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Design of an Undergraduate Programme in Informatics and Systems Science [1]

Introduction

Not long before I took my present appointment at Luleå University of Technology, I completed my book *Information and Managerial Wisdom* which was the output of about eight years of research begun in Australia and completed in the United States. The conclusions of this research regarding the contribution that computer information systems can make to management are not very optimistic. Most of information systems have been built on the assumption that an increase of power in modern information technology signifies a greater amount of information available to managers and social systems. Since the power of computers is overwhelming, we believe that we are living in an information society. However, I conclude that rather than living in an information age, we live in an uncertainty age, and that our information technology is unable significantly to decrease this uncertainty. On the contrary, in may instances the introduction of information technology increases the uncertainty in our social systems.

I also argue that our understanding of information should be based on a closer understanding of social systems and their management rather than on the machines - computers - that are supposed to produce such information. There is also a need to develop a science of information based on a non-mechanical view of the world, for its precisely this mechanical view that leads us to confuse information with information technology. This mechanistic view is also found in modern management so that there is a correspondence between the mechanical approach to information and to management.

I concluded that to deal with this problem, we must firstly search the epistemology that underlies our ideas of management and information and expose the naïve misconceptions that are rooted in the enlightenment and the industrial revolution. Secondly, we must establish a programme of research to rebuild our management and information thought on a sounder epistemological foundation. Thirdly, we need a new educational curriculum for the education of managers and information professionals. So when the opportunity presented itself to develop such a curriculum at Luleå University of Technology, I took it and this paper describes what my colleagues and I built as a result.

Multi-Modal Systems Thinking

The curriculum is based on multi-modal systems thinking, a framework that links three elements together - life, wisdom and management - along two dimensions represented by the axes in Figure 1. Since I have provided a detailed explanation of multi-modal systems thinking in previous work (de Raadt, 1989*a*,*b*, 1991, 1995, 1996, 1997), I will only give a brief overview here of what has already been written. In the horizontal axis lie a string of interacting systems such as orchards, families, trades, dance companies, schools, transport, courts of justice and hospitals. Within such systems life - both biological and cultural - unfolds. Within them mankind realises its vocation and finds its fulfilment. Yet to understand these systems we must also refer to the vertical axis where we find layered a number of modalities that command all these systems: credal, ethical, juridical,

aesthetic, economic, operational social, epistemic, informatory, historical, logical, psychic, biotic, physical, kinetic, spatial and numeric (Dooyeweerd, 1958).

The foundation and character of multi-modal systems thinking - as we have labelled this approach to systems science - is prophetic rather than philosophic. The philosophic approach which we have inherited from the Greeks regards the universe as governed by inert, impersonal and static laws. Accordingly, the philosopher's inquiry reflects his concern with existence, he asks: what is reality? There being no satisfactory answer to this, philosophy gets bogged down. It is in this state that it is passed on to us by medieval scholasticism and modernism.

Modernism has added to this formula its own secularisation and mechanisation. There is no hope, therefore, that such an understanding of science, being built upon inert, impersonal and static view of the universe can address the predicament of humanity. Post-modernism has attempted to escape out of this mire by regarding reality as the product of our own construction and landed us with the only culture in history ever to have been called the "idiot culture". We hear about the arrogance of Rome and the cruelty of Assyria or the inability of Israel ever being content with its lot and getting into perennial trouble for it, but we do not hear of a whole civilisation being junk. It is the greatest insult that our generation can receive. Tragically, it is well deserved.

Therefore I have sought to follow the path of the prophet rather than the philosopher. In contrast to the philosopher, the prophet regards the world as governed by a living personal and dynamic God. Life, not existence is his chief concern. The prophet asks: how should we live? And while the philosopher struggles in his own mire, the prophet and his successors bring relief and hope to the poor, the needy and the underdog, for in contrast to philosophy, prophecy not only loves wisdom but also its practice.

God's command of the universe is thus multi-modal and is addressed in two directions (see Figure 2). The first is to nature (shaded are) in general in the other to the heart of man (blank area). By heart, we do not just mean emotions, but the inner centrality of our person which makes us
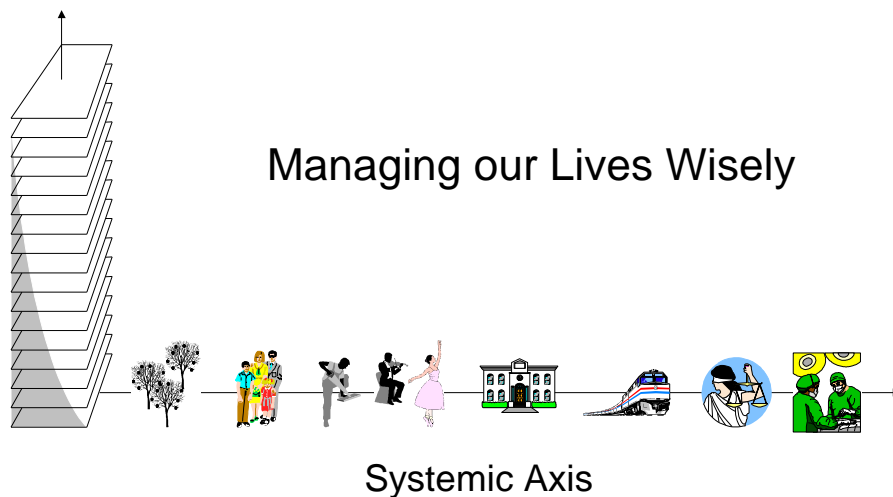

Figure 1: Multi-Modal Systems Framework

responsible for our actions as distinct those things that happen to us as part of nature. Though the dominion of the heart extends over all modalities it is greatest in the higher modalities and least in the lower ones. The highest modality is the credal, the realm of faith. Faith is the foundation of all activities that are distinctively human, that is, those for which man is responsible as man. Man therefore lives by faith or by inspiration (represented by the arrow) which means that life must be anchored outside of ourselves, in God, rather than within ourselves as in existentialism or constructivism.

Understanding, in all its forms including scientific, are an integral part of human life, and also founded on inspiration. All understanding is governed by the epistemic modality and its final goal is gaining wisdom. This wisdom, though being one, reflects nevertheless all the modalities. This multiplicity is evinced in the variety of specialised sciences that we have for each variety. For example, the credal, ethical, and social modalities are respectively studied by theology, ethics and sociology. Yet, to avoid the scientific fragmentation that followed the enlightenment, multi-modal systems thinking aims to stress the unity of these modalities - without denying their variety - and to provide a bridge for the integration of the sciences.

While the heart of every person functions in each modality each person has a special talent and love for one or more modalities. This special manifestation or preference for a select group of modalities forms the vocation of the person, that is, that special field in which a person wishes to serve his fellow man. These means that each vocation is linked to one of the modalities, the lawyer with the juridical, the biologist with the biotic, the information professional with the informatory. Vocations such as these must be turned into work and this work is governed by skills found in the operational modality. Furthermore, work does not take place in an isolated manner, but within the social context of an operational system (Beer,1979) where people gather together to realise their vocations as a community of professionals. For example, in the lower part of Figure 3 is illustrated the operational systems of a hospital. Doctor and nurses carry out their work (ruled by the operational modality) motivated by the vocation which is focused on the biotic modality. They serve people by biologically healing them.
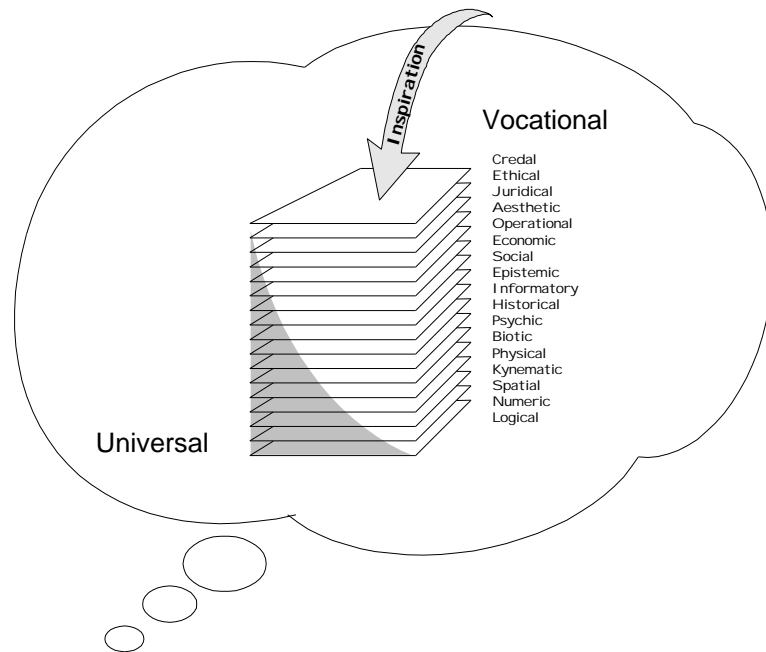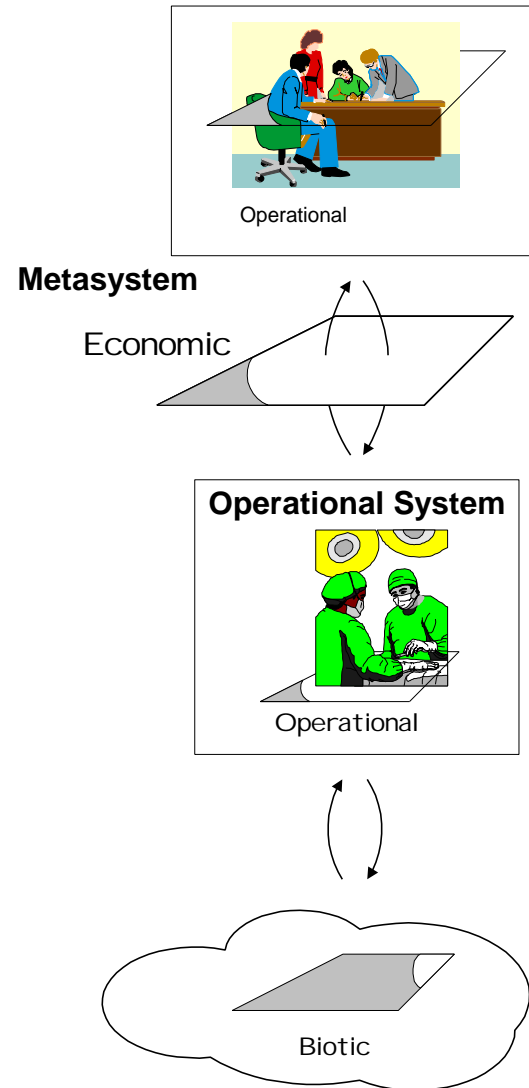
Figure 2: Nature and the Heart of Man

These social systems interact with each other and also with the natural systems as indicated by the horizontal axis of Figure 1. Each one of these systems in particular as well as their whole aggregate must be managed by a metasystem (see Figure 3) for them to be viable (Beer, 1979). Viability constitutes the essence of management which is ruled by the economic modality and which provides the link between the metasystem and the operational system, as indicated in Figure 3. By *economics* we do not mean *utilitarian economics*, but economics (*oikonomia)* in the ancient sense, that is, the management of the old household with the sustenance of life as its essence. We have therefore defined multi-modal systems management as a new economics that aims at sustaining life in each one of the modalities and where systems though distinct, operate nevertheless in a integrated manner. Human life, however, must not only be sustained but developed; multi-modal systems development is the cultural opening progress of human systems in harmony with natural systems that takes place in each one of the modalities. Once more, this process must take place in a balanced manner, without any of the modalities dominating over the development of the others, and where every modal level of life is sustained.

Management is, therefore, the erudition and skill that sustain and develop both human and natural systems as explained by Beer (1979, 1981). His theory of management emerges out of his study of regulation in biology, especially in the human brain. According to Beer, every living thing, whether plant, animal or man, needs a system to manage its interactions within

Figure 3: Operational and Metasystem

and with its external environment to sustain its life, or make it viable. This concurs with the modal idea of vitality - life - being the essence of the biotic modality. Human life, however, is not restricted to the biotic: there also is life in the other modalities, such as social life and artistic life. Biological life, then, has homomorphisms in the other modalities and it is these other lives that the economic modality seeks to sustain. Thus the essence and principles of the economic modality, viability, are homomorphic with the essence and principles of the biotic, vitality, but the viability that management seeks is the viability of a social system rather than a biological one as it interacts with its own environment. This viability is defined by the particular mission of the social system, and can be attained by the application of managerial cybernetics (de Raadt, 1991). The word *cybernetics* originates from the Greek and signifies *steward* or *governor* and when applied to the ancient household, has the same meaning that the word *oikonomos* cited above. Thus the grounds of Beer's managerial cybernetics are in harmony with the ancient idea of economics and it is in this sense most appropriate that he should called it The Viable System Model.
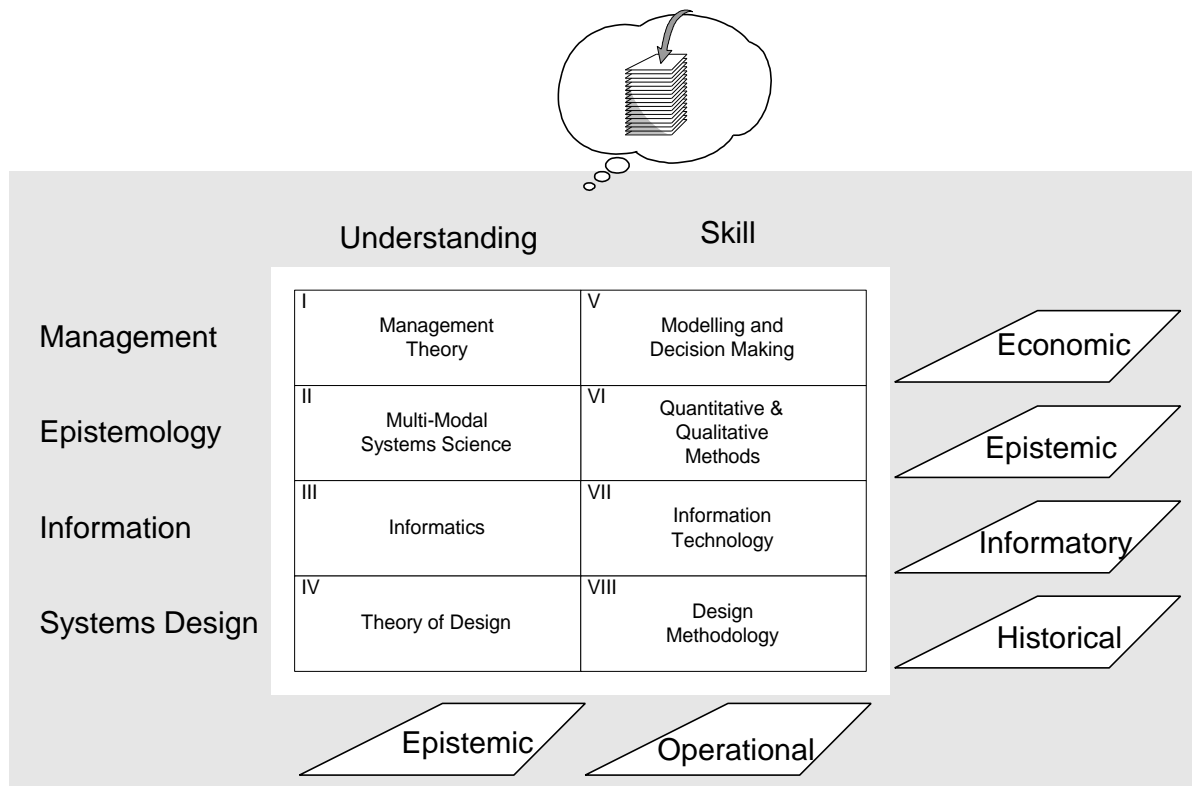
Informatics and Systems Science Programme

The above is in brief the intellectual foundation of the department of informatics and systems science inaugurated in Autumn 1995 with the mission to focus its research and teaching programmes on the management of our technological civilisation.

The emphasis of our teaching programme is threefold: firstly its is concerned with the development of students as persons by increasing their understanding of life and their mission in it, and also by developing a sense of service to their neighbours. Secondly, we aim at developing in them an understanding (epistemic modality) that is critical - in regard as to how we should live - managerial and creative. Education is directed to the whole intellect, which means that our students are not only encouraged to think with rigour in each one of the departments of knowledge, from mathematics and lingual expression to aesthetics and ethics but also with reference to the whole of life, both cultural and natural. Thirdly, in addition to understanding, education must also be able to provide students with the skill that will allow them to apply their talents in vocational service, specifically management, management information and systems design. While recognising the differences between the many disciplines, we stress in class the essential unity of knowledge. Students are taught how knowledge from the different disciplines can be woven together to understand the world.

The process through which the programme was designed is illustrated in Figure 4. The grey area highlights the academic requirements of the programme. On the top is placed understanding and skill (involving nature and heart as defined in Figure 2); these involve two modalities - epistemic and operational - shown at the bottom. On the left side are the areas in which students are seeking understanding and skill - management, epistemology, information and systems design; these in turn belong to four modalities - economic, epistemic, informatory and historical - listed on the right side.

We needed therefore to build a programme of studies that would satisfy these academic requirements. In the centre of the figure are eight boxes containing the curricular domains that were defined by the intersection of the modalities on the right and bottom of the figure. For example, Box III and VII indicate the need for courses in information (informatory). Box III point to course requirements that teach information from a theoretical point of view (epistemic) while Box VII to courses teaching practical (operational) skills such as programming, spreadsheets techniques and so on. These curricular domains were then used to develop the courses that are listed in Figure 5. The programme spans four academic years and each year is divided into four terms. The first set of thirty students entered the programme in August 1996 and have recently completed the first year. Therefore it is not possible at this stage to evaluate the programme as a whole. Nevertheless there are some experiences in this first year that are worthwhile noting.

We have concentrated the students work in the first three terms almost solely in establishing a foundation for thought. Only in the fourth term do they meet with something more practical in Information Technology I. Some students became a little anxious and wondered what they had got into after dealing with so much philosophy and epistemology and were relieved when in term four

	Understanding	Skill	
Management	I Management Theory	V Modelling and Decision Making	Economic
Epistemology	II Multi-Modal Systems Science	VI Quantitative & Qualitative Methods	Epistemic
Information	III Informatics	VII Information Technology	Informatory
Systems Design	IV Theory of Design	VIII Design Methodology	Historical
	Epistemic	Operational	

Figure 4: Multi-Modal Foundation of the Programme

they finally became involved with computers and software. Yet we believe that is important to start their studies this way and to give them as sense of priority of what is really important and lasting in their university years. This anxiety I believe will decrease next years for the new students will now be able to be reassured by their second year colleagues. Students within the different programmes at our university display a strong sense of cohesion across the levels and this facilitates the introduction of a new curricula such as ours.

We have sought to integrate research and teaching, not only by continuously updating our curriculum with the latest outcomes of our research[i], but also by having undergraduate students share with doctoral students in some research activity of the department. Accordingly in the beginning of March this year, students spend three days on a field study in a village south of Luleå[ii]. Apart from teaching the practical aspects of qualitative research and exposing the students to doctoral research in a light manner, they were also able to gain first hand experience of threats to the sustainability of village life in Sweden. This made them aware of the community needs beyond the interests of industry and the need to apply managerial and systemic tools - which so far have tended to be monopolised by industry - to help the community as a whole.

Although this programme is somewhat unique, it is possible to make some comparisons with my own experiences in teaching similar multi-modal courses - in management information systems, systems design, and management of information systems - to business students in the USA. Most of the responses by students in the USA fell in two opposite poles with very few in between. About 40% of students expressed strong approval of such courses and appreciated an educational experience that challenged their way at looking at life. Most of the rest felt that it was not proper to

teach business students material that was of interest to society as a whole but of no specific interest to the business of making money. They felt it was more important to concentrate their studies on skills directly relevant to their employment opportunities.

The experience in Sweden is somewhat different. Most of our students approve the multi-modal systems approach and very few show lack of interest. This may be due to students in Sweden being somewhat more serious, but may also be that, due to a generous welfare system, they do not feel the harsh employment pressures experienced by their American counterparts.

Year

1	Introduction to Systems Science	Information Technology 1	MIS Theory
	Scientific Inquiry & Argumentation	Statistics / Theory of Science	Qualitative Methods
2	Technology & Society or Elective	Elective	Systems Design Methods / Information Technology 2
3	Elective	Elective	Modelling & Decision Methods / Project
4	Social Systems Management	Advanced Systems Design	Literature Review / Thesis

Figure 5: Informatics and Systems Science Programme

Conclusions

We may now draw some conclusions from what has been said. Our world view was firstly inspired by the inert, impersonal and static view of the universe held by the classical philosophers and later secularised and mechanised by the Enlightenment and the Industrial Revolution. As such, not only does it ignore the threat to the natural and cultural life of our world, but it is the very cause of this threat. We need a different way of thinking, and we have adopted the stance of the prophet. It is upon this that multi-modal systems thinking is built and upon which it integrates the diverse natural and human systems that comprise our world and our different ways of understanding. Multi-modal systems thinking also returns man's heart to its rightful place, for the life of the heart is the essence of civilisation. Sustaining and developing both natural and cultural life is the task of management but management requires a different perspective than the utilitarian and mechanistic

approach that pervades our society today. I propose a multi-modal systems management that also integrates the diverse departments of knowledge, the diverse natural and human systems and the heart of man with his natural side.

We need much research in this area, and there is a great need to prepare new leaders among our young people by teaching them a different approach to thinking and managing our technological civilisation. The informatics and systems science programme at Luleå University of Technology is a modest attempt to serve the future generation of leaders and, though still in its early stages, it already shows some promise in what we have done so far. Finally, while I have provided some of the fundamental ideas in which our research and educational programmes are based I would like to conclude by acknowledge the very significant contribution that has been provided by my colleagues at my department[iii] and also the Centre for Technology[iv] and Social Systems. Right from the beginning this has been a team effort and its success will certainly depend upon the continuing effort this team of committed scholars with whom I have the privilege to work.

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[i] Research at the department is carried out within the Centre for Technology and Social Systems, a collaboration between our department, the Faculty of Philosophy at the Free University, Amsterdam and the Information technology Institute at Salford University, United Kingdom.

[ii] Refer to the paper by Veronica D. de Raadt. "Viability and Multi-Modal Systems Thinking: A Village Application" also presented at this conference.

[iii] Veronica D. de Raadt, Anita Mirijamdotter, Birgitta Bergvall-Kåreborn, Darek Eriksson

[iv] Andrew Basden (Salford University and Sytse Strijbos (Free University)