach prescribed by Jerome Ravetz. To appreciate the limits of human knowledge, the ignorance map introduced in the health sciences curriculum by Witte, Kerwin and Witte was reviewed.

4.1.4 Cluster 4: Dialogue, engagement, intervention -- *What approaches can we use for community engagement?*
The distinctions between strategic dialogue and generative dialogue made by Bela H. Banathy was surfaced through a summary by Gary Metcalf, and framed as a component of evolutionary systems design by Doug Walton. The bond between human beings through commitments was explained in the language action perspective developed by Terry Winograd and Fernando Flores. In considering the impacts of redesigning or changing a system, the critical review mode for Total Systems Intervention outlined by Jennifer Wilby presented a step by step guide for (re-)considering action.

Since students in October 2010 were particularly challenged with this content cluster, an addendum lecture was offered as an optional module in Feburary 2011 (extending a full instructional day by another 90 minutes). In addition to the conversations for action in the language action perspective, three other types of conversation (for clarification, for possibilities, and for orientation) were surfaced. A map of types of dialogue by William Isaacs supplemented the idea of design as multidimensional inquiry by Bela H. Banathy. The six conversation types used in civic engagement by Peter Block were described. Finally, to help students organize their positions in their group work, the seven elements of negotiation developed in the Harvard Negotiation Project cited Fisher, Ury and Patton.

4.1.5 Cluster 5: Ecosystems, collapse, resilience -- *How can we appreciate resilience, as an alternative to the possibility of a system collapse?*
To preempt debates on "what is sustainability?", the alternative state of collapse was presented through Joseph Tainter's history on complex societies. The research on resilience, panarchy and the adaptive loop from ecologist C.S. Holling led to thinking about whether maintaining an unsustainable system would be productive, with

reorganization as a more reasonable future. The influence of the panarchy research on the polycentric approaches to governance by Elinor Ostrom received credibility with referrals to watch her speech at acceptance of the Nobel Prize in economics.

In the October 2010 session of CS2010, the science of supply-side sustainability by Allen, Tainter and Hoekstra was explained. With the benefit of hindsight, this content is better aligned with the orientation in CS0005, and should be excluded from future CS0004 lists. The research by John T. Lyle on regenerative design would better fit with panarchy research, and general orientation towards sustainable communities.

4.1.6 Cluster 6: System design frameworks -- *How will we know when we've been successful?*
Rounding out the course, the 20 critical subsystems of a Living System developed by James Grier Miller was outlined. With an eye towards future system designs, the model of anticipatory systems by Robert Rosen was excerpted from articles by Judith Rosen and John Kineman. The Viable Systems Model by Stafford Beer was supplemented by an article by Allenna Leonard, making ties to sustainability practices.

4.2 Learning journey: While systems thinking foundations were readily adopted by students, the emphasis towards designing engagements or designing conversations proved challenging for action-biased individuals

With each of these six clusters of references packing potentially as much content as a single a master's level course might, students were warned and then reminded that they might feel a sense of uneasiness with the breadth and depth. As an attribute of becoming a systems thinker, however, dealing with such ambiguity can be seen as part of the learning experience. Understanding one system – or even a perspective on a system – calls for appreciation of the distinctions between precision and detail. Systems can be described with high precision and low detail. Human mental processing limitations may require a shift of the lens or reorientation to a system defined in a different way.

The content in the six clusters of the October 2010 session of CS0004 should be noted for topics and authors that were explicitly excluded.

The focus on designing engagements and conversations based on a systems approach excluded the design of systems from other frames (e.g. systems with physical operations, or enterprises with narrowly-defined collective purposes). Those would be more appropriate for CS0005.

Despite the name of the course including the label "sustainable", human preferences for stability make *resilience* a sufficiently challenging goal. Attaining true sustainability would require reason to win over "common sense", and likely a reliance on science and method that would be brought by experts (e.g. planner and designers in roles aligned with CS0005).

In addition, conceptual appreciation the value(s) of social engagement were favoured over training in specific facilitation techniques. Future sessions of CS0004 may consider

adding, as an optional reference, a workbook on methods for systemic engagement that has been a focus of a group in Toronto (Design with Dialogue 2009).

In hindsight, the orientation of CS0004 oriented towards community engagement and dialogue was appropriate and productive. In practice, students generally learned the ideas, but had difficulty in applying the concepts to their group exercises. As an example, rather than considering the potential constituents who could contribute to a reflective design on locavore agriculture, students fell back on trying to (re-)design an agricultural system. Instead of focusing on the methods to design a conversation, they oriented towards designing land use. In future offerings of CS0004, more structure in the expected outcomes and artifacts could reduce this confusion. An unsavory alternative that would result in greater alignment would be to give student "fill in the blank" templates or study in depth only technique (as practical within the short time frames), as this would narrow perspectives and limit the development of intuition exhibited by systemically reflective practitioners.

5. PLANNERS AND DESIGNERS EMPHASIS: THE FEBRUARY 2011 SECTION ORIENTED TOWARDS METHOD FRAMEWORKS FOR REDESIGNING COMPLEX SOCIO-ECOLOGICAL SYSTEMS

The second course on system thinking was oriented towards professionals who might plan or design systems, coordinating or interacting with experts in sustainability. While these professionals might not have have depth in fields such as ecology, biology, sociology, or geography, the foundations of systems thinking could provide a context in which the disciplines can be bridged..

The February 2011 session of CS0005 followed the body of content as listed in subsection 5.1. Details are available at http://coevolving.com/aalto/201010-cs0005/.

Insights emerging from experiences in the course period are described in subsection 5.2. The prior experience of CS0004 reduced some of the stresses associated with mounting a new course.

5.1 Body of content: The course on *Systems Thinking for Planners and Designers* emphasized scientific foundations in methods, frameworks and techniques with which experts might facilitate sustainability

While the community interested in attaining sustainability might spontaneously self-organize, major initiatives that require resources typically look for expertise that will preclude "reinventing the wheel". Systems thinking can be found both explicitly and implicitly in methods, frameworks and techniques with varying levels of maturity. Creative Sustainability students can be educated on systemic approaches, and conditions under which one way might be more appropriate than others. In a pattern that parallels CS0004, the content for CS0005 was divided up into six clusters, described below.

The first meeting of CS0005 in February 2011 started with a "cluster 0" session, repeating the content of Cluster 1 from CS0004. For all but a few of the students (and instructors), this content was a repeat performance of the lecture delivered 4 months earlier. However, with additional context and the opportunity to digest the concepts in the intervening period, many questions of clarification emerged. The repetition of foundational vocabulary, concepts and definitions was a productive use of class time that should be repeated in future years.

5.1.1 Cluster 1: Method frameworks -- *As planners and designers, how should we go about designing a system of engagement?*
Planners and designers with knowledge of systems thinking are expected to be prepared to lead parties in activities resulting in productive outcomes. The emergence of the science of service systems – i.e. design in the next context of a service or post-industrial economy – was presented in a new context by the Institute for Manufacturing at the University of Cambridge and IBM. The programs and services reference model from the Government of Ontario (in Canada) has been identified as a world-leading framework for public sector institutions and agencies, so key concepts were reviewed as examples. In the delivery of professional services such as consulting, the Eclipse Foundation provides a framework and tools to specify collaborative efforts as work products, roles, tasks, processes and guidance. These references preceded group work to design a service system, with a first step of defining the target group(s) that would be served.

5.1.2 Cluster 2: Appreciating the current state-- *Before we suggest changing the world, we should first attempt to understand how it currently operates.*
Most interventions begin with the first step of understanding the current state of the system. The rich pictures describing the Soft Systems Methodology from Peter Checkland put the user in the centre of situation, appreciating a methodology that could be tailored into a specific approach. Following this lecture, students returned to their cells to follow high-level directions associated with SSM analyses, starting with the identification of roles in the problematique.

5.1.3 Cluster 3: Futures -- *Since human beings can plan, an alternative way of moving towards desirable futures is to start from more idealized positions to which we can aspire*
After the current state has been appreciated, potential future states are envisioned. Techniques of idealized design and interactive planning as the preferred posture developed by Russell Ackoff in the 1970s and 1980s were outlined. As an information age, circa-2000 alternative, the sense-and-respond organization of an adaptive enterprise as prescribed by Stephan Haeckel was described. In the group exercise that followed, students were given the opportunity to try out these approaches.

5.1.4 Cluster 4: Ecological complexity and gain -- *Can we design our futures?*
Between the current state and future state, questions of feasibility of future alternative designs are likely to arise. Principles of supply-side sustainability from Allen, Tainter and Hoekstra were presented. Models of average returns and marginal returns, and elaboration of structure horizontally to increase complicatedness versus elaboration of structure vertically to increase complexity were explained to students, with the caution that this science is difficult and might require years to full appreciate. The concept of

high gain and low gain in ecology by Allen, Allen, Malek, Flynn and Flynn was described as even more difficult, although worth the effort in the long run. Students returned to their groups to consider the sustainability of the future state designs they were developing.

5.1.5 Cluster 5: Social-ecological systems -- *Coming from the perspectives of ecologists (in social-ecological systems)*
Having now digested a significant body of content associated with systems thinking, students were led to definitions for sustainability and sustainable development by Gilberto Gallopin. While this reading might have been positioned earlier in class readings, sequencing it as late in the course allowed students to have a full appreciation of how systems foundations can lend clarity to thinking. Immersing students in the current (and possibly incomplete) research of contemporary ecologies, the socio-ecological systems perspective described by Carl Folke was connected to the prior work on panarchy and resilience.

5.1.6 Cluster 6: Coevolution and turbulence -- *In world of systems of systems, changes at multiple scales means coevolution*
With future state designs having taken feasibility into consideration, the potential influences of other systems in a coevolving world and conditions of turbulence were added. Positive interactions of mutualism, protocooperation and commensalisms were compared with mixed and negative interactions in an analysis in basic ecology by Eugene Odum. The four causal textures of placid random, placid clustered, disturbed reactive and turbulent from Fred Emery and Eric Trist were reviewed in a historical overview by Ramirez, Selsky and van der Heijden. Finally, in the most current research in economics, new research into coevolutionary ecological economics by Kallis and Norgaard was placed in the context of the "development betrayed" thesis by Richard Norgaard.

5.2 Learning journey: The distinctions between designing a system versus designing a service system emerged as a profound insight during the course

With the science of service systems a relatively new body of work, its positive impact on the learning in CS0005 was significant. Shifting the group work orientation from "(re-)designing a system" to "(re-)designing a service system" immediately drew students to speak more about stakeholders / beneficiaries / customers of a system, in contrast to typical systems discussions reductively focused on system internals. The question of who a system serves is powerful, and complementary to prescriptions of "synthesis before analysis" from Russell Ackoff.

Group work more directly tied to lecture content reduced confusion in student group work. The accumulated knowledge over two courses was impressive. Halfway through CS0005 the content lecturer congratulated students for having demonstrated sufficient comprehension and vocabulary to be ready to attend a systems science conference.

6. FUTURE PROSPECTS: COURSES IN FINLAND WILL INCREMENTALLY EVOLVE, WITH REPLICABILTY TO OTHER CONTEXTS AN OPEN QUESTION

Successfully completing one cycle of two courses in systems thinking for the Creative Sustainability program represents a milestone. Informal feedback on both courses was positive, and schedules to offerings for the second cohort of master's students immediately followed the conclusion of the February 2011 session.

6.1 Artifacts from the first cycle or courses are a foundation for continuing development

With a shared appreciation of the experiences from CS0004 and CS0005, the course leaders have a foundation on which improvements can be built. While the philosophy of action learning should be retained, small adjustments to lecture plans and student instructions should reduce student anxiety and frustration.

As of summer 2011, the original content leader has become unavailable due to increase in other responsibilities. A smooth handoff has been planned for a colleague with more experience in university education, with audio recordings of lectures and coaching to support the transition. While the style of lecturing may change, the basic staffing of the courses remain the same: the two course leaders from Aalto University will be joined by a visiting lecturer from North America.

6.2 Replicability of the courses in other contexts is an opportunity with challenges

With open courseware and student weblogs readily accessible on the public Internet to be applied by others, questions as to the probable success of replicating efforts in alternate or additional context arise. There are (at least) three conditions that would encourage or discourage similar or parallel courses: (1) the domain knowledge of the content instructional lead; (2) engagement style of students, and (3) institutional interest in sponsorship.

(1) The domain knowledge of systems thinking and systems science, at the level of the original content lead, may be possessed by only a small group of individuals in the world. For this 2010-2011 cycle, the domain knowledge was embedded in an individual with over 10 years of attendance in systems sciences conferences and leadership in executive roles in the systems community, complemented by systems practice in a progressive multinational business enterprise. By reviewing the artifacts from the 2010-2011 courses, candidates should be able to self-assess the completeness of their knowledge base, and the degree of effort to fill in or substitute content.

(2) The engagement style of master's students in Finland is mature and appreciative of science. Finnish students – whose first language is not English – were not intimidated by being assigned articles by contemporary researchers directly out of leading academic journals. While practically all students had never written on their own blogs, they did not grouse at learning to write commentary in an

academic style on public web sites. When tasked with expectations to help their peers who were less proficient with technology, students did not require undue attention or handholding by instructors.

(3) While educational institutions often espouse innovation, the sponsorship of multidisciplinary studies is a challenge in universities where organizational disciplines tend to reproduce their structures. The complicatedness of the Creative Sustainability programme, supported by five alternative MA and MSc degrees demonstrates a commitment that makes offering two systems thinking courses just a small detail.

While all three conditions could be negotiated over time, the experience in Finland was a successful confluence that emerged into coherence. This could prove to be a serendipitous occurrence that will be challenging to synthesize in other contexts.

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