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An Enhanced Product-Process Design Pattern

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Abstract

This paper discussed design patterns in Information Systems. It presents an enhanced 'product - process' design pattern that integrates governance, project management, project context and, particularly, quality. The pattern is used to bring coherence to the teaching of Information Systems development projects. A 'Project Management Support System' has been developed to reify the pattern enabling its practical use in education. The possible use of the design pattern approach in Information Systems is considered.

Keywords

Design Pattern, Systems Product, Systems Process, Stakeholders, Quality, Project Management and Governance, Education

INFORMATION SYSTEMS, ARCHITECTURE AND DESIGN PATTERNS

Information Systems (IS) practice has to do with coming to an understanding of the data, information and knowledge in a complex human activity system (HAS) and intervening in that HAS by modifying information systems in an effort to improve the lives of stakeholders.

Architecture is analogous to Information Systems. *Architectural* practice has to do with coming to an understanding of the *spatial aspects* of a complex human activity system (HAS) and intervening in that HAS by modifying *buildings an*d *landscape* in an effort to improve the lives of stakeholders.

In 1977 Christopher Alexander published "A Pattern Language" and, two years later, "The Timeless Way of Building". These books capture the very human nature of designed change:

> ... when you build a thing you cannot merely build that thing in isolation, but must also repair the world around it, and within it, so that the larger world at that one place becomes more coherent, and more whole; and the thing which you make takes its place in the web of nature, as you make it. (Alexander 1977 p. xiii)

Architecture is more concrete than IS, but the disciplines share many fundamental principles.

An IS intervention will change the way data, information and knowledge is created and used in an organisation. It may involve the implementation of a new or modified computer based information system, changes to enterprise processes, operations, architecture, management; internal and external relationships and so on. These changes are made through systems projects of different kinds and ultimately they change the nature of the organisational setting in which they are implemented.

Alexander's design pattern approach attempts to balance the professional, engineering approach with the real, human, on-the-ground impact of development projects.

> Historically, the modern "rational" design paradigm was both a contributing factor towards and a byproduct of the professionalization of design. Rational design is distinguished from traditional craftmanship by its "selfconscious" separation of designs from products..., its use of analytic models, and its focus on methods that anyone with sufficient formal training may apply. Analytic designers first make tractable models (from simple blueprints on up) that are analyzed and manipulated into a form that specifies construction. Rational design was in many ways a major advance over traditional methods. However, ... the notions of analysis and synthesis are badly, and harmfully, construed in architecture and artifact design, leading to the sterile study of methods that have no bearing on the vast majority of artifacts actually built or the work involved in developing them. (Lea 1997)

There are many valuable ideas and experiences in the IS community. However, there are only the vagaries of scholarly publishing and personal experience to guide developers in their professional work. Would a 'design pattern' approach to reporting these ideas and experiences allow a more coherent and complete picture of IS practice to be assembled? The design pattern approach has been adopted in Object-Oriented software development (Gamma et al 1994; El-Salam et. al. 2006, Portland Pattern Repository), in education (Goodyear 2004; PedagogicalPatterns), in organisational analysis (Bell Labs 2006) and in other fields. The 'pattern language' in those fields does seem to provide some framework for the collection and promulgation of knowledge concerning practical problems and solutions. New technologies, particularly the Wiki, offer so far untapped possibilities to support a broad design pattern approach to the capturing and promulgation of IS knowledge.

This paper presents a high-level design pattern concerning IS project development. The pattern attempts to capture knowledge about systems development projects for use in teaching and practice, and as a formulation of an idea to be criticised, tested and modified.

THE PRODUCT-PROCESS PATTERN

The motivation behind this pattern, or model, is to represent a coherent overview of factors involved in the creation of an intervention in a human activity system. This pattern encapsulates the ideas of systems projects in a form that is useful for understanding and communicating the nature of an intervention, for managing a project and for ensuring that the impacts of projects are such that the "larger world at that one place becomes more coherent, and more whole; and the thing which you make takes its place" (Alexander op.cit).

The 'waterfall' model of systems development (eg. Sommerville 2004 p.66) is an example of the traditional product-process model. The waterfall model recognises a series of processes, each of which creates a product or artefact that is input to the next process. An analysis process creates a requirements document, the design process uses the requirements as input and creates a design, the construction process used the design and creates an artefact, etc. The two entities are process and product. Each step follows a traditional input-process-output model:

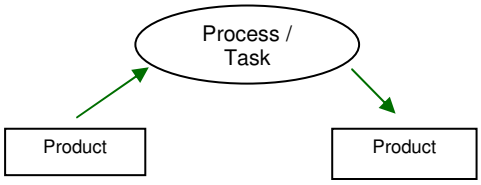

Figure 1: The traditional product - process (input-process-output) model

The model applies at any level of granularity. A process might be huge and complex (build an entire system) involving many sub-processes. Or it may be small and simple (prepare a management presentation). Similarly, a product might be complex (an entire systems specification) or simple (help on the filling in of a field on a screen). This idea of granularity is very important in the discussion to come.

Unfortunately, the coherence of systems development can be lost in teaching and in practice. Developments are complex and interesting so focus at any one point is given to some particular aspect at the expense of the whole, or given to some present problem at the expense of the bigger picture.

Enhancements are needed to make this simple model powerful as a pattern for learning and practicing systems development. Firstly, it is the impact of products, not their development, that is most important from the IS perspective. The point of systems projects is intervention, not artefact creation. Every product has impact on those associated with it (stakeholders). Secondly, every process is executed in a rich human, organisational, managerial and governance context. These two attributes of development need to be specifically built in to the model. Lastly, the model needs to be reified to make it effective in learning and practice; that is it needs to be built into the world of which it is a part. Patterns are abstractions and descriptions, but, like computer programs, become powerful and active when executed.

AN ENHANCED PRODUCT-PROCESS PATTERN

The idea behind the enhanced model is two fold. First it identifies the constellation of factors that influence projects. In particular it retains the core of the traditional model then (a) adds layers for governance, project management and quality assurance, and (b) identifies organisational resources and context for processes. Secondly it uses the concept of granularity to allow all processes, especially the smallest, to be quality assured and so to be conducted in the holistic, responsible and professional manner.

Governance Layer

The investment in an IS project and the organisational benefits that flow from that investment are better seen as governance, rather than management issues. The governance layer includes the organisational executive that establishes strategy and policy and the project management office that determines priorities between projects.

Project Management Layer

The traditional features of the Project Management Body of Knowledge (PMBoK) (PMI 2000; Schwalbe 2005) are incorporated in the model as a layer over any process. It causes the process to be planned, monitored and reviewed. Much current project management education looks to risk reduction and the protection of the project manager through professionalising the management process. The project manager is a stakeholder in the project, but that can lead to management being an end in itself rather than a facilitator of a high quality intervention for other stakeholders.

Process Resources

Traditional project management is based in cost, time etc as expressed for example in the 9 knowledge areas from the PMBoK. However, important resources are not addressed in that set. The knowledge of actors, for example, is a vital resource often recognised only when it is not present. The development of personal and organisational knowledge is a vital success factor and the process knowledge created in the project itself is a significant resource that is often lost. The process actors are stakeholders so need consideration in the project.

Other resources needed to make a process effective include relevant and useful tools and techniques, a recognition and conformance with policy, procedures and standards, access to organisational history and access to external information that might improve the process.

Process Context

The character of the organization that is conducting a project influences the manner in which a process is conducted. The power structures provide the capacity for responsibility and authority of actors while organisational culture and networks support them in their process activity.

Quality Assurance

Three points of quality assurance are identified in the model - process quality, product quality and impact quality.

Process Quality concerns how well a process was conducted. Conformance with relevant standards and good development practice is one classic means to assess this quality (eg. AS/NZS ISO 9000).

Product Quality verifies the quality attributes of a product in isolation from its use. A product being tested against its functional specification is an example of assessing product quality. Conformance with external product standards (eg ISO/IEC 15288) may be relevant for some products.

Impact Quality is of two types. Firstly, 'fitness for use' which concentrates on the relationship of the product with the actual user, that is, it views the product as instrument in, or as input to, some other process. To determine impact quality an assessor identifies who is the product for, what it will be used for, and what the context of use is. Secondly, 'stakeholder impact' considers the affects that the system has on the people, organisations and society who are not direct users of the system. In the end, it is this broader impact that is the final determinant of the quality of the system.

Quality Assured work is 'evidence-based'. That is, there is evidence that quality of the work has been explicitly defined and measured. Both process and product have quality attributes and, in a quality assured project, measurements of these attributes are recorded, the processes auditable and the product itself testable. It is said that 'if you can't measure it, you can't manage it'. But of course not all quality attributes are quantitative. Some of the most important qualities have to do with perceptions and values. Take the quality 'fits well with the strategic direction of the organisation'; while this quality attribute cannot be measured, it can be argued for (or against!).

While there are general quality standards, 'quality' always relates to some specific object, event or impact. General ideas about what to measure (correctness, modifiability, testability, usability, reliability, efficiency, integrity, reusability, interoperability, etc.) can be useful guides but each unique product, process and impact needs its own quality criteria to be established and satisfied.

This proposition leads to the idea that every single product and process needs to have embedded in it the means to assess its own quality. Imagine for instance each object in an object-oriented system having not only its own data and services, but also its own methods of evaluating itself.

The enhanced Product-Process Pattern is as follows:

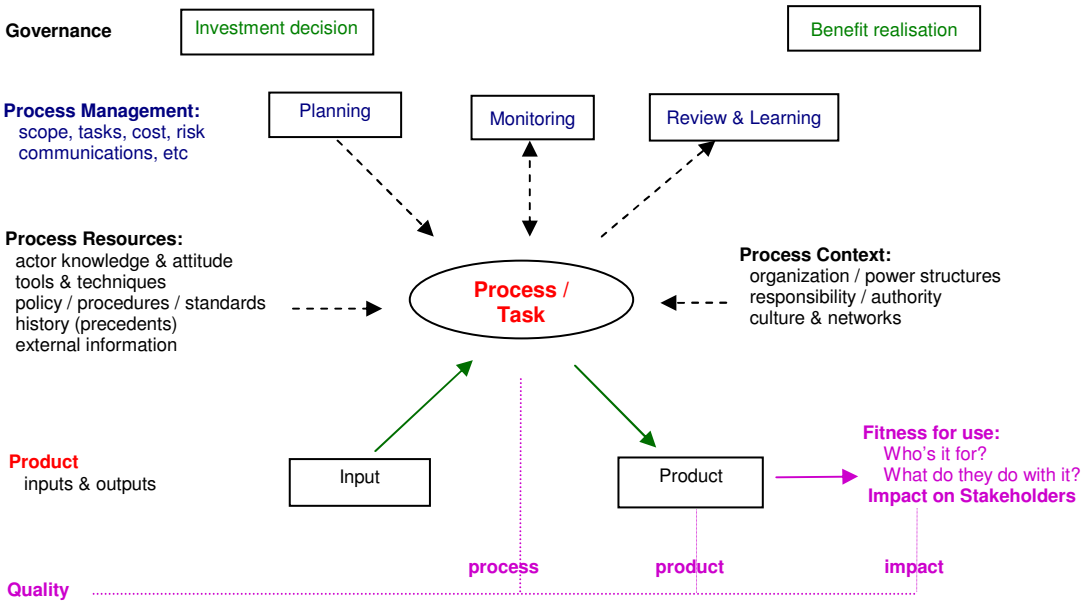

Figure 2: The enhanced product - process model

The key point in systems projects is the integration and interaction of all these model components rather than the division of these components into separate independent parts. The model invites a systematic approach to projects that allows each component to be considered in its own right, but then to focus each component on its contribution to the whole effective intervention.

REIFYING THE PATTERN: A TEACHING SUPPORT SYSTEM

Teaching from a coherent and encompassing pattern promotes the integration of component knowledge. To activate, or reify, the pattern a 'Project Management Support System' (PMSS) has been developed. The system supports a student team in the various aspects of project development.

Figure 3 shows a screenshot of one part of the system. The menu on the left has the following functions:

Home:	the PMSS system home page.
About the Project:	the project home page containing details about the project and the project team.
Issue Log:	The risk management facility allowing risks and issues to be noted and tracked.
Deliverables:	A document management facility for project products (configuration management).
Messages:	An email facility for sending and tracking communications.
Meeting Log:	A meetings organiser with agendas, minutes with issues linked to the issues log, action allocation ant tracking.
Contact:	An address book used for communications.

The main part of Figure 3 is a list of deliverables for the 'Fishman' project. PMSS contains a set of templates for typical project documents. Students select and modify templates appropriate to their own project and can create their own deliverables. Notice that these templates are organised by stakeholder type. Embedding quality into project work can be facilitated by explicitly catering for exactly who will be impacted by each process is and each product. PMSS embodies this idea by having students specify quality criteria for each development process and deliverable as they create it. Meeting the interests and needs of stakeholders is the key to a good quality project.

Figure 3: Deliverables page of the Project Management Support System

At the start of a project, typical stakeholders include the following :

The project team itself, which is responsible for the professional conduct of the project and for meeting the needs of the team members;

The re-developers, those who have to understand and change the system in the future;

The system/business owner, who as an investor expects to benefit from the returns the system brings;

The system's immediate users, who interact directly with the system and who have to adapt to the changes it brings;

The systems manager responsible for the operations of the technology including security, backups, etc;

The business manager, who administers the departments in which the system has been implemented (see Bowern et al 2004; Pouloudi 2000).

Of course, as each project is unique, the range of stakeholders diverges rapidly from the typical case. But if the principle of catering to all stakeholders is sound, then lessons learned from typical cases can be applied to each new situation.

To implement quality assurance in the PMSS, each template has a set of quality criteria built in as the final section of the document. The idea is that every process and every product should have its specific quality criteria made explicit. Figure 4 shows an example of this section from a System's Owners Manual.

SYSTEM OWNER'S MANUAL

6. Quality Assurance

The purpose of this manual is to address the interests of the system's owner by describing the facilities in the system and other methods that the owner can use to ensure the system is meeting needs.

6.1 Stakeholder Validation

The people affected by this product, and their interests, are:
Owner: benefits realisation, manageability
Line Managers: responsibilities, skills, reporting issues
Board: Governance issues

6.2 Process of Document Development

This document was constructed from
meetings with the client (see minutes..)
meetings with line managers (see minutes ...
a review of text books (see Thomsett..)
comparing with the content of other systems owners manuals

6.3 Traceability

Other documents that are related to this is are:
Project Charter - the agreement that specified the scope and character of the system
Business Managers Manusl - operational details about workflow

6.4 Verification

This document was tested against other owners manual.
Simulation was used to test the owner's facilities under unusual situations (see test pack ...). Line managers tested the EIS for accuracy (test ...).
Usability was examined (Test ...)

6.5 References

Schwalbe K (2004) Information Technology Project Management
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6.6 Document History

Figure 4: Quality Assurance Section of a System Owner's Manual

The System Owner's Manual may be created for upper management or governance level executive responsible for the business area in which the system is installed. The opportunity to design executive level facilities into operational systems is often neglected in favour of more mundane data processing aspects. The very existence of this template in the PMSS raises the awareness of the student developer that he/she has to actually consider the executive level in the environment that surrounds her technical designs. Similarly, the system's technical manager, as a stakeholder, needs diagnostic facilities built into the system in order to be equipped to carry out his/her task.

The quality section of each product (section 6 above) requires all stakeholders to be identified. The interests and purposes of those who use, or are affected by, the product are specified. It then addresses the process of product creation and the means by which the product can be, and was, validated. The 'references' section attempts to ground the work in reliable knowledge.

Once the student developer recognises that each stakeholder deserves explicit individual consideration, the scene is set for responsible (Bittner & Hornecker 2002) and quality design work.

Assessment of Systems Development Education

The assessment of student's work reinforces the idea of embedding quality of process and product into their project work. The assessment of a typical systems development project is conducted this way:

1. Product and Impact quality is examined from the standpoint of each stakeholder including:
system owner - how do I know I am getting the benefits promised?

various operational users - can I use this system effectively and efficiently in my day-to-day tasks?
line manager - can I better manage the workflow of this business process?
external stakeholder - am I being affected, perhaps by doing work that used to be done internally, or by carrying additional carrying risk?
next developer - can I modify the system easily?
systems manager - can I ensure the stability, reliability, resilience of the system?
auditor - can I examine the system? The academic is in the role of auditor in the assessment of the project.

2. Process quality is examined using the evidence collected in PMSS of project planning, modification and review; team management; communication, information & configuration management; and risk prevention, detection, and correction.

3. Students' learning is examined by an individual reflection and an assessment of the contribution of their peers, coupled with reviews from clients and other systems stakeholders. The tutor's review focuses on the innovation and creativity students bring to the task, their perception and insights and the way they have built their own learning into the process of system development.

This section of the paper has discussed the reification of the enhanced product-process pattern in software and its use in a teaching setting.

CONCLUSION - DESIGN PATTERNS FOR INFORMATION SYSTEMS

The enhanced product-process pattern, and the PMSS, is set in an educational context to try to bring a more holistic view to students of what 'good' IS project work should be. Every time students address the quality of a process or product they improve the system of which it is a part and they improve their own personal capability to do the right thing. These improvements are not trivial. Being responsible for action (or inaction) involves knowing who will be affected by the action, knowing the affects, caring about them. This paper has reported on an educational approach that fosters these ideas.

But there are many valuable ideas and experiences in the IS community. Would a 'design pattern' approach to reporting these ideas allow a more coherent and complete picture of IS practice to be assembled? ISWorld has started a collection of IS theories (Schneberger & Wade). With a little thought, these could become design patterns for researchers and a 'pattern language' might emerge that allows these theories and associated methods to be elaborated and interrelated. But what of IS practice? The increasing acceptance of Design Science (Gregor 2006) needs to be complemented with a pattern language and IS patterns.

This paper has shown one high-level pattern (enhanced product-process) and how it is being used in a specific context (teaching IS project development). This paper has not attempted to construct a pattern language for the project aspects of IS - that is a very different venture.

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