THE DEVELOPMENT OF A PROCESS MODELLING METHOD.

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Abstract.

This paper introduces the Process Engineering Framework. This is a new method which shall be published as a book. The method is concerned with the contribution of an IT system as a whole and emphasises the importance of understanding the organisational context. This paper describes its origins and presents the framework of activities which constitute the research agenda for its development.

Introduction.

On 'process.'

What do we expect of 'process?' Apparently a simple concept it has become laden by ill defined usage, differing contexts and high expectations. We hear of business processes, software processes, reengineered processes, redesigned processes, mature processes and evolved processes. We wait for a paper which defines the common and uncommon characteristics of the many initiatives which rely upon a concept of process. This paper seeks only to describe one method, the Process Engineering Framework.

For our purposes a process is defined as "a set of identifiable, repeatable actions which are in some way ordered and contribute to the fulfilment of an objective," Kawalek (1993). Thus, we recognise that work is made up of many processes (e.g. opening and sorting mail, developing an insurance quote for a broker). This is an intuitive understanding of process but we recognise that the fashionable Business Process Reengineering (BPR) initiative is concerned with process as a high level, end to end concept, Hammer and Champy (1993).

We are interested in processes because businesses need to be able to design and maintain the way they work in order that they can operate effectively and flexibly. Hence this interest in process is shared by the management communities who developed and propagated the TQM initiative, for example Bank (1992), and more recently BPR. We are also interested in processes because the IT systems which we design must serve work processes. As people carry out processes, and IT systems serve them, we develop our understanding of processes as way of mediating between the requirements of people and the functionality of IT systems.

Coordination Technology.

The IPSE 2.5 project sought to develop a computer environment suited to the support of software development work. It was an ambitious project, which sought to "provide

a set of facilities to support people and organisations" Warboys (1990) and to "raise the level of integration within the support system above the store-plus-tools approach", thus becoming an "integrated framework" Snowdon (1989). Hindsight shows its intentions in good light in that there is now a plethora of workflow, groupware and process enactment type technologies which address similar issues. These alternative technologies are genealogically different to each other (e.g. office automation, database, IPSEs) and so their common characteristics are all the more remarkable. We can ascribe to them membership of a genus, 'coordination technology,' which is revealed by the coordination of teams, the integration of tools and the automation of processes.

Using the IPSE 2.5 project as a basis, we hypothesised in 1990 that this process based approach to the support of software development could be extended to other application domains in the wider business community. Moreover, we believed process modelling to be a suitable basis for the development of a method which would explore an organisation's requirements of IT and exploit the benefits of the new coordination technologies, Evans et al. (1991). This led to the development of the Process Engineering Framework through empirical research[1]. Collaborative action research projects have been undertaken with a number of companies, including an international insurance company, an IT procurement agency, a telephone billing centre and a software development team in a safety critical context.

1. The development of the Process Engineering Framework is sponsored by SERC. It is intended that it shall be published in late 1995.

Orientation.

The Process Engineering Framework has been influenced by sociotechnical design, for example Mumford (1983) and systems thinking, for example Checkland and Scholes (1990). Process modelling is used as a complex hermeneutic process which involves talking to users, trying to understand their point of view, drawing diagrams, checking, correcting, examining preconceptions and so on. As well as the modelling of processes, the Process Engineering Framework supports the evaluation of their effectiveness, their evolution and their support through advanced coordination technology such as workflow. It is intended that it can be applied as a cycle so as to support the management of processes. In placing most weight upon the need to explore organisational context, to develop this context, and to make IT serve it, the method accords with the polemic of Earl who states that IT must not be treated "in isolation, or, even worse, above the business." Earl 1992.

Although it is always subject to the practical restrictions of the project scope, the method seeks to take the broadest possible view of the relationship between an organisation and an IT system. It is concerned with relationships such as that which exists between an IT system as a whole and its organisational context, the relationships between roles at work and the relationships between parts of an IT system. It seeks to synthesise these parts of an IT system so that they serve as a unified whole. Where it is appropriate it may use high level coordinative technologies to 'glue' IT components together. For these coordinative technologies it can be seen as a systems development method, but, for the components they glue together (e.g. databases, off the shelf packages) it exists only at the domain analysis and requirements levels.

Foundation.

The Process Engineering Framework builds upon the foundation laid out in the Process Modelling Cookbook, Kawalek (1991). The name of this method was chosen to reflect the intention of gathering a useful collection of techniques rather than a single prescriptive dialogue. The core dynamic of the Cookbook is a learning cycle which involves two iterating phases of 'process representation' and 'process refinement' through which a process model is built and then analysed. These phases each incorporate defined activities.

Process representation emphasises the importance of dialogue with the participants of a process to discover how work is really carried out. It is concerned with knowledge elicitation so that the resulting process model describes a user's interpretation of his or her work and not some procedural or managerial view of it. The Cookbook suggested that a process be modelled using a number of complementary techniques. Among them were Role Activity Diagrams (RADs) which remain vital to the modelling approach of the Process Engineering Framework (see "Baseline Process Capture.")

The refinement phase also requires dialogue with participants. This dialogue is concerned with perceived problems and objectives. Where these problems and objectives require change to the process there is the opportunity for modelling the proposals and the analysis of their likely implications. The phrase "the metric of the user's view" is used to describe the sub-phase of the method where the opinions of participants are

input. Checkland and Scholes (1990) argue that there is a need to explore user's perceptions of reality and that methodology should be systemic. The Cookbook has a similarly phenomenological stance in as much as it recognises the likely requirement for a reconciliation of perspectives when considering process change.

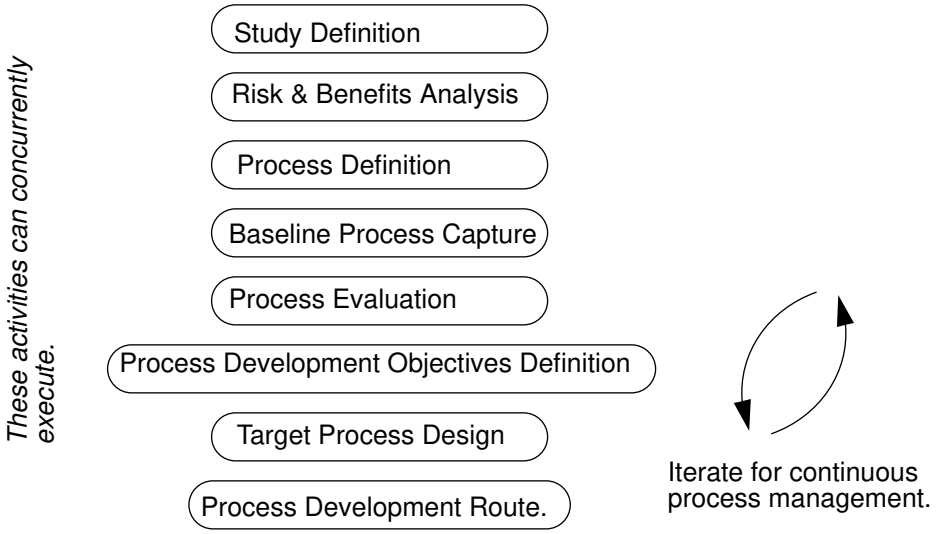
The Process Modelling Cookbook has the following features. These have been inherited by the Process Engineering Framework:

- The Cookbook seeks to investigate a work process and through this explore the inter-relationships of activities, people, objectives and support technology.
- The process model provides a standpoint from which the interlocking components of IT support for a process can be viewed. Note that the Cookbook encourages us to think of process support in a broad way; computer based technology may only be a part of it.
- The Cookbook provides a framework for continuous process management. In doing so it recognises that a process is dynamic. Changes to a process are likely to have implications for support technology requirements.

The Research Agenda.

The simple two phase structure of the Cookbook has been refined into a more detailed framework of activities. These activities form the core of the Process Engineering Framework. They are introduced below as an agenda of research issues which are being addressed by the IPG. Figure One summarises the framework which was originally presented by White (1992.)

Figure 1: The Process Engineering Framework.



Study Definition.

The Study Definition activity aims to obtain and then maintain a definition of the aims of the study. It is necessary to do this in order to clarify the study objectives, its scope, constraints and the concerned participants. Normally a preliminary study definition will have to be revised as new concerns come to the fore during the course of a study. Carrying out a process modelling study can be itself a very complex process. The availability of a clear study definition by which to navigate can be the difference between success and failure.

Risk And Benefits Analysis.

The Risk and Benefits Analysis activity does two things. First, it aims to ensure that likely risks and benefits arising from a study are recognised and judged to be acceptable. Secondly, it makes it possible to identify the change opportunities and priorities identified by the process owner, participants and modeller respectively. This makes it possible to reconcile differences or clarify strategy.

To date this activity has been undertaken through assessment and judgement and without the aid of simulation packages. However, we are assessing the utility of simulation packages (especially discrete event simulation).

Process Definition.

The objective of the Process Definition activity is to obtain and maintain a clear definition of the *objectives* of the studied process, its boundaries and interfaces. This is important in that it makes it possible to scope the study, clarify the process objectives and forms the basis for evaluation of the process.

A process definition can be obtained through discussion with managers and participants, examination of documents and analysis of the interfaces of a process. However case studies have shown that it can be naive to assume that there will be agreement as to the objectives of a process, see for example the case of 'Pineapple Computers' in Wastell et al. (1994).

As well as defining the objectives of a process it should be possible to categorise it. This is an immature area which needs further research. Process categorisation is concerned with the recognition of common characteristics between different processes. This may lead to reuse opportunities. The support technology for a case management process might be instantiated in very different domains such as a customer services department of a large IT company or a lettings office of a government housing agency. The core activities are the same in each case (e.g. receive and log query, assign query to relevant expert, prescribe course of action). It is hoped that categorisation of processes will help in the identification of common issues and facilitate benchmarking between industries.

Baseline Process Capture.

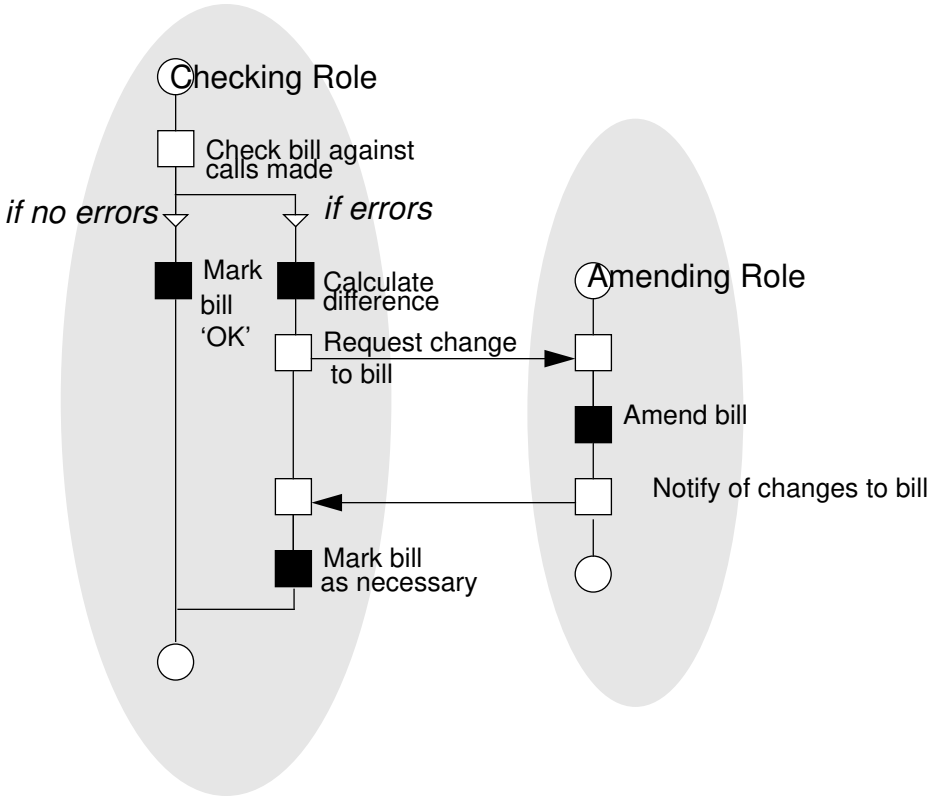
The objective of the Baseline Process Capture activity is to develop a model of an existing process so as to aid understanding, isolate issues and provide a platform for

change projects. The IPG have been concerned with evaluating and developing techniques and software tools which can be used to model processes. The approach which is being developed for the Process Engineering Framework uses IDEF0 diagrams and Role Activity Diagrams (RADs).

IDEF0 is a familiar technique which originated as the Integrated DEFinition method of the US Air Force ICAM (Integrated Computer Aided Manufacturing) Program. An IDEF0 diagram focuses on activity. It shows required data or objects input to the activity as an arrow entering from the left. Any number of data or objects can be shown. In a similar way objects or data are shown exiting the activity from the right side. Business rules or controls are shown as arrows entering from above whilst mechanisms (e.g. IT support) are shown as arrows entering from below.

IDEF0 diagrams are used to provide a high level 'umbrella' for more detailed RADs. RADs are a less familiar technique which originate from the work of Holt et al. (1983). They describe roles, actions and interactions. The feature which makes them particularly powerful is that role is a modular concept. The modeller is able to identify and describe modules of work activity which make up the responsibilities of a team or individual. These modular units may be reusable (i.e. the work they describe may be common to a number of staff and/or processes). A very simple RAD example is shown below. In it, a checking role interacts with an amending role. More details on RADs can be obtained by reference to Kawalek (1994.)

Figure 2: An example Role Activity Diagram.



It is important to be clear about what we are doing when we build process models. We are representing human activity. It is tempting to build process models which suggest that people follow procedures akin to the way in which a computer executes an algorithm. Fikes (1982) has pointed out this folly. Avison and Fitzgerald (1988) have shown that in part it arises because the notations we use rely on abstraction and generalisation. It also arises because in interviews staff will provide simplified descriptions of the way in which they work for the benefit of the interviewer. Thus, they will say "When I have finished doing *X*, I start doing *Y*." One of the first problems in building a process model is to try and understand the reasons why *X* precedes *Y*. Does the ordering matter? It may matter in a nuclear power plant, but is it significant in a telephone company, or an insurance business? The reality of office work is characterised by contingency and ad-hoc solutions, Gerson and Star (1986). Considerable effort needs to be expended to make process models reflect the reality of work and not a normative ideal. Even then, the modeller is wise to be aware that actions are situated in and determined by a context, Suchman (1987).

Process Evaluation.

Process Evaluation seeks to provide an agreed assessment of the value and capability of a process. Feiler and Humphrey (1993) have provided a listing of "process properties" upon which such assessment can be based. Among the properties suggested are the following:

- Accuracy: This is the degree to which the product or outputs of the process match the intended result.
- Fidelity: This relates to the faithfulness with which a defined process is followed.
- Scalability: This is concerned with the range of workload which the process can accommodate.

These process properties have proved to be useful as a basis for evaluation of processes. However, it is intended to add to this the use of metrics and simulation in order to enrich the Process Evaluation activity.

Process Development Objectives Definition.

The objective of the Process Development Objectives Definition activity is to set the direction for development of the process. Inputs to this activity will be the Process Definition (which may be reworked as a consequence) and the Process Evaluation.

Among the issues which will need to be addressed are the types of benefits that are sought, the goals to be aimed for as the change plans are implemented and whether to go for evolutionary or revolutionary change. The output from this activity will be a statement of objectives which is input in the Target Process Design activity.

Process Design.

The Process Design activity aims to develop a revised model which can be implemented in place of the extant process. It is likely that a target process will be modelled

using the same notation as the baseline process. When a target design is arrived at it will be seen as an ideal, an archetype which will be implemented by a certain date if all else stays the same. However, it is acknowledged that rapid change is characteristic of the modern business world. Therefore, it is likely that the target process design will have to be revised and this may occur before it has ever been implemented.

The Process Design activity incorporates the development of computer support for a process. The method recognises that to introduce new technology to an organisation can affect its process, and that to change a process can require alterations to the support technology. This managing of the relationship between the support technology and the organisation is at the heart of the method. This is why, earlier, we stated that process can be seen as a mediator between people and the support technology.

Recently we have been involved in a collaborative project with an insurance company. This focused upon process design. The project has resulted in the development of a prototype of a support system for use by underwriters and administrators. A brief description of the project is given below.

A Process Design Case Study.

The insurance company is international with offices in three continents. This project took place in their U.K. headquarters, although the project to which it has contributed is concerned with the development of a pan-European IT strategy. The project culminated in a series of workshops with users in which the prototype was very well received.

The company have invested heavily in two worldwide databases, one for in progress work and one for active policies. However, currently their business processes are characteristically manual. Most work is done using bulky paper files which contain the policy submissions received from brokers. These are used by underwriters who scour the details of the submission as part of their risk assessment. They add handwritten notes to the files which describe the reasoning which underpins their decisions about premium quotes and so forth. Administrators use paper forms upon which they hand write summary details of each submission. These are attached to the files. At specified points in the process the information contained in these forms is transferred to a database. Cases which progress to the successful negotiation of a premium will be entered into both databases thereby requiring duplication of effort. Locally, in order to remedy perceived information shortages, initiatives have resulted in the development of new databases (e.g. containing brokers names) using systems such as Paradox. Although these do remedy the information shortages, they add to the problem of repeated data entries. Certain items of information now have to be entered in triplicate to databases and at least once to paper forms. This, we might argue, is a fine example of succeeding with analysis but failing with synthesis.

The aim of the collaboration was to develop a prototype system which would demonstrate benefits to the business. Four key criteria were highlighted. First, the shortening of the time taken from receipt of a submission to the booking or declination of that business. Secondly, the reduction of duplicated data entries. Thirdly, improvements to the quality of captured information. Fourthly, promotion of the profile of the company as one which is concerned with quality and pleasant to deal with.

The initial part of the study was concerned with Baseline Process Capture using IDEF0 and RADs. We worked closely with users who expressed how they work, how they might like to organise their work and the ideas they had for the prototype. When we moved on to the Process Design activity we used the IDEF0 and RAD models to help us identify and structure the way in which IT systems can contribute to the process. Thus the prototype includes provision for an on-line summary sheet of each new business submission, fax facilities to allow easy communication with brokers, support for letter writing and policy generation and premium calculation modules.

We carefully considered how these services should be presented to users. We sought to maximise the flexibility of the system so that it was suitable for a contingent and dynamic work environment. We developed a simple state model for the support system. This provides a loose governance over which services were available to the user at any particular state in the progress of a submission. An on-screen 'in-basket' shows the user which items of work are allocated to him/ her. Thus, if an underwriter selects a new submission from his/ her in-basket a range of possible services will be presented on screen. If he/ she then selects a different item from the in-basket which has reached a later state of process (e.g. a quote has already been issued to a broker), a rather different set of services would be made available. Many services are available in more than one state. The range of services available is also affected by the status of the user. That is, non-managerial administrators are able to access only a subset of the services presented to underwriters.

The prototype was developed using ICL's ProcessWise Integrator (PWI)[1]. This is the product derivative of the IPSE 2.5 project. PWI is a workflow-type technology which has its own language, the Process Management Language (PML). This allows its behaviour to be prescribed as a process with roles, actions, interactions and entities. This invites a simple mapping from RADs, which have a very similar vocabulary. However, in practice, we were not satisfied by the means of translating from RADs to PML. We are currently undertaking another collaborative project to try and address this problem. This new project will also develop Staffware and Lotus Notes demonstrators.

Process Development Route.

The objective of the Process Development Route activity is to work out how an organisation can progress towards a target Process Design. This may involve the development of interim stage models whereby the organisation plans to incrementally introduce certain parts or aspects of a target process.

Conclusion.

In this paper we have introduced a number of important characteristics of the Process Engineering Framework, viz:

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1. Note that the prototype was also successfully developed using Powerbuilder, a GUI tool developed by Powersoft. The lessons of this particular implementation are not considered in this paper.

- It seeks to take the broadest possible view of the relationship between an organisation and the technology which supports its processes.
- It is concerned with the relationship between the organisation in general and its support technology and between component parts of the support infrastructure.
- It is intended that the framework of activities can be applied as a cycle so as to assist with the management of processes.
- It utilises high level coordination technology (such as workflow) to provide support for activities and to provide a loose integration mechanism between IT components such as databases.

The Process Engineering Framework is at heart a process modelling method. Any user of it can expect to spend a lot of time talking to those who carry out work, representing the information in a model, reviewing the model and revising it. The process model is used to develop understanding and, ultimately, to help mould the relationship of work activities with the technology that supports them. In order to appreciate how much this approach can contribute there is a need to better understand the positioning of the Process Engineering Framework against that of other methods.

The research agenda for the Process Engineering Framework is ambitious. It requires that a number of activities are well understood and described. Some parts of the framework are better developed than others. We may seek to develop different parts of the framework on different time scales. Currently, there is a need to undertake further action research projects. In particular, we seek to gain further experience of process design activity and the development of coordination technology.

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