The Right Tools for the Right Tasks: Meaningful Education for IS professionals

P.M. Bednar[1,2] and C. Welch[3]

[1] School of Computing, University of Portsmouth, UK

[2]Department of Informatics, Lund University, Sweden

[3]Department of Strategy & Business Systems, University of Portsmouth, UK

Abstract The predicament in which we find ourselves today is that many professionals lack a sufficient grounding in formal methods, tools and techniques to enable them to make an appropriate selection for different kinds of problem. This can mean that complexity remains unrecognized and ambiguous problem situations are addressed as if they were clear and straightforward, resulting in inadequate solutions that are not experienced as useful by clients. We are thus faced with a circular dilemma. Those who attempt to use, e.g. SSM are unable to do so effectively through lack of understanding. They are thus driven back to the need for formal methods, and the disadvantages inherent in these approaches which SSM was originally created to address. Thus, there is a need to reintroduce into the agenda of soft and Agile methods an understanding of the skills and tool sets offered by hard/formal approaches. New professionals require a comprehensive *education* in use of tools and techniques, including their complementarity. This will not be delivered by training individuals in application of particular methodologies in a piecemeal and fragmented way, but by thorough and rigorous examination of whole methodologies in use. Only then can they engage in practice in the real world and develop their own tool sets, from which to select in an informed way those most appropriate to a problem situation.

Introduction

For many years, hard systems methodologies have been criticized for being unwieldy, prescriptive and time-consuming. Furthermore, these approaches ignore the need to explore the problem space and develop it taking into account the perspectives of different engaged actors (see Checkland, 1999; Mumford, 1995). Reactions against this have led to such diverse developments such as the Soft Systems Methodology Checkland, 1999), which attempted to incorporate the

bigger picture, or prototyping (Smith, 1991) and Agile methods (Shore and Warden, 2008; Mumford, et al, 2006), which attempted to support rapid progress towards solutions. Agile methods can be considered a response to the perceived disadvantages of formal methodologies, which could produce over-engineered solutions (Avison and Fitzgerald, 2006). Recognizing that the World changes very rapidly, Agile methods are intended to achieve a solution that may be imperfect but is achieved while still relevant to current problems. Agile methods move quickly from one aspect to another without necessarily attempting permanent and lasting solutions.

Initial critique of formal methodologies (e.g. SSADM and JSD and their predecessors) came from academics and professionals well-versed in the tools, techniques and application of such approaches (see e.g. Langefors, 1966; Avison and Wood-Harper, 1990). Flensburg (2008) comments that early developments in organizational Informatics followed in the wake of approaches to Computer Science that were themselves driven by a focus on numerical analysis (see Flensburg, 2008).

These critics were well qualified to create ideas for new approaches that might overcome the disadvantages of structured methods. However, less skilled practitioners have subsequently made less-than-informed choices about approaches to development. These were not always successful because of uninformed ideas about inherent flaws in formal methods, combined with an imperfect understanding of the practical strengths and weaknesses of either category. As a result, soft methods were also criticized as unsatisfactory in use, due to similar ignorance of any tools that would render these approaches productive (see, e.g. Kreher's study (1994)). However, what is actually lacking is a sufficiently deep understanding of the nature of systemic analysis and design principles.

Thus, soft and Agile approaches have both, in their turn, been subject to criticism for failing to provide a blueprint from which to build a new system. Nevertheless, analysts only familiar with Agile approaches, without a deep understanding of first principles, may try to apply them regardless of context, leading to poor design, inconsistency and low traceability (Avison and Fitzgerald, 2006). The predicament in which we find ourselves today is that many professionals lack a sufficient grounding in formal methods, tools and

techniques to enable them to make an appropriate selection for different kinds of problem. This can mean that complexity remains unrecognised and ambiguous problem situations are addressed as if they were clear and straightforward, resulting in inadequate solutions that are not experienced as useful by clients (Avison and Wood-Harper, 1990). New professionals require a comprehensive *education* in use of tools and techniques, including their complementarity (see Mathiessen, et al, 2002; Omland, 2009). This will not be delivered by training individuals in application of particular methodologies in a piecemeal and fragmented way, but by thorough and rigorous examination of whole methodologies in use. Only then can they engage in practice in the real world and develop their own tool sets, from which to select in an informed way those most appropriate to a problem situation.

Educating the IS Professional

Omland (2009) discusses an indissoluble relationship between competence, methods and practice. Reporting research into a successful ISD in a Norwegian municipality, he states:

"*In theory, competence, methods and practice are separate and clearly distinct elements. In actual ISD, however, the three elements form close and integrated relationships*" (Omland, 2009, p.3)

Mathiesson, et al (2000) discuss teaching as a process in which students must gain basic skills from which to build their understandings. Their pedagogical approach to Object Oriented analysis and design goes through the approach step-by-step. However, it is necessary to understand that application does not follow the linear path of the pedagogical vehicle, but reflects the complexity of context in which it is applied.

It can be seen, therefore, that a professional analyst requires more than just knowledge of the steps involved in any particular methodology. It is necessary to combine such knowledge with practical skill and the ability to reflect upon a problem space in order to select and apply *relevant* tools. Furthermore, a problem is neither given nor predictable; it emerges and changes during exploration. Analysts need to reframe the problem as they proceed. Thus, analysis is *contextual* (Checkland 1999; Bednar, 2000). This in itself presents a di-

lemma: analysts cannot know what to explore in the context until they have explored it. However, that means that they do not know what is to be explored. Furthermore, deep understanding of contextual dependencies is vested in the engaged actors who participate in the context under examination. It is easy to say 'consult with stakeholders' but another matter entirely to choose with whom to liaise, under what conditions and when. The internal politics of situations often constrain who can be involved and how they participate. Contextual analysis is messy and problematic. Even a skilled and experienced professional analyst does not automatically know, in a particular context, what questions to ask and of whom.

It has long been recognized that there is a need for a sociotechnical approach to design, i.e. that the development of a technical solution will be inadequate without consideration of the work practices and human context within which such a solution will be implemented (Cherns, 1976).

Analysis and design are more commonly undertaken in order to change a legacy system than to embark on development of a completely novel IS. This leads us to reflect that approaches to education of IS professionals that discuss methodologies as if they are to be applied as recipes, creating systems from scratch on a step-by-step basis, will be an inadequate preparation for the exigencies of professional life, engaging in maintenance, enhancement and re-engineering of existing systems. Such a view is confirmed by Omland (2009) and Mathiessen, et al (2000) and by Madsen, et al (2006). Analysts must collaborate with engaged actors to explore problem situations in order to support creation and shaping of requirements. It is essential that a naive and premature view of 'the problem' is avoided in favour of an holistic and exploratory approach. Differences in perspective among engaged actors (highlighted by Checkland, 1999 in relation to soft systems approaches) must be taken into account in questioning what the nature of 'the problem' may be. Ulrich (2001) points out a need to consider the stance from which problem definition is undertaken, and undertake *boundary critique* – what is considered within the scope of inquiry and what is excluded is an important decision for the success of any design process and can only be undertaken in collaboration with engaged actors. It is these individuals for whom

any created system must be perceived as useful, and it is they who must therefore own and control the context of development (Friis, 1991).

Since competence, methods, and practice can be seen to form a tight, integrated whole (Omland, 2009), it follows that new practitioners cannot gain sufficient understandings from an academic and detached study of particular methodological 'recipes'. It is vital for educators to promote an engaged attitude among students of analysis and design. Brown, et al, (1997) report the results of a series of interviews in which students were invited to explain what they understood by 'learning'. A range of definitions emerged:

- ✓ Learning as an increase in knowledge. These students apparently saw themselves as acquiring this 'commodity' from their tutors;
- ✓ Learning as memorizing. Here students appeared to see their task as storage of the said 'commodity' for a temporary period;
- ✓ Learning as acquiring facts or procedures which to be used – skills, algorithms, formulae. These they appeared to see as means to particular ends, e.g. as background to later material or for use in an examination;
- ✓ Learning as making sense. These students appeared to make active attempts to abstract meaning in a process of learning so that they could describe their methods and reasoning, as well as answers to problems or tasks;
- ✓ Learning as understanding 'reality'. This group of students appeared to see learning as personally meaningful. They described a transformation in perceptions of the world before and after learning.

It is clear from the discussion above that an educational experience matching student views 1-3 above would provide an inadequate preparation for a student embarking upon professional practice. The pedagogical approach adopted must provide maximum opportunity for students to engage their own sense-making processes and to apply what they learn to their own (current or future) professional roles. They require encouragement to engage in reflection, entering into creation of productive learning spirals. At this point, it is useful to consider the possibility of multiple orders of learning (see, for example, Bateson's discussion (1972, p.287)). Argyris and Schon (1978) describe two distinct orders of learning in terms of single- or double-loop learning. When an individual needs to solve an immediate problem, she may harness her sense-making processes in order to close a perceived gap between expected and actual experience. In doing so, she operates within a context of existing goals, values,

plans and rules, without questioning their appropriateness. However, if she goes beyond this to engage in reflection, and in doing so challenge and critically appraise the assumptions previously applied, this may be considered as double-loop learning.

Notes from the field

The descriptions which follow show how this challenge has been taken up in the authors' own experience of educating undergraduates preparing for careers as IS professionals in a UK University. New Units were prepared in response to several years of very poor pass rates achieved in previous versions taught solely by didactic methods including no engagement with 'real world' contexts.

Level 2 unit (building on introductory work at Level 1) was designed to include a curriculum and practical tasks that engage students with difficulties inherent in analysis and modeling techniques in a real world context. 114 students took this unit in 2007; 62 in 2008 and 92 in 2009. The approach is grounded in an updated version of the ETHICS methodology (Mumford, 1985; Cherns, 1976). Each student is asked to analyse a different organization, gathering the data for themselves by visiting their chosen context. In 2007 these were drawn from local supermarkets; in 2008 students analysed local GP practices; and in 2009 local pharmacies. Templates have been produced covering approximately 30 different analyses (e.g. business process analysis, work design, social analysis), each of which incorporates a guide to application. In applying each of these, students are required to proceed by adopting different perspectives, making use of a range of techniques including visible thinking (Tishman and Palmer, 2005). The results achieved at first attempt were over 75% in 2007; 70% in 2008 and 68% in 2009, comparing very favorably with earlier versions that had pass rates of 25% or less.

In the Level 3 unit, the Soft Systems Methodology (Checkland, 1999) was chosen to encourage students to appreciate the messy and problematic nature of analysis of organizational context. The object is for students to engage with the benefits of SSM in conjunction with application of a chosen toolsets from other methodologies. This is similar to the approach of Checkland in first introducing SSM to

professionals experienced in hard/formal methods (Checkland, 1999). This unit is encourages students to in engage with creation of a systemic learning process, using problem-based and problem focused learning experiences, and adopts Socratic method (Engel, 1991; Jarvis, 2006). Students are given an unstructured problem scenario and asked to develop the problem space and create the boundary from different perspectives. Different categories of skills/tools are then applied selectively depending on how their inquiry develops the problem space. Supporting lectures focus on problematic issues relating to application of hard/formal methods. The intention is to promote understanding about assumptions underlying professional practice. Students apply analytical techniques from methodologies such as, e.g. SSM (Checkland, 1999), and Client-led Design (Stowell and West, 1995) e.g. Rich Pictures, mind mapping, CATWOE (Checkland, 1999), or PEArL (Champion and Stowell, 2001), FACTOR (Mathiesson, et al, 2000). A range of seminar themes were adopted to introduce students to complex and ambiguous problem spaces with no simple, straightforward answer. Students are given a common objective for which they must create individually a suitable methodology. They then analyze the strengths and weaknesses of their chosen approach by developing and applying a framework for evaluation that they can justify as relevant. Thus, the focus of this unit is on relevance, and in particular boundary setting and critique. Students must recognize that systems are not given – they exist only as mental constructs depend upon perspectives of individual observers engaged in a learning-based inquiry. In 2007, 13 out of 14 submissions passed. In 2008, 22 out of 24 submissions were successful and in 2009, 17 out of 20 were successful at the first attempt.

Thus, at Level 2, students are introduced to a particular tool kit and given opportunities to experience it in use. At Level 3, fuzzier problems are introduced. Students must explore the problem space for themselves, set and question the boundaries of the problem they wish to explore, using Ulrich's concept of boundary critique (Ulrich, 2001). They must apply tools that are more ambiguous in use and require creative thinking, judgment and selectivity.

Summary and Conclusion

How should an IS professional be prepared to undertake development work? Flensburg (2009) and Mathiessen (2000), among others, criticise pedagogical approaches that treat methodologies as recipes – students need to be able to understand how to follow the recipe but real educational value is in learning how not to follow it – methodology is not prescriptive but enabling. First, it is necessary to know of the existence and potential context of application of a particular tool in the toolbox. To be able to understand any tools, it is necessary to understand the context in which such a tool will be useful – to be able to judge its relevance. Flensburg, in particular, criticises teaching future IS professionals as if the only developments they will face are those undertaken in-house where the process starts from scratch and is pursued through application of a whole methodology – SSADM, RAD or whatever – from beginning to end. He points out that real world experience of IS development is far more likely to focus on maintenance and redesign of systems. This becomes clear when we consider that many companies today adopt service-oriented rather than developmental practice. An example can be seen in the case of Skandia, who two years ago outsourced much of their technical development and maintenance work and diverted their resources to employing business analysts, rather than technical experts (Grant, 2007). In a recent White Paper, IBM emphasised a need for more professional IT Service Managers with a deep understanding of the business and its processes in order to facilitate meaningful discussions with business colleagues about their needs (Salvage and Dhanda, 2007). Thus, analysts employed in future will increasingly be engaged in continuous improvement of business processes, not development of technical solutions from inception to implementation. It is vital therefore that educational programmes are designed to reflect this, discussing not development of IT but redevelopment of organizational processes incorporating IT (which may or may not include new IT systems or artefacts). For these reasons, the units described here focus upon information and context, rather than the technologies by which data is processed. This is the essence of the distinction between computer science and informatics (Langefors, 1966).

A person who is ignorant of the role and context in which application of particular tools is appropriate will be unable to use them except according to particular rules and instructions. Judgment in the use of tools requires a deeper understanding.

This is apparent from, e.g. Ciborra's (2002) discussion of the role of bricolage in development of useful systems – improvisation can only take place from a platform of skill and understanding in the principles, tools and techniques upon which good design is founded, i.e. informed judgment.

Rigour in professional practice is of course vital. To be able to select and apply tools, you first need to learn about the 'correct' role and application of those tools. E.g. a trainee bricklayer will first learn to build small walls in a workshop environment. The walls are not intended to serve any purpose but s/he learns about the integrity of walls, including the skills in the use of a trowel, correct mixing of mortar, and correct alignment of bricks. Every type of skilful professional activity has its own standards of rigour, relating to the purpose of that activity and to quality choices. Appreciation and assessment of risk is another important factor here. Relevance emerges in selection of an appropriate tool for the kind of work to be undertaken in context. Possibly, adaptation or invention of an appropriate tool will be needed where none exists for a particular purpose. Again, ability to make informed judgments is critical here. Understanding how scale and complexity impact upon context and therefore choice of appropriate tools and techniques is a further aspect of relevance in practice. The greater the consequences of failure, the greater the importance of attention to relevance. A professional needs to know when selection of relatively minor items can be crucial to overall success. Thus, a rope to a rock climber may not be expensive but his life may depend upon selection of the right for his purpose.

What are we educating people for – relevance or rigour? Is it meaningful to educate people in methodological toolkits? On the one hand, methodologies have been developed in order to 'professionalise' the approach taken to systems analysis and development – focusing on rigour. On the other hand, methodologies have been criticised as being naïve, restrictive, unwieldy, etc. – not supportive of relevance. Fashion can have an impact in influencing professional

education – methodologies come into and go out of vogue with no relation to their actual usefulness to professionals in context. The past twenty years have seen a move from structured to OO methods. Structured methods were developed as a response to the perceived inadequacy of ad hoc approaches. OO was then promoted because of perceived inadequacies in solutions 'not designed'. Thus, professionals (and their educators) may have attempted to solve a problem of lack of skill in application of tools by substituting a different tool – the problem, however, persists. Educators may have focused on drilling students in particular techniques within a methodology, without providing them with expertise in application of the toolkit to a contextual problem space.

References

Argyris C., and Schön D. A. (1978). *Organisational Learning*. Reading Mass: Addison Wesley.

.Avison, D.E. and Fitzgerald, G. (2006). *Information Systems Development.* 4th edition, McGraw Hill

Avison, D. E., Wood-Harper, A. T. (1990), *Multiview: An Exploration in Information Systems Development*, McGraw-Hill

Bateson, G (1972), *Steps to an Ecology of Mind*, Chicago University

Bednar P. M. (2000). 'A Contextual Integration of Individual and Organizational Learning Perspectives as Part of IS Analysis'. *Informing Science.* 3(3). 2000

Brown, G., Bull, J. and Pendlebury, M. (1997). Assessing Student Learning in Higher Education. Routledge

Champion, D., Stowell, F.A. (2001), "PEArL: a systems approach to demonstrating authenticity in information system design", *Journal of Information Technology*, Vol. 16 pp.3-12.

Checkland, P. (1999). *Systems Thinking, Systems Practice:* a 30-year retrospective. Wiley

Cherns, A (1976). Principles of Socio-technical Design. Human Relations, Vol. 2, pp 783-792

Ciborra, C.U. (2002). *The Labyrinths of Information*. Oxford University Press

Engel, C.E. (1991) *Not just a method but a way of learning.* In Boud, D. and Feletti, G. (eds) The Challenge of Problem-Based Learning, London: Kogan Page, pp. 23-33

Flensburg, P. (2008). 'The new informatics revolution – not', *IRIS* 31, Åre, Sweden, 10-13 aug 2008

Friis, S. (1991). *User Controlled Information Systems Development*, Dept of Information and Computer Science, Lund University

Grant, I. (2007). 'India deal clears Skandia's app maintenance backlog,' *Computer Weekly*, 6 November 2007, p.4

Jarvis, P. (2006). *The Socratic Method, in The Theory and Practice of Teaching*, 2nd Edition, 1(3) July 2006 , pages 90 – 97

Kreher, H. (1994). 'Some recurring themes in using SSM', *Journal of Operational Research Society*, 45, 1293-1303

Langefors, B. (1966). *Theoretical Analysis of Information Systems*, Studentlitteratur

Madsen, S., Kautz, K., and Vidgen, R., (2006). A framework for understanding how a unique and local development method emerges in practice. *EJIS*, 15 225-238.

Mathiassen, L., Munk-Madsen, A., Nielsen, P. A., and Stage, J., (2000). *Object-Oriented Analysis and Design,* Forlaget Marko

Mathiassen, L., and Purao, S., (2002). Educating reflective systems developers. *Information Systems Journal*, (12): 81-102

Mumford, E. (2003). *Redesigning Human Systems*. IRM Press

Mumford, E., Hickey S. and Matthies, H. (2006). *Designing human systems : an agile update to ETHICS*. Lulu.com

Omland, H.O. (2009). 'The relationships between competence, methods, and practice in information systems development', *Scandinavian Journal of Information Systems*, 21(2), 3-26

Salvage, I. and Dhanda, I.S. (2007) IBM White Paper. *'IT Service Management: is it now too important to leave to the IT department alone? How and why the IT function needs to change its relationship with the business'*. IBM Global Technology Services, September 2007, viewed at http://whitepapers.theregister.co.uk/search/?q=IBM 11 November 2007

Smith, M.F. (1991). *Software Prototyping: Adoption, Practice and Management*. McGraw-Hill, London

Shore, J. and Warden, S. (2008). *The Art of Agile Development*. O'Reilly Media Inc

Stowell, F. and West, D. (1995). *Client-led Design: A Systemic Approach to Information Systems* Definition. McGraw-Hill

Tishman, S. and Palmer, P. (2005). Visible Thinking. *Leadership Compass*, n.p. retrieved 24 April 2010 from http://pzweb.harvard.edu/tc/content/thinkingDispositions/VT_LeadershipCompass.pdf

Ulrich, W. (2001). 'Boundary Critique', in *The Informed Student Guide to Management Science*, H.G. Daellenbach and R.L.Flood, editors, 2002, London: Thomson Learning