On journey with system thinkers - Systems thinking in education and research, today and tomorrow

“Challenges for the future in an ICT context”

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ABSTRACT

This contribution describes and discusses how some approaches from Systems Thinking have been used in higher education in Informatics with the aim to broaden the course content and give the students a toolbox to use in the future. The courses have been offered at Mid Sweden University, Future use of Systems Thinking in higher education – both in traditional campus education and also in eLearning (distance courses where the communication is supported by some kind of ICT) - is discussed. Some ongoing research related to technical communication where Systems Thinking has been used, is presented and finally, the concept of critical information is related to Systems Thinking. The latter concept is a core concept for the research group in Informatics, Campus Östersund. This contribution is dedicated to Professor Stig C Holmberg, who has been the “architect” and source of inspiration due to his design and realization of courses in informatics.

Keywords: systems thinking, course development, higher education, critical information

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21) I will use the concept “Systems Thinking” throughout this chapter. Different Systems Approaches such as Soft Systems Methodology (Checkland, 1981), Viable Systems Model (Beer, 1972; 1974), and Reflection in Practice (Schön, 1983) is included in my use of the concept Systems Thinking.

38) One of the courses – Communication in learning organizations – is in collaboration with Blekinge Institute of Technology. The course was designed and manned with representatives from Informatics at Campus Östersund, Mid Sweden University.
1. INTRODUCTION

The theme for this booklet is “Challenges for the future in an ICT context”. This is a broad theme and it was also meant to be broad in our early discussions. Research within the Department of Informatics at Mid Sweden University, Campus Östersund, has recently been formed under the “umbrella” – Critical Information and the first discussions about this booklet concerned the idea to write about this theme from different angles. However, as this might have been a too narrow theme for participants/authors participating in the booklet, the theme was changed to be more “including”. I apply the theme on my experiences from higher education and the use of different Systems Thinking in different courses – mainly distance courses where students and teachers interact through ICT tools. Finally, the potential in Systems Thinking in research is exemplified.

1.1 The background

Systems approaches such as Team Syntegrity (Beer, 1994, Leonard, 2002) are used worldwide. Team Syntegrity for example, is a group process which facilitates team building, planning and innovation. The approach was developed by Stafford Beer and first introduced in his book “Beyond Dispute” in 1994. As much of Stafford Beer’s work, Team Syntegrity is characterized to be non-hierarchical in order to support and promote communication to be open and that synergy can be captured (Leonard, 2002). Conferences and groups are working with themes such as “Cybernetics of Crisis”, and “Syntegration”, in order to offer new ways of thinking about crisis and future transformation of organizations and societies. The approaches offers methods and tools for analyzing, diagnosing, understanding and redesigning as well as for communicating different kind of problematic situations.

I first got in touch with Systems Science or Systems Thinking in the beginning of the 1980s, when I read a description about a Systems Science program at the local university in Östersund. I was enrolled in the Systems Science program in January 1985. My first contact with Systems Science was an exercise in identifying J.R Miller’s 20 subsystems (Miller, 1991). The exercise aimed to apply Miller’s subsystem on a transatlantic liner. The identification of the subsystems supporting Material was not so difficult, but when the identification of information subsystems was in turn, it became more complicated. I had never thought about information in that way and a general knowledge about systems and organizations was necessary to solve the problem. Systems as hierarchies of subsystems – systems of systems – were also something totally new. It was a new way to look at and think about things.

It is not easy to introduce new students to Systems Science and the way of thinking this represents. As the semesters went on, we were introduced to some
more approaches and representatives belonging to different schools and directions. However, the fully potential was not understood until I became a Master student several years after the graduate education.

I finished my Bachelor of science on a Friday in January, 1988 and started to work as an assistant teacher on the following Monday. My introduction to become a teacher went smooth because during the first semester I only worked half-time, which meant that I had a lot of time to prepare the lessons, exercises, and assignments I would use. Between 1988 and 1999, I worked as a junior lecturer – mainly within courses close to systems development. The “big bang” or big change for me, according to me, when becoming a systems science disciple, happened in the middle of the 1990s, when I attended a master course called “Information technology”. The theme for this course varied from one year to another and in 1996, the theme was “Early warning”. It was not easy to find so much about the theme but concepts like “anticipation” and “anticipatory systems” (Rosen, 1985) were close. In this course, the students were expected to apply Early Warning Systems in some kind of practical example, I read what I could find about EWS, but I could not find any definition, so I had to define the concept myself. My final definition looked like this:

“The purpose of an Early Warning System is to make some kind of Target System aware of future events and processes, inside or outside the target System, that affect the Target System in a negative way”.

This was probably the first time I developed a definition on my own and that was a new experience. Afterwards, various definitions and their different meanings have been introduced and discussed in several courses. Often, students react on the fact that definitions differ and the reader must decide which one fits him or her, depending on several parameters such as aim and context. This is maybe one of the first experiences when students are exposed to the absence of “right or wrong” causing them not so little frustration.

Furthermore, most of the texts and discussions about early warning dealt with processes and how to handle and master undesired courses of events. Looking in the rear-view mirror, this should be close to “critical information” – the theme for our research group. However, not much was said about occurrences in the texts about early warning. From now on, we are well aware of the need for early warning with respect to earthquakes, volcanic eruptions, and so on. In these days, when we witness earthquakes and tsunamis in Japan, it feels even more urgent and highly topical.

Master courses were examined through writing scientific papers with final submissions to academic journals or acceptance to and preferably also participation in conferences. The background was of course to emulate the process to be close to scientific publication. This year, the attendees submitted abstracts to
1996 International Conference of the Swedish Operations Research Association (SORA). The conference was held in Luleå in October the same year.

I applied early warning on undesired occurrences such as bullying in compulsory school. The result was a model where I suggested routines for how to handle bullying in progress but also routines for avoidance of bullying in the future—preventive actions. Feed-forward and anticipation were some of the keywords used in the presentation. I read this paper a while ago, and it is still topical and of great interest. As late as this morning (July, 27th, 2011) bullying in the compulsory school was discussed on the radio due to some trials where local authorities in different municipalities had been sentenced to pay a fine to pupils who were victims of bullying. The conclusion of the radio programme was that tools and resources for how to handle this problem were missing.

For a master student, it was really encouraging and also a little bit "unreal" to see the "thinkers" one had read about and discussed for several years. We attended a workshop arranged by Stafford Beer and Allenn Leonard where we were supposed to "play/act" as a Viable System (Beer, 1972; 1974; 1979; 1985; Leonard, 1999). The participants in the workshop manned the Viable System Model which in this case represented a publishing house of academic literature where the main category of customers was students. VSM consists of five systems. System 1 is operations/Implementations where the main activities in the organization take place (production). System 2 deals with coordination and is responsible for planning and coordinating plans and outcomes. System 3 is the control system which monitors sensors in System 1 in order to ensure internal homeostasis, System 4 is responsible for development/intelligence. This system is also responsible for contacts with the environment, guarding and could be understood as the organization’s main anticipatory system. System 4 has also access to the historic records so new information from the environment could be compared, ranged and analyzed with this information. This information is forwarded to System 5 which deals with overall direction and policy for the "whole" system/organization.

At the workshop, I was participating in System 1—the printing office. Viability is warranted by recursivity in the systems. Therefore, the printing office also consisted of all 5 systems. Our task was to think upon and decide about future threats as increased occurrences of on-line books and how this phenomenon could influence and affect our survival.

To act and discuss VSM through the lenses of Beer and Leonard was indeed an adventure and maybe the most exciting single happening where I came in contact with Systems thinking in practice. At the following dinner, I happened to sit next to Stafford Beer and he was really an interesting and amusing dinner partner. This conference and the meeting—and mainly the workshop—with Stafford Beer and
Allenna Leonard, is probably the reason why I have chosen VSM in several of my later articles and also recommended the model to my students as a possible model for analyzing, diagnosing, and designing organizations.

The following headings present how different approaches from systems thinking have been used, both in courses I have been engaged in, and also in my own research. Much of the results would not have been as good without the use of these approaches.

2. SYSTEMS THINKING IN EDUCATION – SOME SNAPSHOTS

This section is divided into two sections – education at basic level (Bachelor) and education at advanced level (Master).

2.1. Courses at basic level – some examples

2.1.1 Business Informatics, Management of business processes – Analyzing organizations in order to see new opportunities

This course has had several precursors. The former department of Informatics at the university collaborated with Business economics and management, a discipline which also offered courses in our systems science program. The department where courses in “Business economics and management” were offered asked our discipline to tailor a course in “Informatics for business economists”. Later on, this course was further developed and “Business Informatics” was introduced to the students as a free-standing course which they could add to their exam. The course focused on business processes and how these should be analyzed, designed and maintained with the aid of ICT. A supplementary course was in demand and “Business Informatics, management of business processes” was developed. The latter course focuses more on management, innovation and visions in comparison with the first course, where more basic concepts concerning business informatics such as requirement analysis of business information systems, IT revision and IT security, were in focus. The course was developed by a team of teachers who had been involved in the former courses and with an interest in business informatics. As one of the goals, of the syllabus states: “After accomplished course, the student should have deeper knowledge about models, principles and concepts for management and steering of business processes, the student should be able to identify, change and create new business processes based on cybernetic principles ...” Cybernetics as a concept was introduced in the course and related to businesses and organizations. Hence, VSM as an example of a cybernetic model was introduced and also connected to one of the assignments of the course. Feedback, variation and systems of systems are
discussed in relation with business processes. The main processes and supporting processes are analyzed with the lens of VSM and the importance of feedback. Other important parts of the course is identification of threats and possibilities – business Intelligence for an organization, IT trends and their potential, business processes: identification, creation, evaluating and changing, creative techniques for identification and development of visions and work with organizational strategies, the concepts Quality in relation with business processes, networks and strategic alliances. The examination of the course is based on two former assignments. In the former assignments, the students had identified threats and possibilities in either an organization of their own choice which they were familiar with, or a fictitious organization. Furthermore, good examples of similar organizations had been identified and analyzed. With these former assignments as input, the students design or re-design the processes of the organization, based on the five systems in VSM. The course evaluations have been varying between very good experiences and new ways of thinking, until “difficult and not applicable on business processes”. The latter viewpoint is of course a defeat though the intention with cybernetics has failed with respect to potential and usefulness. This reaction is of course a challenge for further developing of the course.

2.1.2 Strategic Intranet development

This course is a result from the work with my PhD thesis. The name of my thesis was: “Designing Intranets for Viability – Approaching Organizational Empowerment and Participation” (Nyström, 2006). I have always had a great believe in democracy and empowering of people. The examples of Intranets studied during the work with the thesis were poor examples of empowering and also of participation in the process with the design of the Intranets. These facts encouraged and motivated me even more to come up with design principles supporting these matters. This was also in line with Beer and his mapping of VSM in the Chile case (Beer, 1974; Becket, 2003). While reading Andy Becket story about the “Santiago dreaming”, it is obvious how much Beer has influenced and inspired researchers as Raul Espejo and Fernando Flores among others. Becket begins: “When Pinochet’s military overthrew the Chilean government 30 years ago, they discovered a revolutionary communication system, a ‘socialist internet’ connecting the whole country” (Becket, 2003). This “socialist internet” was the “Cybersyn25" which

25) Project Cybersyn was a Chilean attempt at real-time computer-controlled planned economy in the years 1970–1973. It was essentially a network of telex machines that linked factories with a single computer centre in Santiago, which controlled them using principles of cybernetics. (Wikipedia).
precursor probably was the early work of Simon Beer – the son of Stafford, who many years earlier, as a teenager, built a simple system consisting of bits of radios and pieces of pink and green cardboard - a series of electrical meters for measuring public opinion.

I used VSM as a model for diagnosing and design in the thesis and mapped the different systems of an Intranet as described in the Table below.

**Table 1** VSM mapped on an Intranet (Nyström, 2006).

<table>
<thead>
<tr>
<th>Function</th>
<th>Example Intranet and some design principles</th>
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<tr>
<td><strong>System 1 Action/Operations or implementation</strong></td>
<td>In order to remain viable, undesired occurrences or conditions in an operation must be measured, monitored and handed over to System 3. This can be done through some kind of Early Warning System (EWS). Conditions must also be compared with acceptable values. If production is spread geographically, communication links and different kinds of collaboration software should be established. Furthermore, the units must be autonomous so that viability is guaranteed. Policies, rules, states and different kinds of demands must be collected, presented and accessible for everyone (empowerment).</td>
</tr>
<tr>
<td><strong>System 2 Coordination</strong></td>
<td>A planning and coordinating system with both plans (budget) and outcomes/results concerning resources such as money, staff, equipment, etc. Planning meetings with support systems, such as calendars, planning systems, electronic whiteboards, schedules, etc. Everyone should have access to the planning systems.</td>
</tr>
<tr>
<td><strong>System 3 Audit, System 3</strong> Control</td>
<td>A monitoring system with sensors in System 1. Comparison of desired conditions and outcomes, “Direct line” to managers in charge. This system ensures internal homeostasis. System 3 holds a model of System 1, which has to be controlled. According to the nature of models, this model is incomplete.</td>
</tr>
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</table>
System 4, Development/Intelligence

Supported by functions for collecting, presenting and analysing external data. It forwards analyzed information to System 3 and the policy level. The model of the entire company is represented in an Intranet. Research and development is supported by historical records and by functions for updating the state-of-the-art. A “Control centre” should be supported by electronic whiteboards and collaboration tools. Interactive functions where the environment can comment and react upon the organization, “Filters” which transform information from the environment to desirable representation (summary, aggregate) and vice versa. System 4 can be seen as the organization’s main anticipatory system.

Overall Direction/Policy, System 5

Supported by tools for presentation (visions, etc. of the environment). Different kinds of decision support systems. Regular meetings supported by planning systems and presentation/simulation tools.

The students participating in this course do not actually build any Intranet. They define important concepts in the course, relate environmental guards with Business Intelligence and System 4 in the VSM. Discussions about need for participation, empowering of users, strategies and policies, as well as more technical philosophical issues, are carried out in the course. The students test Intranet freeware, available online, and relate questions from the different lectures on the Intranets content functions. The course assignment consists of a planned study visit in an organization with a quite large Intranet, where the Intranet is investigated through interviews according to issues such as content, development process and user empowerment and participation. Finally, they document the result of the interviews and the analysis in a report. This course could probably be developed and enriched by the use of Boundary Critique (Simon, 1996) and boundary questions (Ulrich and Reynolds, 2010) where e.g. stakeholders and third parties in an Intranet could and should be critically discussed. The need for a more holistic view on Intranets was obvious in former studies so there is a need for a more comprehensive view of designing Intranets according to the effects of the organization, participation, power aspects, and not at least, influence. Systems Thinking could be a suitable tool for this.
2.2 Courses at advanced level – more examples

2.2.1 eCulture

The aim of this course should, to a high degree, encourage the students to react and reflect upon ICT in their daily life. The main content of the course considers human beings in socio-technical systems, historic, current and future ICT trends, theories and models for problemizing and explanation of ICT use due to social, cultural and psychological effects, ICT-based social groups, human and cultural effects of typical ICT use.

In one assignment, they should avoid some kind of ICT device for some days, and also discuss how it would work in a longer time perspective – a month or even longer. Several students choose their cellular phone in this exercise and discuss the experiences in the discussion board. It is amazing to see the discussions and the “oops” and “ahas” they got after this task. In later assignments, they are looking at the eSociety through the lences of Herbert Simon (1996) and his Boundary Critique, Critical Systems Heuristics and the boundary questions by Werner Ulrich (Ulrich and Reynolds, 2010), as well as the multimodalities by Donald deRadt (2000) in order to raise new questions about stakeholders, third parties, different angles to look at things through modalities and so on. Finally, they plan and write an essay about a phenomenon of their own choice in the eSociety. During the autumn 2011, this course will be further developed and connected to a course at postgraduate level. The intention is to implement interaction between the students at different levels. The students at the postgraduate level could act as tutors and sounding boards for master students. Interaction between courses was a “characteristic” for the former System Science program and it was also found to be a very good pedagogic step – learning-by-teaching-and-tutoring.

2.2.2 Communication in learning organizations

This course is developed and offered by BTH⁵ in the International Master program. Learning-by-doing and reflection in practice (Schön, 1983) is practiced both in the eCulture course and in this course. The students are for example identifying adequate internet links and formulating questions about the different sources. Furthermore, they refine these questions in the discussions with each other. To formulate “good” questions is not easy and the students gather valuable

⁵) Blekinge Tekniska Högskola, Blekinge Institute of Technology
experience when they practice this part of the course. There is a set of scientific articles related to “communication and learning” where they have to choose one of them and act as a reviewer for a fictive scientific journal, where they are supposed to review and grade one article. The articles discuss different angles of learning organizations, where for example Soft Systems Methodology (Checkland, 1981; 2000) could be used (Mirjamdotter, Somerville, 2008). The article by Mirjamdotter & Somerville discusses organizational change based on SSM in a North American university library. SSM is a systemic approach for tackling real-world problematic situations and it is a well-known and used model/method although it is an aid to structure complex problems and attacks them from several angles. Finally, they construct a “Handbook for learning organizations” using the “Synergy-4 Model” by Holmberg (2001) and characteristics from systems thinking (Senge 1990; 2006). The model by Holmberg aims to highlight the connections and intersections between Competence, Management, Organization and Technology. These intersections should of course be of great interest in learning organizations as they are due to continuous change. Of course, the outcome from the course varies, but some of the students produce excellent works where they discuss the model and the use of it. The main outcome is the analysis and design/re-design of the handbook for the chosen organization – fictitious or not – where they have to take several dimensions or spheres in the organization in account in order to fulfil the task.

3. SYSTEMS THINKING IN FUTURE EDUCATION

In my view, the use of systems thinking in courses at higher level is a wise choice. The students are offered methods and models which help them to attack what in some cases may be quite complex problems. Furthermore, they have a “tool box” for future situations where new ways of thinking is needed. The characteristics of how courses in informatics have been realized with a high degree of “learning-by-doing”, reflection in practice, and a tutor system where students in higher courses are tutoring students at lower levels are well worth keeping and developing further. Every situation – despite if it is e.g. a re-design of an information system, organizational change, design of inter-organizational systems spanning over country borders with the aim to support emergency management and planning in crisis – is unique. If the designer has the ability to act as a “system thinker”, then the outcome would probably be satisfactory. It is hard to prophesy about the future, but I am convinced that with a point of departure in a careful analysis of the situation at hand, methods and models based on Systems Thinking will be even more topical and relevant to use in the future. The need for such thinking in education is obvious,
It is probably not enough to use good tools for a good outcome in courses. The “total believe” in what students can produce that Stig C Holmberg had, is essential and a factor of success. Often, assignments were designed without a clue how to solve complex problems: “If you show them (students) too closely how to solve problems, then you are limiting them in their creativity” as Stig declared. Accordingly, the general design of courses should be based on the motto: “Students can, if they get the opportunity to show it”!

4. SYSTEMS THINKING IN RESEARCH

As mentioned before, I have used the ideas of Stafford Beer in several articles and reports. The work of Stafford Beer, together with e.g. Wemer Ulrich and his critical heuristics, Soft Systems Methodology by Peter Checkland, and Synergy-4 by Stig C Holmberg, are good examples of models/methods which could be used in several contexts. According to our research theme – Critical Information - Systems Thinking could be a fruitful way to tackle the different problems to be solved in different contexts where Critical Information is present. The concept Critical Information is to be found in the formulation of the vision, our research group in Informatics at Campus Östersund has made: “We shall be acknowledged and lead within design of systems for accessibility of critical information. This will be carried out through applied research in close cooperation with stakeholders in order to create benefit.” Furthermore, the concept critical information is defined: “Critical information is connected to a certain context at a certain time and a certain place. Critical information is governed by needs and should have enough quality for the purpose where it shall be used. Critical information might exist on several levels - individual, group, organization, and society – which also should be connected to possible consequences. Critical information must be made accessible for a certain target group – for those who need access to the information so steps to minimize possible damages could be taken. In systems containing and handling critical information, possibilities to aggregate data depending on different needs, should exist. Finally, the connection to applied research implies that we, in practice, together with different stakeholders design and create those systems.” Critical Information could easily be related to Early Warning Systems, and this is today probably more urgent than ever with respect to the terrifying bomb attack and shooting in Oslo and on Utøya in Norway. The work in the Critical Information research group has just started under the new theme and an exciting and hopefully fruitful process is about to take form.

My last article – work in progress, is a presentation of collaboration between researchers and former doctoral students of our department. Together, we designed a model to support the work with guarding the environment in
organizations dealing with technical communication\textsuperscript{27}. The model is not limited to this type of organizations. It is a general model which could easily be used in other kinds of organizations. The idea with the model is to support continuously efforts to match of competence, organizational procedures, technology within an organization and visions/doctrines with demands from customers/purchasers who would like to buy services such as technical communication from the organization. In this case, the organizational memory is critical. This memory must be up-to-date and also complemented with information from the outside. We have used Stafford Beer’s VSM and Stig C Holmberg’s Synergy-4 when designing this model. I call this organizational function “\textit{Viable Intelligence}” to be compared with Business Intelligence, which leads the thoughts more to business economics and management.

5. SUMMARY

In summary, Systems Thinking could and should work as a good cocktail. One part should consist of Reflection, another of Criticism, and the third of Action. Blend them together carefully, and you will have a magic blend which could be used in several contexts. The society is becoming more and more complex and the challenges, threats and needs, demand new ways of thinking. It is important that this way of reflecting, criticizing and acting, is presented and made familiar for future decision makers early – at different levels during the school time. Systems Thinking could hopefully be one of the tools to handle future situations.

REFERENCES


\textsuperscript{27} “TC is the process of conveying technical information through writing, speech, and other mediums to a specific audience. Information is usable if the intended audience can perform an action or make a decision based on it (Johnson-Sheehan 7). Technical communicators often work collaboratively to create products (deliverables) for various media, including paper, video, and the Internet. Deliverables include online help user manuals, technical manuals, specifications, process and procedure manuals, reference cards, training, business papers and reports.” [http://en.wikipedia.org/wiki/Technical_communication, [accessed 2011-07-25]


