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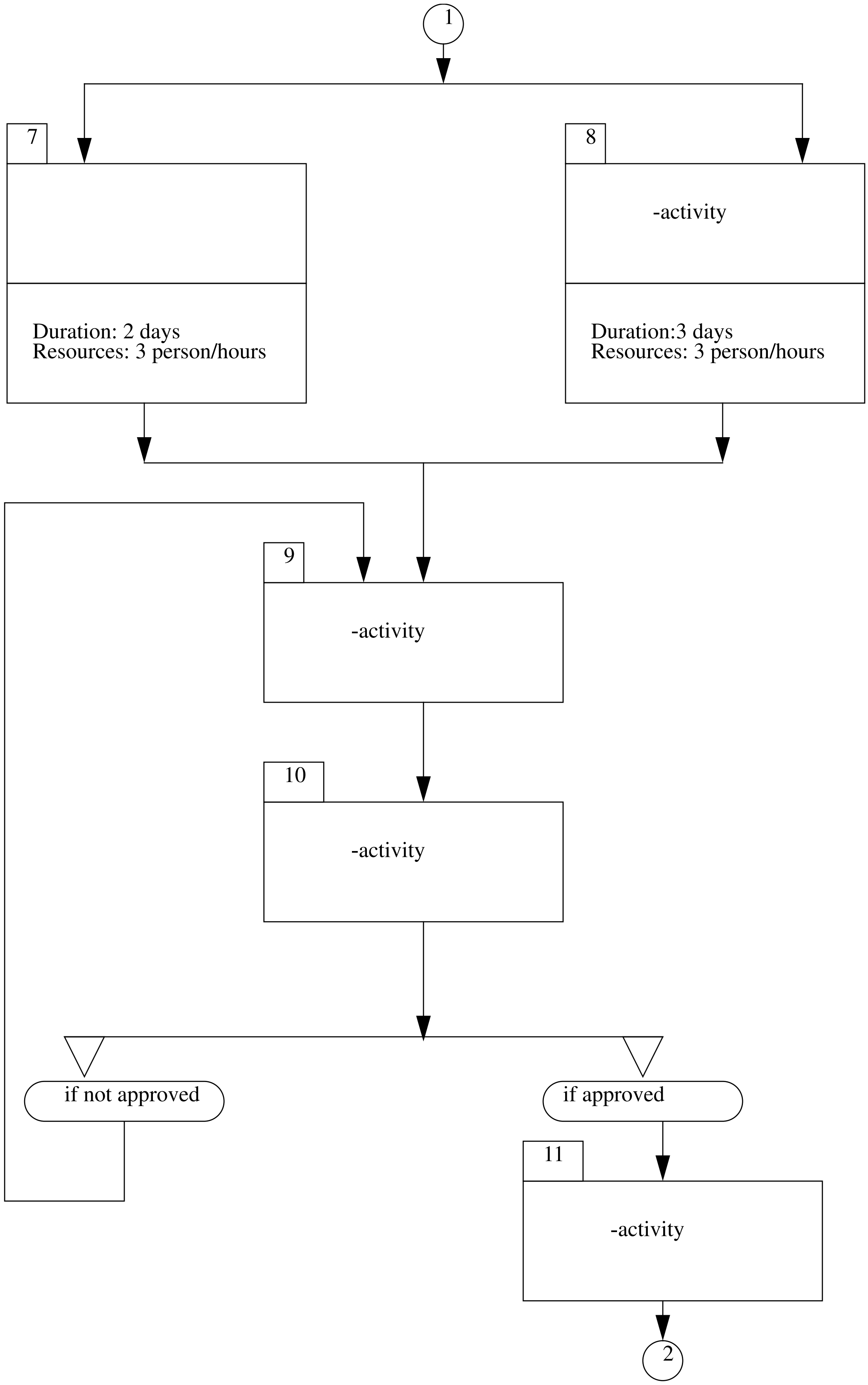
## 3.0 Decomposition

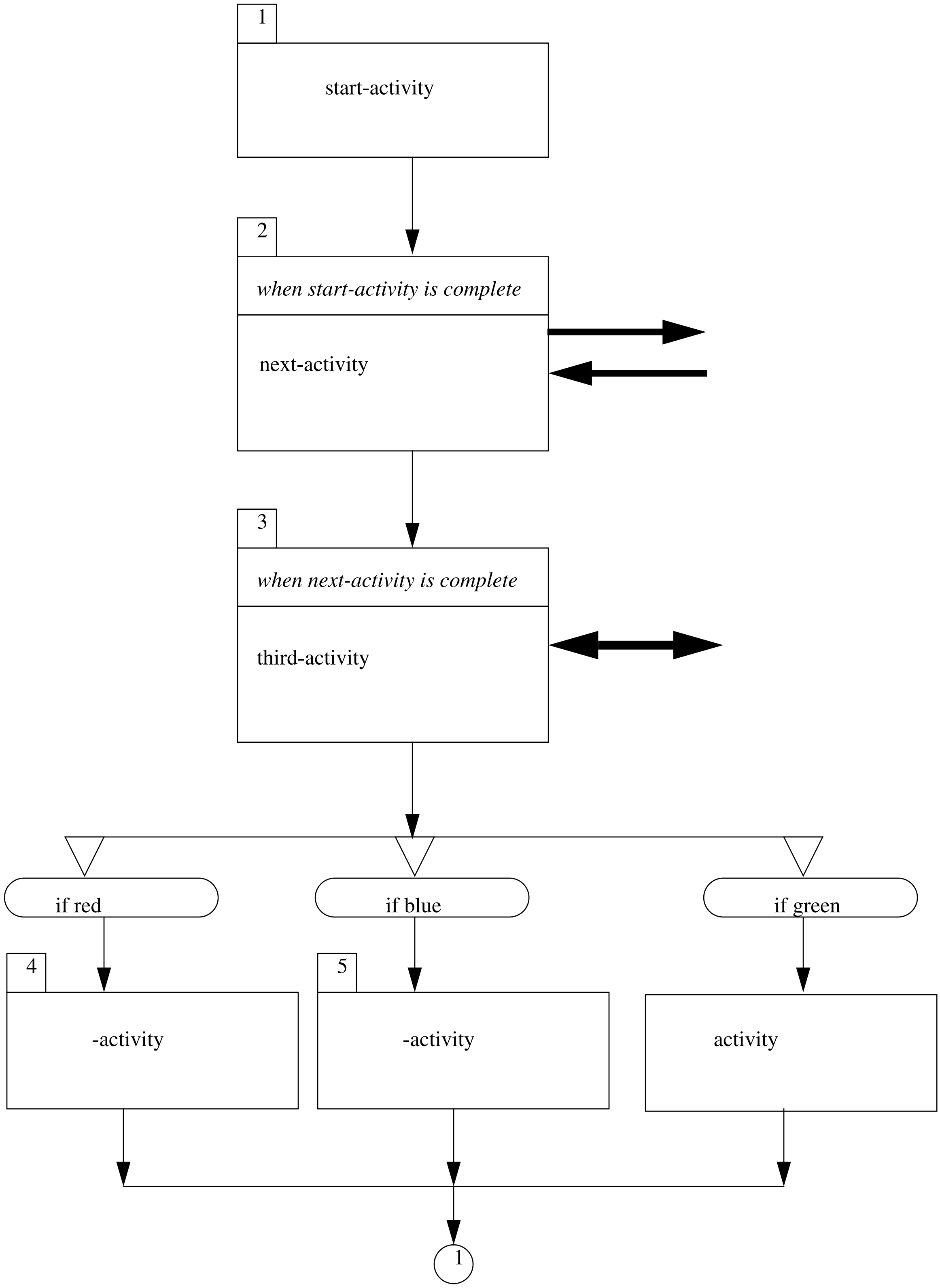
It must be possible for any activity box to be itself decomposed into its own activity diagram.

## 4.0 Modes of Use

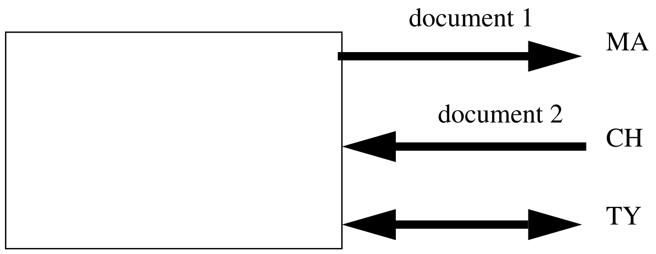
There should be “View/Analyse Only” and “Diagram Construction” modes of use.


1
7
Duration: 2 days
Resources: 3 person/hours
8
-activity
Duration:3 days
Resources: 3 person/hours
9
-activity
10
-activity
if not approved
if approved
11
-activity
2

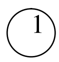
## 2.0 Example diagrams



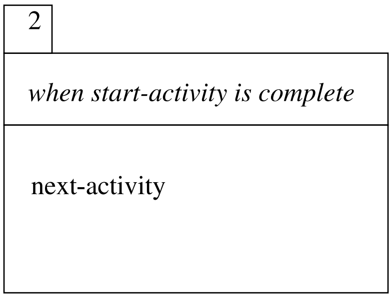
1.7 **Bold arrows attached to activity boxes indicate INTERACTIONS. Single-headed arrows indicate INPUT or OUTPUT. They may be labelled for content and Source/destination. Double-headed arrows indicate dialogue.**



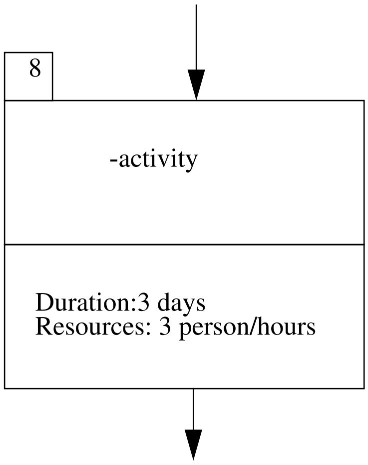

1.8 **Circles containing a unique identifier indicate a point in the process. Thus they may be used to indicate iteration (return to identified point), or to link diagrams where one process is spread over more than one diagram.**



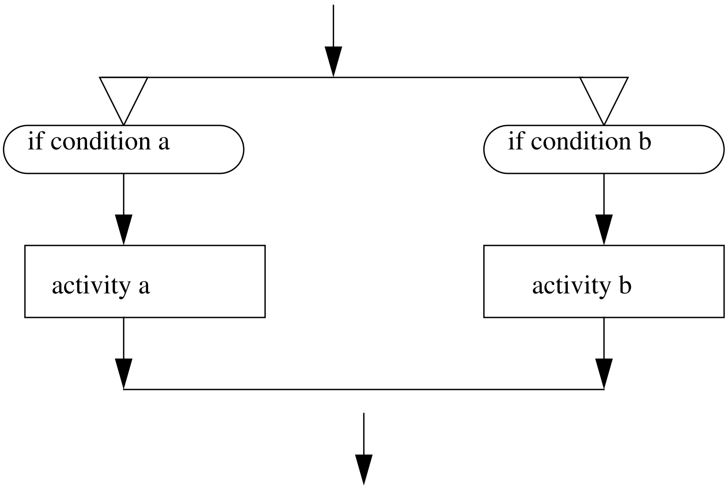
1.6.2 They may have CONDITIONS for their performance, which are displayed in a sub-rectangle at the top of the activity box.




1.6.3 They may have a further unlimited number of attributes, to be defined by the tool user, which may be displayed in a rectangle beneath the activity box.



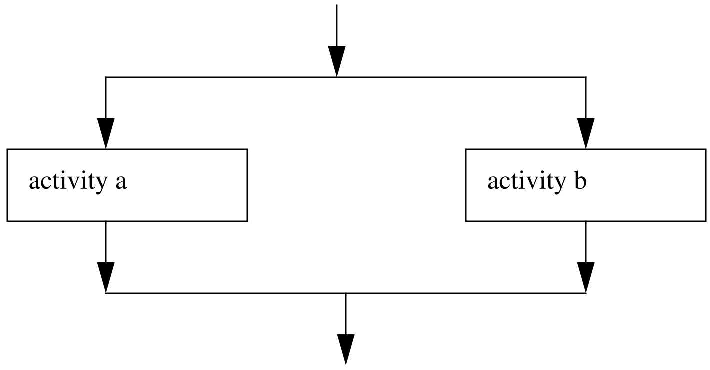
## 1.5 Paths may have ATTRIBUTES, consisting of CONDITIONS, and FREQUENCY of occurrence (as a percentage). These may be displayed in rounded rectangles immediately below the triangles.



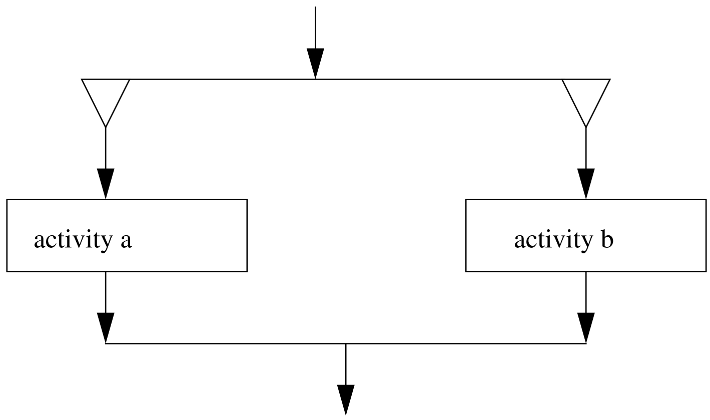

## 1.6 Activities also have attributes.

### 1.6.1 They may be given an IDENTIFIER, which may be displayed in a box to the top left of the activity box.

### 1.3 Links may branch and merge, indicating that activities occur CONCURRENTLY




### 1.4 ALTERNATIVE paths are indicated by inverted triangles at the top of branching paths.

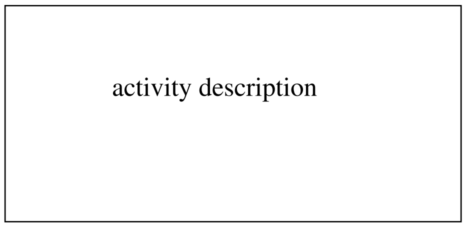


# Appendix 1: Requirements for an Activity Diagram Editor

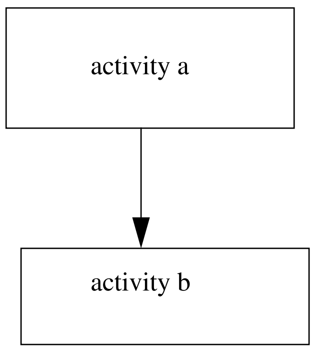
The following provides the outline of requirements for a tool for constructing and viewing Activity Diagrams, which may be used for representing processes.

## 1.0 Semantics

### 1.1 Activity boxes consist of rectangles, which contain text forming an ACTIVITY DEFINITION




### 1.2 Activity boxes are linked by directed lines, indicating PRECEDENCE.



It is desirable to be thinking some way ahead.

One possibility which we have examined is the creation of a series of targets for the process, each with a date for implementation. The aim would then be that should be convergence of the process as practised with the target processes. Obviously close targets would be more highly detailed than those further in the future. Detail would be added, and changes made as necessary, to target processes as their implementation dates approached.

# 20.0 Specification of Requirements for Automated Process Support

The models developed for the target process should show those parts of the process which will be automated, and how IT will support the rest. It remains to extract from these models all the requirements for IT support for the process and turn them into a specification of requirements.

# 21.0 Conclusion

## 21.1 Further development of the PADM

The major area of the PADM still needing development is the “Specification of Requirements for Automated Process Support”. However, there is still work to be done in the area of Process Evaluation. The notations for process modelling still need further development, in particular the full integration of Base Model techniques.

Usually several root definitions will be constructed in order to reflect different views of the process. These should be reconciled in the later stages.

### 18.4.2 Soft Process Modelling Method

From the root definitions there are constructed what SSM terms “conceptual models”. These contain the essential activities needed to achieve the objective identified. Different conceptual models may be unified in order to cover different objectives contained in the root definitions. Conflicts contained in those definitions can then be identified, and dealt with in discussions with process owners and participants.

Once a unified conceptual model has been agreed it can be transformed into a Dependency Diagram, and this in turn will be the basis for building an Activity Diagram as more detail is gradually added to the process design.

### 18.4.3 Use of Workshops

Workshops were found to be very useful in the early stages of the redesign. They provide the opportunity to bring together all those with a say in the final shape of the process. It is most important to bring together the right people for the workshops. The process engineer should act as a facilitator, helping formally but not substantively in the production of root definitions and conceptual models. The process owner(s), and the various kinds of process participant need to be represented. However, given this, smaller workshops work better and make quicker progress. Problems have been encountered where the client is neither process owner nor participant but has sought representation in such workshops.

### 18.4.4 Cultural Stream

The main aim of the cultural stream of analysis is to check that proposed solutions are socially workable as well as technically optimal. There are many possible reasons why technically good solutions may fail in practice. The solution will always have to be acceptable to the client and the process owner; in most cases it will need to be acceptable overall to the process participants.

## 19.0 Process development route with interim process stage models

It is usually not sufficient to just design a target process, it is necessary to work out how the organisation is going to progress from their baseline process to that target process.

Reasons for:

- - Participants will understand it when it is implemented
- - Aids in foreseeing possible complications
- - Helps prevent alienation of users

## 18.3 Evolution

The evaluation phase should have highlighted the areas of concern in the baseline process. Suggestions for improvements to these areas may come from the process engineers, process owners or process participants. The problem then is firstly to check the feasibility of the suggested improvements. This may be partly answered by the process managers, but it is hoped that analysis and simulation facilities in process modelling tools may also help. The second problem is in ensuring that suggested changes do not interact with one another in unforeseen ways. Again, analysis tools could be most helpful here.

## 18.4 Redesign

The methods which we have been developing for process redesign are based on Soft Systems Methodology as developed by Checkland [CS90]. SSM provides a basis which is particularly well suited to this phase because:

- - It recognises the socially constructed nature of the phenomena with which we have to deal, and suggests methods of working with this
- - It is designed to handle ill-defined problem situations. Organisational situations are usually complex and difficult to understand
- - SSM provides means of examining the objectives as well as the techniques of a process, it deals with the ‘what’ as well as the ‘how’. There is often a need to balance objectives in the organisational context
- - SSM provides ways of dealing with the social as well as technical factors in process design

### 18.4.1 Start from Process Definition

Any redesign will have to start from the process definition.

The process is equivalent to what SSM terms ‘purposeful human activity systems’. The objectives of process may be described in terms of the ‘root definitions’ used in SSM. The root definition looks at the following aspects of the process:

- Customers : the victims or beneficiaries of T
- Actors : those who would do T
- Transformation : the conversion of input to output
- Weltanschauung : the worldview which makes this T meaningful in context
- Owner(s) : those who could stop T
- Environmental constraints: elements outside the system which it takes as given

### 16.5 The Advantages and Disadvantages of Metrics

It is a truism that measurement is better than guesswork, but an informed judgment of the vital parameters is better than measuring the wrong things.

## 17.0 Process development objectives definition

This is concerned with setting directions for process development, deciding the type of benefits to be aimed for, setting goals to be aimed for along the development route, deciding whether to go for evolution of the process or a revolution.

Inputs to it will be the "Process Definition" (which may need reworking) and the Process Evaluation. Also required will be details of constraints on process development, in terms of resources, available skills etc.

### 17.1 Evolution or Redesign

The major question to be settled at this stage will be whether the process should be completely redesigned, or whether the process engineer should seek to refine the baseline process. It is possible to do both - to produce a complete redesign from first principles as a target at which to aim, but then seek to evolve the process towards this target, rather than attempt a sudden switch.

## 18.0 Target process design

### 18.1 The Role of the Target Process

Initially our view was that the target process should be fixed, and then implemented. This was part of our outlook on process engineering as a ***terminating*** process. If we view it as continuous, however, then the target process itself may be seen as "that at which we aim": the process the organisation would like to have in place, possibly by a target date, *all else remaining the same.* However, in the real world all else does not remain the same. Thus the target process will need to be revised.

### 18.2 Necessity for a Participatory approach to target process design

As opposed to outside experts coming in, sucking out data, disappearing with it to analyse it, and reappearing with a "solution" which the participants are left to try and implement. The less mature the process the greater the need for process participant involvement in the design phase.

All types of process participant need to be represented

- “Fidelity: The faithfulness with which a defined process is followed.... Fidelity is related to enforcement”. This measure is practical but white-box. It requires a clear model of the *prescribed* process, an understanding of the process by the evaluator, and an extended period of observation. Since observation is likely to prejudice the result, it will be very difficult to obtain an accurate and reliable evaluation. Evidently one may look at enforcement techniques, but again in practice there tend to be ways of evading enforcement which will not necessarily come to light. Thus it may be more useful to look at

- “Fitness: The degree to which the people or machines enacting the process can faithfully follow actions it specifies”. In other words how easy it is to follow the prescribed process - how practical, clear, coherent, and convenient it is. The more fit a prescribed process is, the more closely it is likely to be followed. Fit may be assessed through analysis of a process model, controlled trial, or in practice. It is a measure to apply to a prescribed process.

- Precision: Relates to the detail in which a process is prescribed. It is a measure to apply to a prescribed process. It should be noted that higher precision is not necessarily better for all processes.

- “Redundancy: A process step is redundant if its removal would not alter the results of the process”. Straightforward redundancy in the sense that a single step could simply be removed is quite rare. More commonly a sequence of steps might be replaced by a shorter sequence.

- Scalability: The size of workflow which the process can accommodate. It is important to know how easy it is to scale operations up or down in response to changing workload, and the points at which the efficiency and effectiveness of the process start to fall. Some assessment of this may be gleaned from process participants, but for redesigned and untried processes an analysis of a process model is desirable.

- “Maintainability: The degree to which the process is designed to readily permit static or dynamic process evolution”. The ability of processes to evolve is becoming increasingly critical. Feiler and Humphrey talk about the aspects of process which are like software - “Maintainability is achieved through localization of information, a cleanly structured design, and well architected interfaces”. These points are very relevant. However, we believe that this only tells part of the story, and that much more work needs to be done on what makes a process easy or difficult to evolve. Certainly human factors are very important in this.

## 15.4 Verification of the baseline Process Model

It is most important to verify the correctness of the baseline process model. The obvious way is by sample observations of work in progress

# 16.0 Process evaluation

## 16.1 Types of evaluation

There are three orthogonal types of evaluation:

- 'black box' / 'white box'. The process may either be assessed as a whole, looking at its added value, the reward for resource, its effectiveness etc.; or the component parts of the process may be examined.
- absolute - comparative. The process may be assessed in absolute terms or in comparison to other possible solutions
- formal - informal. There may or may not be attempts to quantify aspects of the process.

## 16.2 Categorisation of the process

This uses the categories for process type, level and maturity which are detailed in Section 4.

## 16.3 Efficiency and Effectiveness

Ultimately the value of a process may be reduced to a combination of its:

- effectiveness - how well the process achieves the aims set for it
- efficiency - the value of its output divided by value of resources used

However, this has to be looked at over the long term, to take into account such things as reliability and flexibility of the process

## 16.4 Feiler and Humphrey's "Process Properties"

Feiler and Humphrey [FH] have outlined the following process properties, which give some very useful dimensions for the evaluation of processes. We have taken the basic ideas and expanded on them, and attempted to relate them to our requirements.

- "Accuracy: the degree to which the product produced by the process matches the intended result." This measure is both exterior to the process (black-box) and practical. It requires a clear definition of the intended result such that actual results may be meaningfully compared to it. It is a measure to be applied to a baseline process. It is an important aspect to assess.

#### 15.2.1 Divergence between the baseline "Process as practised" and the prescribed process

It is most important that the baseline process "as practised" is captured. In the analysis phase an investigation of the reasons for divergence may be highly useful.

### 15.3 Sub-phases of baseline process capture

| STAGE | INPUT | OUTPUT | VERIFICATION |
|---|---|---|---|
| 1 Familiarisation | Discussion with managers Documents | None | N/A |
| 2 Identify work-groups and key process participants | Discussion with managers Documents | Text | None |
| 3 Identify activities | Semi-structured interviews with key participants | Text | |
| 4 Organise text into Process Charts | Output from 2 &3 | Process Charts | |
| 5 Link activities according to dependence | Process Charts, and semi-structured interviews with participants | Dependency diagrams | Interviews with key participants |
| 6 Build activity diagrams | Output from 4 and 5, plus structured interviews and documents | Activity diagrams | Interviews with key participants |

#### 15.3.1 Familiarisation

This is a necessary phase for process engineers who are not part of the focus group. They may need to learn the "language", or conceptual framework used by the people from whom they have to learn about the process.

#### 15.3.2 Identification of work groups and key process participants

In processes where there are a large number of people performing similar roles it is not practicable to interview all process participants.

#### 14.3.3 Relationships of objectives

All would be very neat and simple if organisational objectives formed a hierarchy, such that objective A would met by achieving B and C, which would be met by achieving D,E,F, and G, etc. However, in practice the situation is far more complicated. Objectives may conflict, or they may interleave, such that a sub-objective contributes to the achievement of more than one higher-level objective.

## 15.0 Baseline process capture

### 15.1 How important is the capture of the baseline?

Great stress was laid in the early days of Cookbook on the capture of the baseline process. We still view this is a most important part of the method, as long as there is a baseline process in existence. Evidently there will be situations where a group is attempting something completely new. Our experience has also shown, however, that there are situations where there has been some attempt to organise activity towards the achievement of goals, but these goals and the ways of achieving them are so ill-defined that there can hardly be said to be a “process” in place at all. In these situations it will be necessary to call a halt to attempts to produce models of the baseline at an appropriate moment.

### 15.2 Data Gathering, Organisation and the Process of Abstraction

Data gathering can easily fall into one of two traps - either too much raw data being collected, taking an excessive amount of time, and being very difficult to process, or being very rushed and incomplete.

What we have observed in practice has been modellers building up a model of the process in their heads, then trying to get it down on paper in the diagrams. All the raw written data from the interviews was used only in helping to build up these mental models, and to help other modellers who hadn’t been present at the interviews to build up their models. there was no real attempt to work on, or develop this data in any formal way. The sheer bulk of the data worked against this. It was however present as a check and a fall-back.

The method which we present below for the capture of the baseline process attempts to provide a more structured approach. We suggest a cycling through a series of frameworks, using the Process Charts, Dependency Diagrams, and Activity Diagrams. The early processing of data (by the use of these notations) is regarded as essential, if the intervention is not to be bogged down under the weight of data.

In interviews we emphasise the value of first hand data (what the interviewee does), as opposed to second hand data (what the interviewee is responsible for getting someone else to do), or third hand data (about what someone else entirely does).

Besides this, the process definition helps determine the extent to which two enactments should be viewed as enactments of the same process.

Also it is essential to the efficient functioning of any process that the participants are clear as to what their process is supposed to achieve and how their work contributes towards this.

In this area, perhaps more than any, it is important for the modellers not to create their own answers, but to help clarify those of the managers concerned. Process modellers are not business strategists.

## 14.3 Obtaining the Process Definition

This may proceed by:

- Examination of documents
- Unstructured discussions with managers
- Workshops and discussions based on SSM techniques

### 14.3.1 Process boundaries

These may be initially sketched out along organisational lines, i.e. the work done by the staff answerable to a particular manager may be deemed to be the focus process. However, this is only a rough and ready guide, and not in itself sufficient. The acid test as to whether any particular activity is part of a given process or not, is whether it contributes towards the objectives of that process.

### 14.3.2 Process objectives

It may be that a clear and coherent statement of the process objectives can be quite readily obtained from the client or process owner. However, it is still important to check this with the other parties (clients, owners, and participants). It is not uncommon for there to be disagreement about the details of the objectives. Also there may be occasion to revise the statement as the study progresses.

The obvious starting place is the examination of relevant documents. These yielded plenty of high level or “mission statements” of objectives, but little which would indicate what the output of the process should be. Discussions with managers revealed a consensus that, in general terms, their business was the production of systems integration information, but it was felt by both sides that a tighter definition than this was required. Latterly we have introduced a more structured approach based on Soft Systems Methods.

### 13.1 Evaluation of what is achievable in terms of different types of benefits

#### 13.1.1 Possible potential benefits

Cost-cutting by:

- cutting out activities
- cutting out waiting time
- cutting out interactions (especially across organisational boundaries).

Improved manageability of the process

Improved product definition, and improved product

Better targeting of resources

#### 13.1.2 Relation of anticipated benefits to type of process

The owner of a mature process might look for optimisation - cost-cutting, pruning, and stream-lining. On the other hand, in an immature process we might look for gains in consistency, manageability, improved product definition, and improved product.

## 14.0 Process Definition

### 14.1 What does it do?

It is based on the Soft Systems idea of a “root definition” and it does the following:

- Defines the objectives of the process
- Defines the boundaries and interfaces of the focus process
- Categorises the focus process

### 14.2 Why is it necessary?

- To determine what is required of the process
- To scope the investigation
- For evaluation of the process

A most important part of any PM study lies in obtaining a clear definition of the process, in terms of what the process exists to achieve. It helps in scoping the study, in deciding which activities are part of the process and which interface to it; it helps the modellers understand the process; and it is essential to the evaluation of the process and in process redesign.

owner'. Often in hierarchical organisations a manager at one level may make certain changes to the process, but more radical changes need to be referred upwards.

### 12.3 Use

Scoping - depth and breadth of study

Resource allocation (particularly manpower)

Defining the relations between actors in the study - engineers, clients, owners and participants

Providing a framework for their communication

Placing the study in the organisational context

Defining constraints

### 12.4 Form

The study definition is a communication and consensus-forming activity. Typically it will be performed through meetings and the production and distribution of a regularly updated document set detailing objectives and the state of the study.

### 12.5 Output

A definition of the aims of the study, a plan for their achievement, identification of the players of the major roles, and their responsibilities in the study.

### 12.6 Change

The activity needs to be revisited during the course of the study, as many aspects of the definition may change. In particular the objectives may change as the study proceeds. It may, for instance, be impossible to tell at the start of a study whether the process will only need optimising, or whether a complete redesign will be required.

## 13.0 Risk and Benefits analysis

Brings together the process owner's priorities on types of process improvement with the findings of the modellers, and the desires of the participants

Ensures the risk level is always acceptable

should be an on-going activity, and on later iterations some stages will require very little work. For instance the target process may have become the baseline process for the next iteration.

A high degree of concurrency is desirable and should be attainable between the above phases, although they should commence in the above order. In particular process evaluation needs to start as early as possible

# 12.0 Study Definition

Checkland and Scholes report that for SSM "... it was found useful to think of an intervention in a problem situation as itself being problematical."[CS90] The implication of this is that the process engineer needs to understand the structure that underpins his/ her involvement in a work environment.

## 12.1 Objectives

The main objective of this activity is to obtain and maintain a clear definition of the purpose of the study. Experience has shown that this purpose is often only understood in very general terms at the outset of the work by any of those involved. It may be expressed as a desire "to improve the process", or "to see if there is scope for improvement".

## 12.2 Roles

There may be different parties involved in the study, all with their own interests, and their own ideas about what would constitute improvement to the process.

The following roles have been identified as occurring in any study:

- process engineers - those undertaking the study
- clients - those who commissioned the study
- process owners - those with the power to implement changes to the process
- process participants - those whose work is part of the process

It is important for the working out of the objectives of the study, and for the smooth running of the study, to identify who is playing each role, their organisational relationships, and where their interests lie. The same people may play several (or indeed all) of the roles. Indeed commonly the clients are the process owners. However, all groups involved will have their own interests, and these need to be reconciled as far as possible. Where they cannot be reconciled (if, for instance, the process owners wish to cut the number of process participants) then the differences at least need to be known in order to be smoothly managed.

### 12.2.1 Identifying the role players

It should be noted that roles may be played by groups rather than individuals. The only role where there is likely to be a problem identifying the player is the 'process

# Part 2

## 10.0 Use of the PADM

The method was initially designed for our own use, i.e. for the external expert coming in to an organisation for a one-off project. However, we have attempted to develop it in such a way that it is usable in all forms of intervention.

Evidently the balance of effort between the various component activities will vary according to the type, and the particular circumstances of the intervention. In some cases an activity may be completely absent - for instance if a new process is being designed there will be no baseline to capture or evaluate. However, this will be the exception rather than the rule, and we would recommend that the activities all be at least visited, and periodically revisited, to make sure not only that there are answers to the questions raised in those areas, but that the answers remain applicable.

## 11.0 Component Activities in the Engineering Process

The following activities have been identified as the major elements in any process engineering exercise:

- **Study definition**
- **Risk and Benefits analysis**
- **Process definition**
- **Baseline process capture**
- **Process evaluation**
- **Process development objectives definition**
- **Target process design**
- **Process development route**
- **Specification of Requirements for Automated Process Support**

These phases are designed on the basis of the intervention being done on a ‘one-off’ basis, or for initiating process development. However, process development

We see SSM [CS90] as a providing a set of potentially very valuable techniques in the critical areas of process definition and target process design. The "root definitions" used in this method equate very closely to process definitions, and provide a way of organising, examining and analysing the objectives which drive a process. SSM provides a way of moving from these definitions to "conceptual models of a system", which we can equate to high level process descriptions.

We are currently investigating other ways in which systems thinking can be applied to process modelling.

## 9.0 Forms of Process Engineering Intervention

Three different forms of process engineering intervention have been identified as being appropriate in different circumstances.

- One-off projects
- Regular projects
- Continuous process

### 9.1 One-off projects

As process engineering is a skilled activity, one-off projects to analyse and improve a process will usually need to be carried out by outside experts.

### 9.2 Regular projects

Alternatively the process may be revisited on a periodical basis.

### 9.3 Continuous Process

As indicated above we believe that process engineering may in many organisations best take the form of a continuous process, linked to monitoring and control. The process engineer then would be a member of the organisation, and quite possibly a process participant.

procedure manuals and/or the managerial (process owner) view of the process. This was recognised to be inadequate in that it failed to capture essential detail about how things were ***actually*** done as opposed to how they ***theoretically*** were supposed to be done. The refinement of this involved the outside process experts spending a lot of time interviewing process participants and analysing the data gained. It has also been necessary using this approach for the outsiders to understand a lot about the process before significant progress can be made.

A much more efficient way of working is to get process participants to do as much of the actual modelling as possible, with role of the outside process engineers being one of ***guiding, facilitating, and co-ordinating.*** There are a number of advantages to this:

- A reduction in costly time and effort required of outside process engineers.
- Increased participant awareness of process
- Transfer of process engineering skills to process participants, leading to an increased ability of groups to reengineer their own processes
- Increased buy-in to the process engineering process by staff. This buy-in can be critical to success
- Increased commitment to their own process from participants.

### 8.6 Process design is a socio-technical activity

The process designer is engaged in the examination of the activities of organisations, which will, in large part, be carried out by people. The social and technical aspects of these processes are inseparable. The designer may pay no attention to the social aspects, but the social aspects will be affected by the technical ones, and will in their turn affect them.

### 8.7 The Use of Soft Systems Methods (SSM)

It can be seen through investigation of the emerging theoretical structure of process modelling that it has much in common with Soft Systems Methodology. Systems theory identifies the world as containing structured wholes or objects. Components of the structure are potentially or actually involved in complex inter-relationships. Soft systems theory applies these concepts to ‘unstructured,’ complex problem areas where human perceptions and relationships have a significant impact and there is unlikely to be a simple, single solution. Process modelling uses the concept of ‘process’ as a framework for exploring and describing the relationship between parts of a system in a way which is especially suited to work activities. Thus the following quote might equally apply to systems thinking or process thinking:

“....an approach to a problem which takes a broad view, which tries to take all aspects into account, which concentrates on interactions between the different parts of the problem.”

It is in fact Checkland’s description of a systems approach [C81]. Process modelling is different in that through the concept of process it has a prescribed framework intended for meaningful, objective oriented exploration of the work activity sub-system of the greater systems world.

- Identity of Inputs: Each enactment of the process should use inputs of the same type
- Identity of Outputs: Each enactment of the process should produce outputs of the same type
- Regularity of inputs/throughputs

#### 8.2.1 Amalgamated processes in a model

There can be a place for such models, but we need to be aware when we have one. They can mislead one into thinking one has a unity.

### 8.3 Concurrency in the Process Modelling Process

The naive model of process modelling process consists of a series of stages which are passed through on the way to production of a process model, which is then analysed, and acted on. Each stage has a deliverable which forms the basis of the next. it became apparent during the course of this project that it would be much more fruitful to view the PM process as consisting of a number of ***concurrent*** activities. This helps the modeller come to terms with the fact that the baseline process they are examining is a real-world process, subject to the exigencies of the organisational situation in which it occurs, and thus is in a state of continual change. This change would be occurring to some extent even if the modelling were not being done, but is accentuated by the fact that shortcomings in the process will be made visible to the participants during the modelling.

In the real world in which businesses operate there is often pressure to enact improvements of a tactical nature quickly, without waiting for a baseline model to be drawn up, analysed, the strategic changes to the process to be agreed, the target model to be drawn up, and the approach to implementing changes to be determined. Of course, rapidly implemented changes have a higher risk of proving unsuccessful unless their ramifications are analysed, and so a limited tactical level run through of the “later” activities may be needed. Also these changes may eventually be superseded by changes decided on in the strategic context, but they will still often be worth making in the interim.

### 8.4 Process Engineering may be a Continuous Process

The PM process is often seen as a ***terminating*** process, i.e. a number of stages are gone through, a result is achieved (an improved process) and then the PM stops, until it is felt necessary to go through it again. A PM method should indeed be capable of being used in this way, but in many situations, especially those subject to rapid change, it is more valuable to see PM as a ***continuous***, non-terminating process, similar in nature to planning and monitoring processes, and linked to them.

### 8.5 Client Participation in the Process Engineering Process

Concurrency goes hand in hand with an approach whereby the main actors in the process engineering process are the owners and participants in the process being modelled. Early approaches to process modelling worked exclusively from

### 7.5 Data dictionary

The tool must provide a data dictionary.

### 7.6 Capacity to run simulations

The tool should be able to provide dynamic analysis of the model, including the running of 'what-if' scenarios which will show such things as bottle-necks, traffic levels, and resource use under different loadings of the process.

## 8.0 General Guidelines for Process Engineering

### 8.1 Process Modelling

Process modelling consists in finding pattern in activities. It is done by abstracting from the flux of the everyday actuality. At the highest level of abstraction we have the process model for all processes, at the lowest a model which is only instantiated once. The objective of the process modelling process is to work towards the production of the most specific model on which agreement can be obtained that "when we want to achieve X, we do this" - that this model reflects a pattern in the activities. There may be further caveats and limitations - "when we want to achieve X and the conditions are Y, and the input is of type Z, we do this".

There is no lower limit on the width of applicability of a process model, but evidently the tendency will be that the more widely applicable it is the more useful it will be.

Too loose a model leads to activities "rattling around" inside it

The model must be at an appropriate level of generality

The model at its level must provide the information sought.

The model must be:

- (a) unified
- (b) seamless - as decomposition proceeds it should be evident into which higher-level box the lower-level activities fit - no "holes" in higher level

The key part of the process may be difficult to analyse, or even to see. It is easy to get distracted by the more visible bureaucracy - reports that have to be written etc.

### 8.2 Unity of Process

It can be important to determine whether one is dealing with one process or several How do you decide whether you have one process or more than one? The following are possible guides:

- Unity of Objective: If the objective of the process cannot be formulated in such a way as to cover all instances, then there is more than one process.

- identify supply operations, receive operations and step interface operations
- define the operation pattern
- define each operation for each single step object
- identify supply operations, receive operations and step interface operations
- define the operation pattern
- define each operation

## 7.0 Tools to Support the Process Engineer

### 7.1 General requirements

Tool support for the method is seen as being extremely important for process engineering carried out on the scale, and to the depth of detail which we envisage. Without computer support the sheer amount of data will become unmanageable. The IPG at Manchester is working on the development of such a tool, to satisfy the requirements listed below.

The tool has to facilitate the input of information, facilitate the task of organising that data into a process model, help ensure the consistency of that model both logically and through time, provide analysis of the process including simulation of the behaviour of processes under user-specified conditions, and provide easily-comprehensible views of the process from a variety of perspectives.

The tool may be regarded as comprising three integrated aspects:

- diagramming editor
- database
- analysis and simulation

### 7.2 Multiple views on data

As has been mentioned above (Section 6.1), we believe a multi-perspective approach to process representation is essential, and we see these views being integrated through linking all objects to activities.

### 7.3 Decomposition / Hierarchy building

It is important to be able to produce diagrams representing the process with differing degrees of granularity. Process owners and managers, and process engineers, need to see the overall pattern of the process without getting lost in the detail, yet detail may be vital in designing a process that works efficiently (or at all). The tool needs to support the creation of a hierarchy of diagrams, and ensure consistency between the levels. Thus the diagrammer should be able to select any activity from a diagram and decompose it into its constituents.

### 7.4 Version control

The baseline process being modelled and the target process being designed are both likely to be undergoing constant evolution. Consistent updating of versions will be a necessity which the tool must aid.

## 6.4 Base Model

Base Model (BM) [SW91] is an approach developed for specifying concurrent object-based systems. BM provides a framework allowing specifications to be written in a systematic way. A temporal logic semantics is given for each specification construct. Such mathematical foundations provide the basis for formal reasoning of BM specifications.

BM provides the following constructs:

- composed agent object
- composed step object
- single agent object
- single step object

A composed agent object consists of a collection of agent objects that may perform steps (activities) in parallel. Each contained agent object may be either a composed agent object itself or single agent object.

Similarly a composed step object consists of a collection of step objects that may be performed in parallel. Each contained step object may be either a composed step object itself or single step object.

A single agent object contains some encapsulated variables that may only be accessed by the operations provided by the object. There are three types of operations: supply, receive and step interface.

- supply operations send artifacts to other objects
- receive operations receive artifacts from other objects.
- step interface operations are the interfaces for the agents to access the step objects.

Each single agent object has an operation pattern which restrict the orders in which the operations may be executed.

A single step object also contains some encapsulated variables that may only be accessed by the operations provided by the object. There are also three types of operations: supply, receive and step.

Supply and receive operations are the same as in agent objects.

A step operation models an actual activity to be performed.

A single step object also has an operation pattern which specifies the order in which its operations may be executed.

A BM specification is constructed by repeatedly following the guideline below:

- identify agent objects
- identify step objects for each single agent object,

- the process LOGIC, in terms of CONDITIONS for ordering activities,
- INTERACTIONS between the person or role-type and other persons or role-types,
- and ATTRIBUTES of the activities, in terms of such items as TIME REQUIRED, DURATION, RESOURCES USED.

Not all of this information need be represented in any one diagram - the diagram is built up according to need. For full details see Appendix 1. An example is given in Figure 2.

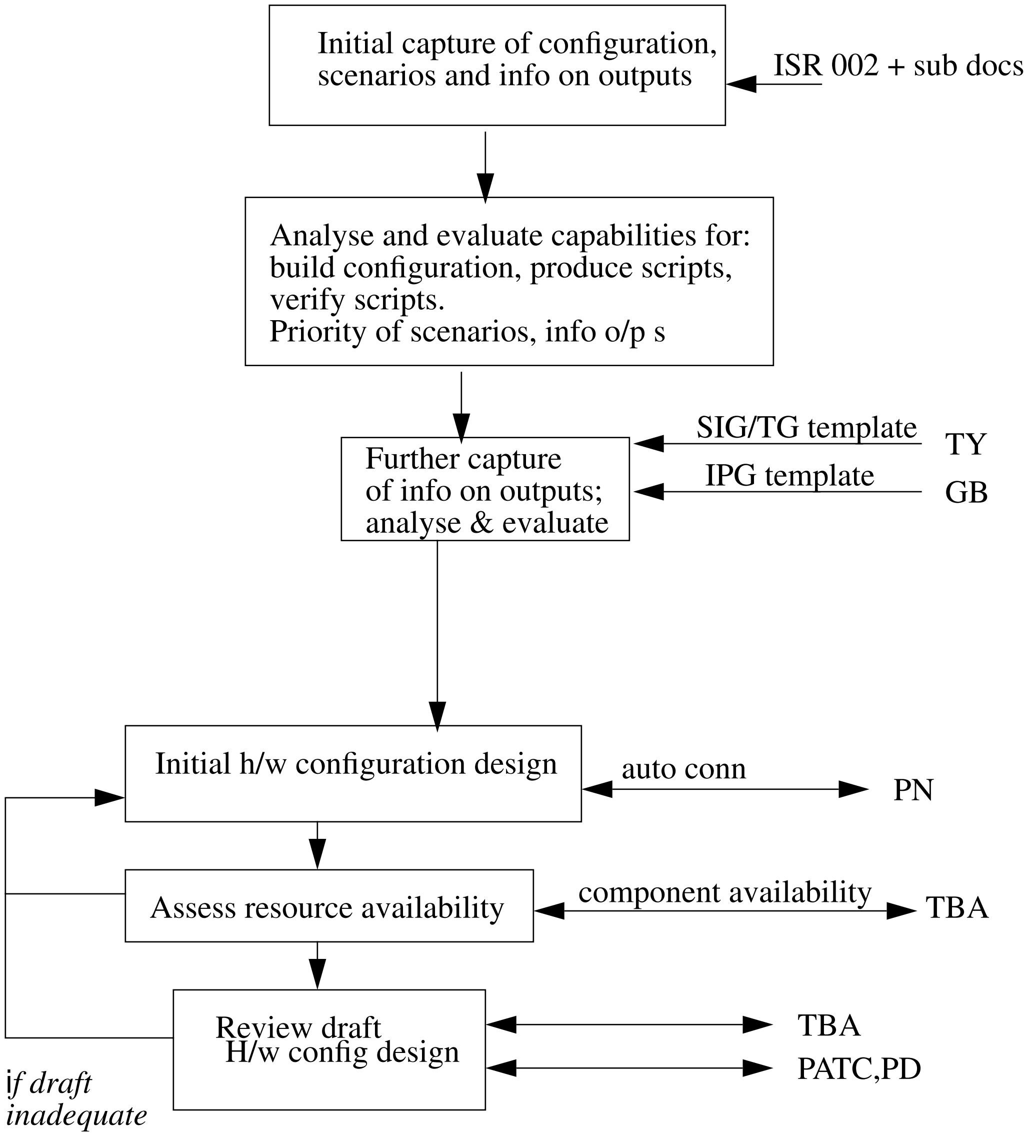



Figure 2.

## Example High-level Dependency Diagram

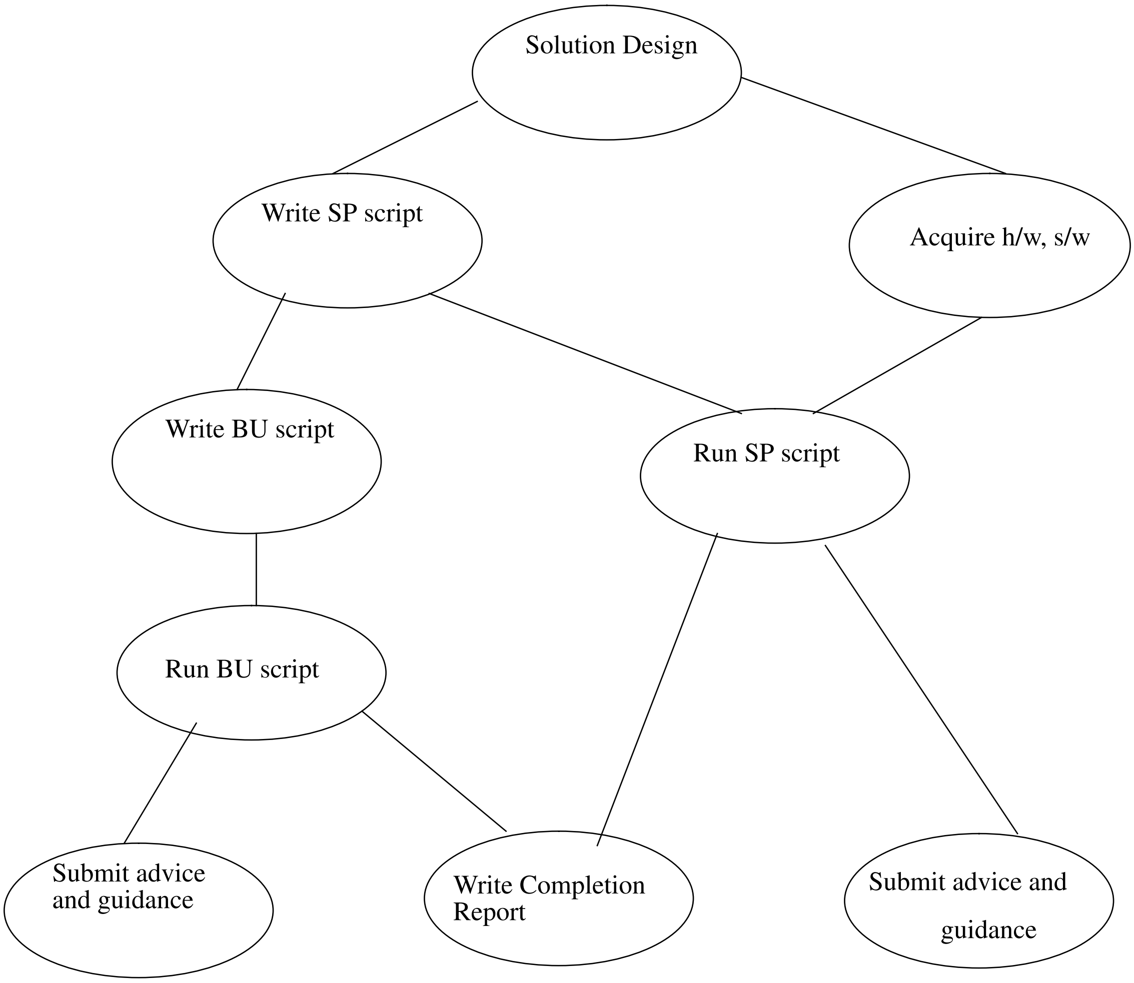



Figure 1

#### 6.3.2 Activity Diagrams

Activity diagrams are built up from observed activities. They capture:

- DEFINITIONS of the activities,
- ORDERING of the activities (including ITERATION and CONCURRENCE),

the process of their construction is always worthwhile in that it raises issues valuable to the development of understanding.

Their main advantage is in showing sequence in actions, and for showing interactions. Some problems were encountered in developing RADs due to difficulties in defining roles in a way which made sense to the process participant and yet fitted the demands of the notation. (See discussion of Role above.)

At a more detailed level of the process, especially in processes which are complex, with a great deal of iteration or conditional branching the RADs could become difficult to read, and had to be broken down, and then the pattern of interactions is lost. Unfortunately there are no facilities for decomposition.

#### 6.2.3 Data Flow Diagrams

Data flow diagrams are good for showing relation between activities and data. The Process Modelling Cookbook cites Ashworth and Goodland [AG90] who state; "The data flow diagram is a meeting point of the analysts and users." The use made of data flow diagrams has been restricted to the early stages of the modelling exercise; and then the notation has not been rigorously applied but used in a loose way to show general flows and activities. They have been used to structure the thoughts of the process modellers and have provided a means for communication between modellers and participants.

### 6.3 New diagramming techniques used

Two main diagramming techniques were used in this study - dependency diagrams and activity diagrams.

#### 6.3.1 Dependency diagrams

Dependency diagrams depict the observed minimum set of sub-processes necessary to the achievement of the objectives of the process. They are very informal, simply showing the main sub-processes, and loosely indicating sequence (time running down the page), and dependency, in that a sub-process may not be completed before one above it to which it is joined by a line. An example is given in Figure 1.

# 6.0 Systems for Representing the Process

## 6.1 Multi-perspectivism

### 6.1.1 The need for multi-perspectivism

As detailed above, a large amount of data concerning the process needs to be represented. This cannot be humanly understood when presented all at once.

### 6.1.2 Problems with multi-perspectivism

The major obstacle to the use of different perspectives in the representation of a process is the problem of consistency between them.

### 6.1.3 Integration of perspectives

Activities, which may be regarded as sub-processes, are the key. All other entities involved in the process are related to them. This is the theoretical basis of the Activity diagram (see below, Section 6.3.2).

## 6.2 Notations

### 6.2.1 Process Charts

These may be used either in interviews, in order to structure the interview, or post interview to structure the information obtained.

The Process Modelling Cookbook specifies that Process Charts should be the first notation used in a modelling study. It was then envisaged that these could be used actually during the interviews to help provide structure. In practice it was found that they were more useful when used after the interview for structuring the information gained.

In an effort to make the charts more easily useable the design was revised several times. Some variations provided less structure but were more easily used in an interview. Others were more structured and less easily used in an interview. The preferred design was one which provided a high degree of structure. This was liked because it provided concise and reasonably complete descriptions of jobs. However it required that the modeller be disciplined about the recording of interview information.

### 6.2.2 Role Activity Diagrams (RADs)

The Role Activity Diagram (RAD) represents processes as grouped and ordered activities (roles) with interactions between them. They are specifically process oriented having been developed to describe the modelling paradigm adopted by IPSE 2.5 technology. A number of interpretations of the RAD have been developed; notable are the Cookbook RAD and the STRIM RAD developed by Praxis.

RADs were found to be suited to high level modelling. They were used after conceptual diagrams, ‘loose’ data flows or process charts to try and solidify understanding of the process. They have sometimes proved very difficult to construct, but

Responsibility accorded to a position within an organisation for the execution of certain types of activity.

Pattern of behaviour exhibited by an individual occupying a position within an organisation, by virtue of their position in the organisation.

## 5.4 Interactions

It is important to identify interactions in the process model, as they are very often hold-up points.

Different classes of interaction may be identified:

- human-computer interaction
- datastore mediated
- document (message) passing
- human- human interaction
- asynchronous/synchronous
- multi-party
- physical meetings
- organisational distance (same group, same dept., same division)

Interactions are recognised as a prime cause of delays in process but some types cause more problems than others - in particular interactions which require synchronous human-human interaction.

It may also be important to show the reasons for interactions. Cutting down the number of interactions may speed up the process, but care must be taken only to cut those which are redundant.

There may be interactions between identified roles but the roles are performed by the same individual. These need to be identified.

- Computer support.
- Artefacts (e.g. reports & facilitators e.g. email)
- Resources
- Conditions.

## 5.2 Activities

Activities are elements of a process. Usually they may be regarded as sub-processes and further refined into their elements in turn.

## 5.3 Roles

The concept of “role” within a process has prompted much debate. It is a concept which it is very difficult to do without, yet it is understood in a variety of different ways, even within the process modelling community. One problem is that the word is in common use, where its meaning is vague. There is a need to clearly define its meaning in the process engineering context, so that roles may be readily identified, be consistent, and be meaningful to process participants.

The concept is used to:

- 1. group activities
- 2. group agents (and abstract away from individuals)
- 3. link activities to agents
- 4. indicate interactions between agents

On many occasions there is a major problem in attempting to reconcile these uses.

Another problem: do we wish role to

- indicate identity of agent - activities A,B,C must all be performed by the same person
- indicate identity of agent-type - activities A,B,C must all be performed by person of the same grade and/or skills (e.g.) a systems analyst grade 2.

### 5.3.1 Responsibility

The concept of responsibility is very closely connected with that of role. Process participants generally seem themselves as having roles in their organisation which accord with responsibilities for the carrying out of certain types of task.

### 5.3.2 Definitions of Role:

“The responsibility for enacting a process or subprocess definition. An agent, when enacting a process, is referred to as assuming the process role.” [FH93]

## 5.0 Vocabulary.

Process modelling is concerned with the representation of activities that contribute towards the fulfilment of some goal. Primarily then there is the question of *what* happens. Note that this does not necessarily imply that the concern is 'What do people do?' Machines contribute too. Secondly therefore there is the question of *how* do things happen (i.e. what facilitates them; people, mainframes, slide-rules etc.). We need to be concerned with the how of process behaviour if we are to contribute to IT design, process enactments etc. We also need to be able to recognise the patterns of predictable behaviour which exist within processes and hence need concern for the *when.*

The *what*, the *how* and the *when* shape the vocabulary which is needed to represent processes. The Process Modelling Cookbook has been described as being able to reference the following vocabulary:

- People.
- Activities
- Roles
- Interactions
- Objects (resources e.g. reports & facilitators e.g. email).
- Conditions.

Within this framework the Cookbook is able to consider the sequence and selection of activities and the data flows between them.

### 5.1 Lessons for a PM vocabulary.

The case studies have contributed the following feedback to the vocabulary of the Cookbook:

The vocabulary has been largely validated although the following components are missing:

- a way of showing the iteration of groups of activities.
- a better way of representing the role of the database in the process (i.e. better than the existing object flow notation).
- a means by which early impressions of the process can be captured and described using very simple vocabulary.

The proposed vocabulary is as follows:

- Activities.
- Tasks.
- Roles
- Responsibility.
- Interactions.

- Initial - not possible to produce baseline model. May move straight from process definition (see Section 14) to target process design. May be parts of the process which are necessarily unformalisable. Need to look to provide formal framework around these parts, to facilitate work and monitoring.
- Repeatable - modelling of the baseline in itself, even without redesign, will bring advantages, facilitating monitoring and evaluation. Look at the definition of ROLES. Baseline model building based on wide discussion with participants.
- Defined - Baseline modelling may be based much more on document examination.
- Managed - Baseline modelling is more likely to need to include metrics
- Optimising - Designing the process to facilitate change is likely to be a major consideration.

#### 4.8.3 Limitations of the Process Maturity Framework

As stated above the Process Maturity Framework is concerned specifically about the software process, so it must be applied with care to other processes. Having said this, it has been criticised [BM91] for being based on an extreme form of the factory model. If we look at the process types delineated above (Section 4.3) we see that this is only one (production-line) of many types of process.

Most of the detailed suggestions about grading processes, and suggestions as to how the process may be progressed to a higher level are software-specific. Again they have been subject to some criticism in [BM91], but for most processes they have limited applicability in any case.

#### 4.8.4 The PADM Maturity Framework

We are working on the development of our own maturity framework, looking at the following factors:

- How well-established the process is.
- How formalised the process is.
- How volatile (subject to major upheavals)
- The rate of change of the process.
- How well the process as enacted matches written procedures.

In describing the form of a process, we would need an indication of complexity, stability, rigour, life cycle, repeatability, clarity of rationale, extent of informal working and its accordance with culture.

How this process evolves could be deduced from a knowledge of its control structure, its centre of change, its mechanism of change and susceptibility to environmental influences.

Its alignment with the organisation needs a knowledge of the distribution of participants, their intellectual level, their familiarity with the process, the nature of automated support and degree of formality.

## 4.5 Process Drivers

By process drivers we mean the pressures which create work and cause it to flow through the process. In service processes this comes immediately from requests for service, in production processes usually from order books or anticipated demand. In either case the process answers a need, and ultimately no evaluation of a process can take place without reference to its value in supplying these needs.

## 4.6 Technicality of Process

Skill level required

## 4.7 Critically of the Process

What are the consequences of failure of the process?

## 4.8 Maturity of Process

### 4.8.1 The Software Engineering Institute's Process Maturity Framework

Humphrey [H88] has proposed a five level maturity framework for the software process. The levels form a progression, with the assumption that the highest level is the best for all software processes. He proposes that the identification of an organisation's place on the ladder will suggest the most appropriate types of improvement for their process. Evidently if such a framework could be reliably applied it would be extremely useful to the process engineer.

The five levels suggested are:

- 1. Initial. An ad hoc process without any formal procedures. Not repeatable.
- 2. Repeatable. Intuitive. The process depends on individuals.
- 3. Defined. Qualitative. The process is institutionalized.
- 4. Managed. Quantitative. The process is measured.
- 5. Optimising.

A thorough exposition and critique of the framework is beyond the scope of this document. The framework is designed for the software process rather than general organizational processes, and our examination of it has led us to conclude that for more general the useful lessons may be better drawn from a short examination of the general principles rather than looking at the details of its application to the software process.

### 4.8.2 Usefulness

The framework does seem to reflect progression, mainly in terms of increasing formality of process. But not all process types may be amenable to movement to highest levels, e.g. design.

In the context of the PADM the following observations may be made about processes at each of the maturity levels:

#### 4.3.2 Project and Production-line

In the archetypal production-line process, such as car manufacture, the units produced may be regarded as identical, and the production of one unit follows the same pattern as the production of another unit down to a very low level of detail. In project working, such as civil engineering, each product is unique in important respects.

#### 4.3.3 Design and Building

For almost any product, from a bridge, to a book, to a piece of software, there is a design process, and a process of building, or instantiating the design. Economies are achieved by building many products from a single design.

Design risk v Replication risk.

#### 4.3.4 Output-oriented v state-oriented

Some processes achieve optimisation by maximising the ratio of output to resource consumed. Others are concerned with the achievement of an ideal state (e.g. all customers are content, all bills sent out are accurate).

#### 4.3.5 Case-handling

Many professions use case-handling processes, such as doctors, lawyers, social workers. The "case" may often correspond to a client of the process owner, and be made the responsibility of a particular process participant. Responsibility is typically a very important aspect of these processes. There may be certain actions which have to be performed in particular circumstances or serious penalties are incurred. However, the details of cases may be very different and the particulars of the handling vary widely. Also cases can be long-running, and lie dormant for long periods.

#### 4.3.6 Work-package handling

A wide range of processes, usually services, are based on the handling of work packages. A typical example would be a Customer Services department providing computer systems maintenance. Requests for service are received centrally, given a job number, then passed to the appropriate team for action. Work-packages are of more limited scope than cases, are more routine to handle, less critical, and finished more quickly. There is a greater need for monitoring the progress of packages, because they will often be transferred between people and teams, and typically will spend more time than cases in states where they are not the responsibility of a particular individual.

### 4.4 Moving between paradigms

Organisations may sometimes be in a position to change the process paradigm they use. For instance, an insurance company might move from a work-package paradigm, where each customer claim or request for new insurance is treated separately by a team with a specialist function, to a case-based approach where staff have a case-load of customers, and deal with all their needs.

#### 3.11.2 The process may be tied to a conceptual framework

It may be impossible to see the process without using the conceptual framework of the process participants, yet radically re-viewing the process may entail restructuring that framework.

#### 3.11.3 The process is liable to be changing during the study.

Even without the disturbing influence of the investigator, many processes undergo steady change. Evidently this will make it difficult for the process engineer to draw up a consistent picture of the process.

#### 3.11.4 The act of investigation itself changes the object of study

The act of investigation makes the participants more aware of their process, and aware of aspects of it which they will have previously completely overlooked. There are two ways in which this can bring change to the process. Firstly the participants may simply see that some of the things they are doing are unnecessary, or might be done better in another way. Secondly they may ascribe different meaning to what they do, which will bring changes in behaviour.

# 4.0 Categorisation of Organisational Processes

## 4.1 The need for categorisation

The most successful approach to process development will vary considerably according to the type of process under consideration. Hence it is vital for the process designer to be able to categorise their process as quickly as possible.

## 4.2 Levels of Process

All processes may be divided into base processes and meta-processes which control or monitor base processes.

## 4.3 Types of process

Product is the major determinant of process.

### 4.3.1 Service-providing and Production.

The important distinction from our point of view is the relative importance of input and output for the two types of process. Also that service is essentially reactive - the service-providing process can only commence in response to a request for service, whereas products can be stored up.

## 3.8 Definitions of Process

Feiler and Humphrey [FH93] define it as "A set of partially ordered steps intended to reach a goal".

"A process is a set of logically related activities producing an output which satisfies a customer need" -KPMG

"A repeatable, partially ordered set of activities to achieve an objective"

"An organisational process exists when, in a given set of circumstances, the same set of activities is carried out. It is an observable regularity.

## 3.9 Articulation

Articulation is required to fit the pattern to the particular circumstances with which the actor is confronted. "Articulation consists of all the tasks needed to co-ordinate a particular task including scheduling subtasks, recovering from errors, and assembling resources" according to Gerson and Star [GS]. We need to understand the articulation occurring in any given work situation in order to bridge the gap between objectives and practice. That is to say, if our model of the activities going on in an organisation only includes those directly related to the achievement of objectives, then if we try to match the model to what is actually going on in the office, the fit will be very uneasy.

## 3.10 Place of processes in defining the organisation

Processes are important in defining an organisation. An organisation's identity is not only dependent on WHAT it does, but also on HOW it does it.

## 3.11 Problems facing the Process Engineer

### 3.11.1 The process engineer is dealing with a socially constructed reality.

A process is a way of conceptualising what goes on, an abstraction from the flux of the concrete.

"What goes on" depends on the meaning given to it by those acting in it. There is no possibility of obtaining an "objective" view.

Therefore there can be problems in identifying processes - what constitutes the identity of a process, such that one should say that event X is part of process A rather than B.

## 3.6 Components of Processes

### 3.6.1 Processes consist of sub-processes

Processes may be viewed as being composed of sub-processes down to whatever level we choose.

### 3.6.2 Do atomic actions exist?

Feiler and Humphrey define a “Process Step” as “an atomic action of a process with no externally visible substructure”. They also define “process” as “a set of partially ordered steps”. This idea of atomic building blocks is very attractive in that it makes for simplicity, and once we have our “process steps” then we know we have all the detail we could need. However, the idea of an action which is in itself “atomic” is a nonsense - any action can be broken down into components if we are so inclined, and as we get more and more detailed we will lose the regularity necessary in order to identify a process at all.

We can choose to take a certain level of breakdown of the process as comprising our “steps”, beyond which we will not go, but this will be our choice, not a property of the actions themselves. In fact there is no need for the concept of an “atomic action”.

## 3.7 The Inter-relation of Processes

### 3.7.1 Process hierarchies

The view that processes are made up of sub-processes implies the existence of hierarchies of process. However, in practice we find that a process may be part of two super-processes, so we do not end up with processes forming tree-graphs.

### 3.7.2 Process relations

Where ‘p’ is a process:

p1 consists of p2 +p3 + p4 (composition)

p3 is part of p1(inclusion)

p3 is part of p5 and of p6: (intersection)

p1 is an alternative to p2 (alternation)

p1 + p2 are alternative to p3 + p4 + p5 (multiple alternation)

p1 depends on p2 (dependence)

p1 depends on p2 and p3

p1 and p2 depend on p3

happen. We are looking for patterns of change, and general rules covering those patterns of change.

A process is an observable regularity, i.e capable of being observed.

#### 3.2.1 Processes may be one-off, or repeating.

We are interested in repeatable processes. When we model a process we are concerned with the repeatable features, with the identification of patterns, not with history.

### 3.3 Identifying processes

#### 3.3.1 The search for unity

It can be important to determine whether one is dealing with one process or several. What is it that permits us to say of a collection of events/activities - "these constitute ONE process"?

#### 3.3.2 The identity of the process

How do you decide whether you have one process or more than one? The following are possible guides:

- Unity of Objective - If the objective of the process cannot be formulated in such a way as to cover all instances, then there is more than one process.
- Identity of Inputs
- Identity of Outputs
- Regularity of inputs/throughputs

### 3.4 Organisational processes are purposeful

The MIT programme "Management in the Nineties" [SM91] defines business processes as "a sequence of interdependent tasks and functions which together produce outcomes that contribute to the (business) success of an organisation". This definition emphasises the purposeful nature of organisational processes.A process is a means to an end. It is always directed toward the achievement of some goal or objective. Sometimes this objective is to produce a product in a very obvious, even physical sense, but the process may also be about the achievement or maintenance of a state. It is not always easy to identify the objective a process.

### 3.5 Organisational processes rely on the co-ordination of people's efforts

A process is an ordered and ***coordinated*** set of activities for the attainment of a particular goal.

# 3.0 The Nature of Process

## 3.1 What is a process?

### 3.1.1 The need for definition

The term "process" is commonly used in a wide variety of contexts. We talk of biological processes, such as the growth of an organism, mechanical processes, chemical processes, computational processes, and also of social processes, such as those which go on within organisations. The meaning of the term is not well defined. If there are to be disciplines such as Process Engineering or Process Modelling then it is most important that a definition with as much precision as possible is agreed.

### 3.1.2 Ontology

There are:

1. events that happen (the actual)
2. patterns of events
3. descriptions of actual events
4. descriptions of types or patterns of events
5. prescriptions for how a particular event (or sequence of events) should occur
6. prescriptions for event patterns to achieve certain aims
7. computer programs which control or guide events

The term "process" as commonly used may be found on occasion to refer to any of the above. It is important to know what is being referred to when the word is used.

### 3.1.3 The Process as Practised and the Process as Prescription

One very important distinction is the one between the process as practised and the process as prescription. The process may exist in the form of "We do A, B, and C in order to achieve X", or in the form of "They should do D, E, and F in order to achieve X". Models of these may be quite different even for the same group of people attempting to achieve the same ends. (The models *may*, of course, coincide). The term "model" is commonly used in both cases. We distinguish the "baseline process model" from the "target process model".

## 3.2 Regularity in change

We are interested in organisational processes, but it is worth looking more generally at what these have in common with other types of process. All processes involve a *change* from an initial state to a finishing state. If we are interested in process then we want to answer the question *how* that change comes about. And thus we are interested in relating the specific instance to the general type of change, whether in order to understand what did happen, predict what will happen, or affect what will

- suitable notations for process descriptions
- a method for capturing, analysing, and redesigning processes
- tools to support the method
- Process technology
- Guide to enactment systems

## 2.4 Process Modelling

### 2.4.1 What is a Process Model?

"A model is an abstract representation of reality that excludes much of the world's infinite detail. The purpose of a model is to reduce the complexity of understanding..... a phenomenon by eliminating the detail that does not influence its relevant behaviour." - Curtis, Kellner, and Over.

Thus a process model represents some aspects of the process of interest. The form of the model should be chosen to best match the purposes for which the model is required. Obviously the search is on for forms which will suit a wide range of purposes, but it is important to be aware of the tension in requirements. For instance, person-to-person communication about a process will require much less formal models than machine analysis of a process.

### 2.4.2 What does the process engineer need process models for?

- understanding processes
- communicating about processes
- reasoning about processes
- analysing processes
- comparing processes
- evaluating processes
- measuring processes
- to aid design of processes
- to work out the requirements for IT support for processes

### 2.4.3 How is process modelling different?

"Process modelling is distinguished from other types of modelling in computer science because many of the phenomena modelled must be enacted by a human rather than a machine" - Curtis, Kellner, Over.

### 2.4.4 Process Modelling Method

Process modelling, like any form of modelling, can be either a *descriptive* or a *creative* activity - we can either describe the process as it is occurring, or prescribe the way in which we would like to see it happening. In most serious applications both these aspects are necessary, and their facilitation must lie at the heart of any process modelling method.

### 2.2.4 Enacting the process - People and Machines

The social aspects of process are inter-linked with the technical

People are better than machines at dealing with unforeseen exceptions to process

People are intelligent - machines are not

People act for reasons - machines have no reasons or objectives or opinions about their instructions

### 2.2.5 Conventional Support for the Process

"Process modelling techniques should be used in mainstream IT development to capture the dynamics of an organisation, ensuring that the human system within which the IT system is embedded is properly considered, and plans are in place to change it where necessary, in parallel with IT implementation" -T J Huckvale, IOPENER 5.

## 2.3 The Business Process Engineer

Thus there is a need for process engineers, engaged in the design of organisational processes, capturing the dynamics of the organisation, ensuring that the human system within which the IT system is embedded is properly considered, and developing plans to change it where necessary, in such a way that developments in IT may be smoothly integrated and capitalised upon.

Process engineering is concerned with the problems of capturing and describing human-oriented systems. It seeks means of improving the real world process being modelled, and this improvement can be accomplished in various ways: by better understanding and by assessment of the process, by controlled change of the process, or by computerized support for the execution of the process.

Process engineering links business concerns to the concerns of the IT developer, to ensure optimal processes, making the best possible use of IT.

A process engineer needs....

- to understand what a process is
- to be able to categorise the process of interest
- to be able to succinctly describe process behaviour
- to understand the process of process development
- the tools to describe, analyse and evaluate processes
- to select suitable enactment vehicles
- to program processes for execution if appropriate

So it is necessary to provide....

- a theory of process
- a classification system for processes

## 2.2 The IT Perspective

### 2.2.1 Supporting the Process

Computer systems are moving from the position of being tools used for well-defined and limited purposes to being highly-integrated parts of the overall system of the organisation. Indeed the rapidly-developing process support technologies such as ProcessWise Integrator are bringing us to a situation where people may be viewed as “process inhabitants” in a system largely computer-driven. It is not sufficient to design such a computer system in isolation. It has to be integrated into its context from the outset.

In today’s business conditions there is an increasing need for organisations to be able to change rapidly.IT must support this.

In order to achieve a satisfactory fit of information systems in the organisation the non-automated parts of the process need to be as well understood as the automated.

### 2.2.2 The Process Perspective to IT Development

Standard IT systems development concentrates on entities - it views activities and processes as being carried out in order to transform entities. In fact, in most work (except production) entities are important only in order to facilitate activities - it is what is done which is important.

If the IT developer concentrates on the entities involved, they will come up with a model of how to develop those entities.

Michael Hammer [Ham90] cites the memorable case of Ford accounts payable section which achieved a 75% head count reduction through process redesign. This would not have been possible using standard SAD techniques based on data modelling - the previous system would simply have been automated. The radical re-engineering was only possible by taking a process perspective, and looking at the *purpose* behind the process.

### 2.2.3 Process Technology

The past few years have seen the development of a whole new class of IT systems, known variously as Process Technology, Coordination Technology, or Process Enactment Technology, foremost amongst these being the ProcessWise Integrator. These provide a framework for co-ordinating people and tools, and seek to automate parts of the process.

If you are to automate a process, you must automate the right process. As Hammer [Ham90] points out, simply automating the baseline process (the process as it exists prior to the automation) may at best be a missed opportunity, and at worst lock the organisation into outmoded ways of working. In order to make the best possible use of process technology it is necessary to design an optimal process, taking account of both the automated and non-automated parts of that process.

# Part 1

## 2.0 Who needs a Process Analysis and Design Method?

### 2.1 The Business Perspective

#### 2.1.1 Process Improvement

Attention to process is increasingly being seen as the way to improved performance and a better quality product across the whole spectrum of organisations. Improving process is seen as a way to:

Better quality product

Increased efficiency

Increased effectiveness

Reduced costs

Increased process flexibility

Improved staff satisfaction

Process development occurs either organically, as staff make changes to cope with changing circumstances and environment, or in a planned way. Both are necessary in different circumstances. The PADM facilitates planned development, achieved through modelling of the processes in the area of interest.

#### 2.1.2 Business Process Reengineering

Business Process Reengineering involves a radical redesign of organisational processes. It entails going back to basics and examining what the processes are really trying to achieve, then redesigning them so as to be as efficient as possible, even if this means the breakdown of old functional boundaries and the restructuring of the organisation.

# 1.0 Introduction

This report draws on a wide range of work performed by the Informatics Process Group (IPG) at Manchester University. Part of this work has consisted of theoretical investigations, but all the ideas have been tested out through a series of case studies.

## 1.1 Structure of the Report

The report comes in two parts. The first part looks at the context within which the Process Analysis and Design Method will be used, and the theoretical and practical constructs on which the method will draw. The second part outlines the method itself.

## 1.2 Terminology

The process modelling field is still in the process of developing the specialised terminology it requires. Many words and phrases in this paper are used in a specialised sense. Where our usage differs from standard I have attempted to investigate and explain the meaning. We have drawn extensively on the definitions drawn up by Feiler and Humphrey [FH93], but in places have felt compelled to use expressions in a radically different sense. In these cases I have attempted to make the differences clear.

# Report on a Process Analysis and Design Method

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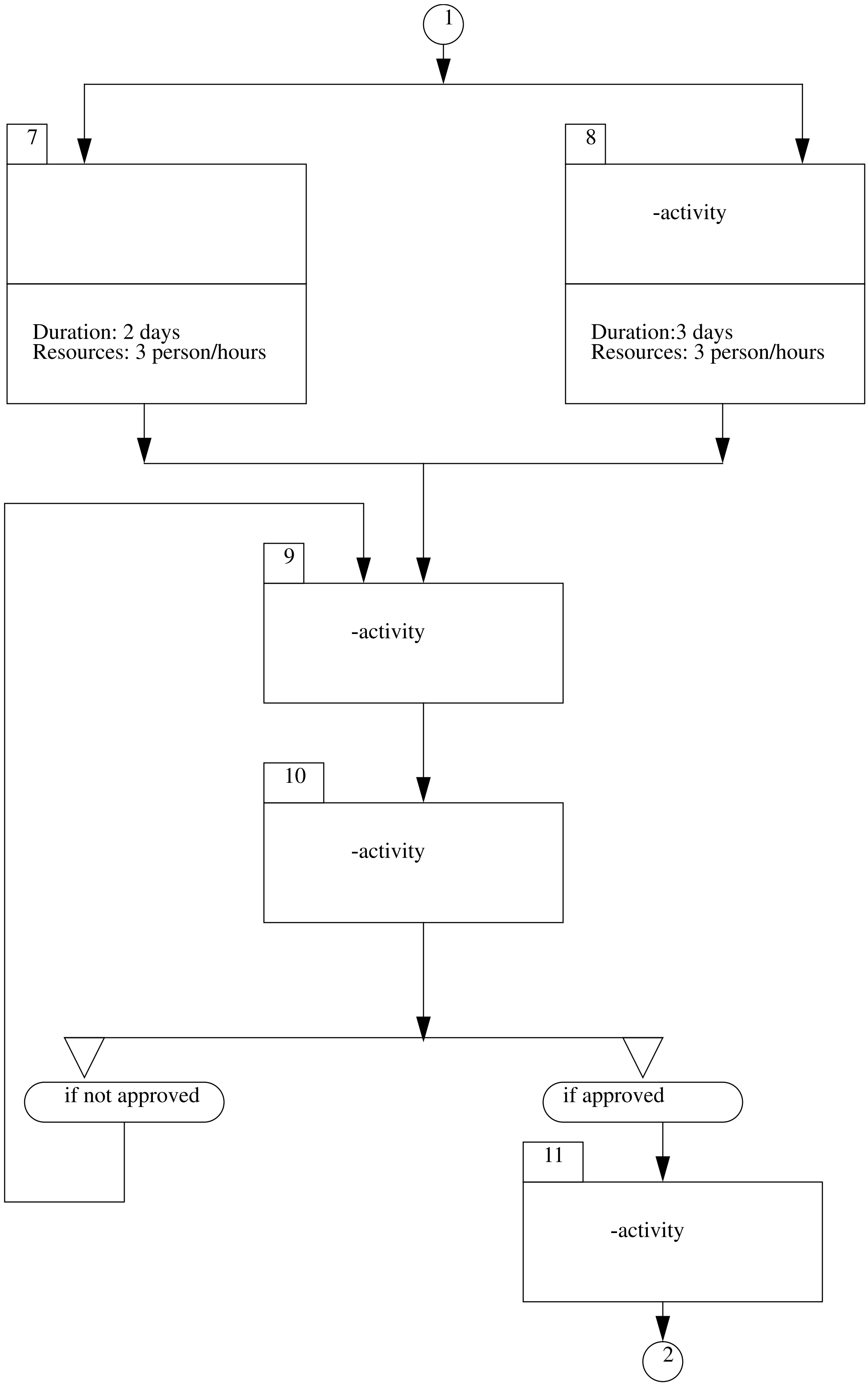
## 3.0 Decomposition

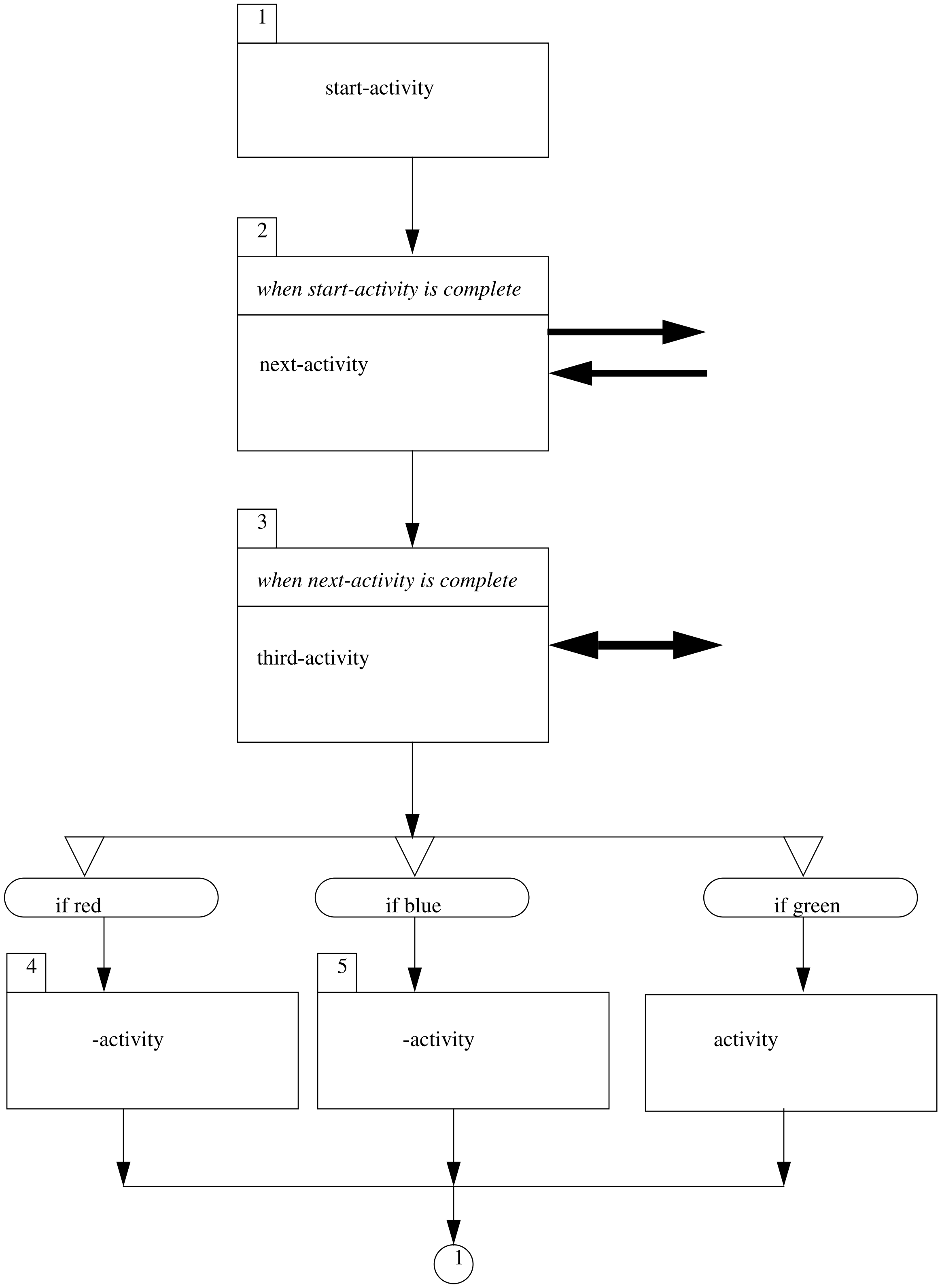
It must be possible for any activity box to be itself decomposed into its own activity diagram.

## 4.0 Modes of Use

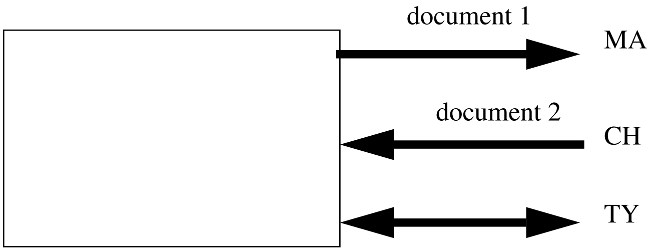
There should be “View/Analyse Only” and “Diagram Construction” modes of use.


1
7
Duration: 2 days
Resources: 3 person/hours
8
-activity
Duration:3 days
Resources: 3 person/hours
9
-activity
10
-activity
if not approved
if approved
11
-activity
2

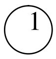
## 2.0 Example diagrams



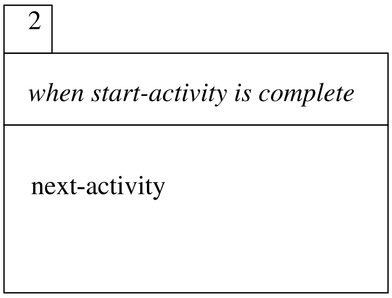
**1.7 Bold arrows attached to activity boxes indicate INTERACTIONS. Single-headed arrows indicate INPUT or OUTPUT. They may be labelled for content and Source/destination. Double-headed arrows indicate dialogue.**



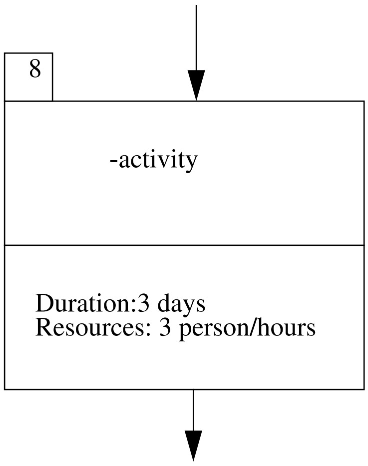

**1.8 Circles containing a unique identifier indicate a point in the process. Thus they may be used to indicate iteration (return to identified point), or to link diagrams where one process is spread over more than one diagram.**



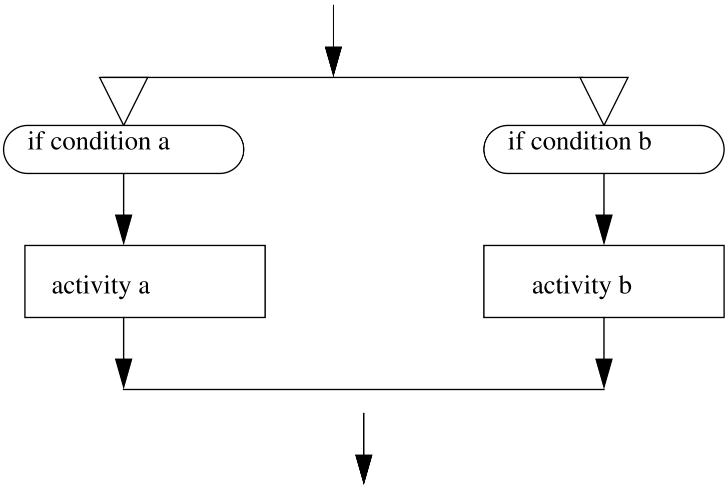
1.6.2 **They may have CONDITIONS for their performance, which are displayed in a sub-rectangle at the top of the activity box.**




1.6.3 **They may have a further unlimited number of attributes, to be defined by the tool user, which may be displayed in a rectangle beneath the activity box.**



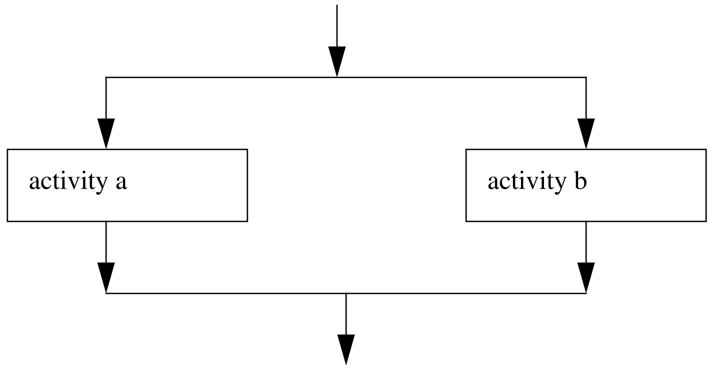
## 1.5 Paths may have ATTRIBUTES, consisting of CONDITIONS, and FREQUENCY of occurrence (as a percentage). These may be displayed in rounded rectangles immediately below the triangles.



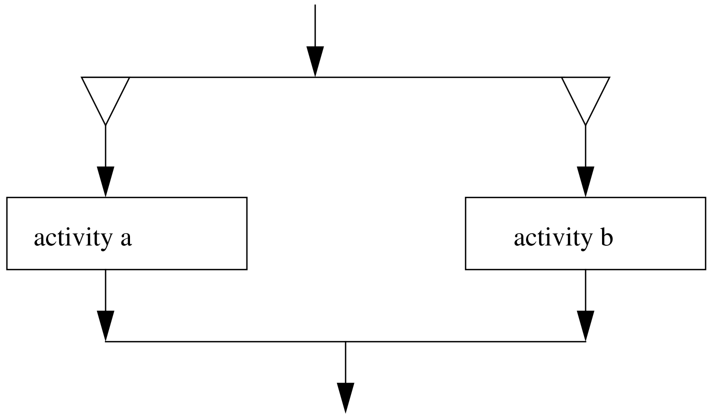

## 1.6 Activities also have attributes.

**1.6.1 They may be given an IDENTIFIER, which may be displayed in a box to the top left of the activity box.**

### 1.3 Links may branch and merge, indicating that activities occur CONCURRENTLY




### 1.4 ALTERNATIVE paths are indicated by inverted triangles at the top of branching paths.

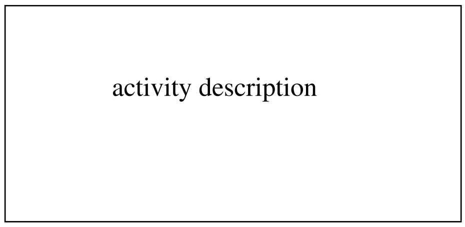


# Appendix 1: Requirements for an Activity Diagram Editor

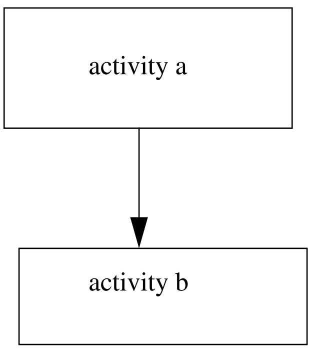
The following provides the outline of requirements for a tool for constructing and viewing Activity Diagrams, which may be used for representing processes.

## 1.0 Semantics

### 1.1 Activity boxes consist of rectangles, which contain text forming an ACTIVITY DEFINITION




### 1.2 Activity boxes are linked by directed lines, indicating PRECEDENCE.



It is desirable to be thinking some way ahead.

One possibility which we have examined is the creation of a series of targets for the process, each with a date for implementation. The aim would then be that should be convergence of the process as practised with the target processes. Obviously close targets would be more highly detailed than those further in the future. Detail would be added, and changes made as necessary, to target processes as their implementation dates approached.

# 20.0 Specification of Requirements for Automated Process Support

The models developed for the target process should show those parts of the process which will be automated, and how IT will support the rest. It remains to extract from these models all the requirements for IT support for the process and turn them into a specification of requirements.

# 21.0 Conclusion

## 21.1 Further development of the PADM

The major area of the PADM still needing development is the "Specification of Requirements for Automated Process Support". However, there is still work to be done in the area of Process Evaluation. The notations for process modelling still need further development, in particular the full integration of Base Model techniques.

Usually several root definitions will be constructed in order to reflect different views of the process. These should be reconciled in the later stages.

### 18.4.2 Soft Process Modelling Method

From the root definitions there are constructed what SSM terms “conceptual models”. These contain the essential activities needed to achieve the objective identified. Different conceptual models may be unified in order to cover different objectives contained in the root definitions. Conflicts contained in those definitions can then be identified, and dealt with in discussions with process owners and participants.

Once a unified conceptual model has been agreed it can be transformed into a Dependency Diagram, and this in turn will be the basis for building an Activity Diagram as more detail is gradually added to the process design.

### 18.4.3 Use of Workshops

Workshops were found to be very useful in the early stages of the redesign. They provide the opportunity to bring together all those with a say in the final shape of the process. It is most important to bring together the right people for the workshops. The process engineer should act as a facilitator, helping formally but not substantively in the production of root definitions and conceptual models. The process owner(s), and the various kinds of process participant need to be represented. However, given this, smaller workshops work better and make quicker progress. Problems have been encountered where the client is neither process owner nor participant but has sought representation in such workshops.

### 18.4.4 Cultural Stream

The main aim of the cultural stream of analysis is to check that proposed solutions are socially workable as well as technically optimal. There are many possible reasons why technically good solutions may fail in practice. The solution will always have to be acceptable to the client and the process owner; in most cases it will need to be acceptable overall to the process participants.

## 19.0 Process development route with interim process stage models

It is usually not sufficient to just design a target process, it is necessary to work out how the organisation is going to progress from their baseline process to that target process.

Reasons for:

- - Participants will understand it when it is implemented
- - Aids in foreseeing possible complications
- - Helps prevent alienation of users

## 18.3 Evolution

The evaluation phase should have highlighted the areas of concern in the baseline process. Suggestions for improvements to these areas may come from the process engineers, process owners or process participants. The problem then is firstly to check the feasibility of the suggested improvements. This may be partly answered by the process managers, but it is hoped that analysis and simulation facilities in process modelling tools may also help. The second problem is in ensuring that suggested changes do not interact with one another in unforeseen ways. Again, analysis tools could be most helpful here.

## 18.4 Redesign

The methods which we have been developing for process redesign are based on Soft Systems Methodology as developed by Checkland [CS90]. SSM provides a basis which is particularly well suited to this phase because:

- - It recognises the socially constructed nature of the phenomena with which we have to deal, and suggests methods of working with this
- - It is designed to handle ill-defined problem situations. Organisational situations are usually complex and difficult to understand
- - SSM provides means of examining the objectives as well as the techniques of a process, it deals with the 'what' as well as the 'how'. There is often a need to balance objectives in the organisational context
- - SSM provides ways of dealing with the social as well as technical factors in process design

### 18.4.1 Start from Process Definition

Any redesign will have to start from the process definition.

The process is equivalent to what SSM terms 'purposeful human activity systems'. The objectives of process may be described in terms of the 'root definitions' used in SSM. The root definition looks at the following aspects of the process:

- Customers : the victims or beneficiaries of T
- Actors : those who would do T
- Transformation : the conversion of input to output
- Weltanschauung : the worldview which makes this T meaningful in context
- Owner(s) : those who could stop T
- Environmental constraints: elements outside the system which it takes as given

### 16.5 The Advantages and Disadvantages of Metrics

It is a truism that measurement is better than guesswork, but an informed judgment of the vital parameters is better than measuring the wrong things.

## 17.0 Process development objectives definition

This is concerned with setting directions for process development, deciding the type of benefits to be aimed for, setting goals to be aimed for along the development route, deciding whether to go for evolution of the process or a revolution.

Inputs to it will be the “Process Definition” (which may need reworking) and the Process Evaluation. Also required will be details of constraints on process development, in terms of resources, available skills etc.

### 17.1 Evolution or Redesign

The major question to be settled at this stage will be whether the process should be completely redesigned, or whether the process engineer should seek to refine the baseline process. It is possible to do both - to produce a complete redesign from first principles as a target at which to aim, but then seek to evolve the process towards this target, rather than attempt a sudden switch.

## 18.0 Target process design

### 18.1 The Role of the Target Process

Initially our view was that the target process should be fixed, and then implemented. This was part of our outlook on process engineering as a ***terminating*** process. If we view it as continuous, however, then the target process itself may be seen as “that at which we aim”: the process the organisation would like to have in place, possibly by a target date, *all else remaining the same.* However, in the real world all else does not remain the same. Thus the target process will need to be revised.

### 18.2 Necessity for a Participatory approach to target process design

As opposed to outside experts coming in, sucking out data, disappearing with it to analyse it, and reappearing with a “solution” which the participants are left to try and implement. The less mature the process the greater the need for process participant involvement in the design phase.

All types of process participant need to be represented

- “Fidelity: The faithfulness with which a defined process is followed.... Fidelity is related to enforcement”. This measure is practical but white-box. It requires a clear model of the *prescribed* process, an understanding of the process by the evaluator, and an extended period of observation. Since observation is likely to prejudice the result, it will be very difficult to obtain an accurate and reliable evaluation. Evidently one may look at enforcement techniques, but again in practice there tend to be ways of evading enforcement which will not necessarily come to light. Thus it may be more useful to look at

- “Fitness: The degree to which the people or machines enacting the process can faithfully follow actions it specifies”. In other words how easy it is to follow the prescribed process - how practical, clear, coherent, and convenient it is. The more fit a prescribed process is, the more closely it is likely to be followed. Fit may be assessed through analysis of a process model, controlled trial, or in practice. It is a measure to apply to a prescribed process.

- Precision: Relates to the detail in which a process is prescribed. It is a measure to apply to a prescribed process. It should be noted that higher precision is not necessarily better for all processes.

- “Redundancy: A process step is redundant if its removal would not alter the results of the process”. Straightforward redundancy in the sense that a single step could simply be removed is quite rare. More commonly a sequence of steps might be replaced by a shorter sequence.

- Scalability: The size of workflow which the process can accommodate. It is important to know how easy it is to scale operations up or down in response to changing workload, and the points at which the efficiency and effectiveness of the process start to fall. Some assessment of this may be gleaned from process participants, but for redesigned and untried processes an analysis of a process model is desirable.

- “Maintainability: The degree to which the process is designed to readily permit static or dynamic process evolution”. The ability of processes to evolve is becoming increasingly critical. Feiler and Humphrey talk about the aspects of process which are like software - “Maintainability is achieved through localization of information, a cleanly structured design, and well architected interfaces”. These points are very relevant. However, we believe that this only tells part of the story, and that much more work needs to be done on what makes a process easy or difficult to evolve. Certainly human factors are very important in this.

### 15.4 Verification of the baseline Process Model

It is most important to verify the correctness of the baseline process model. The obvious way is by sample observations of work in progress

## 16.0 Process evaluation

### 16.1 Types of evaluation

There are three orthogonal types of evaluation:

- ‘black box’ / ‘white box’. The process may either be assessed as a whole, looking at its added value, the reward for resource, its effectiveness etc.; or the component parts of the process may be examined.
- absolute - comparative. The process may be assessed in absolute terms or in comparison to other possible solutions
- formal - informal. There may or may not be attempts to quantify aspects of the process.

### 16.2 Categorisation of the process

This uses the categories for process type, level and maturity which are detailed in Section 4.

### 16.3 Efficiency and Effectiveness

Ultimately the value of a process may be reduced to a combination of its:

- effectiveness - how well the process achieves the aims set for it
- efficiency - the value of its output divided by value of resources used

However, this has to be looked at over the long term, to take into account such things as reliability and flexibility of the process

### 16.4 Feiler and Humphrey’s “Process Properties”

Feiler and Humphrey [FH] have outlined the following process properties, which give some very useful dimensions for the evaluation of processes. We have taken the basic ideas and expanded on them, and attempted to relate them to our requirements.

- “Accuracy: the degree to which the product produced by the process matches the intended result.” This measure is both exterior to the process (black-box) and practical. It requires a clear definition of the intended result such that actual results may be meaningfully compared to it. It is a measure to be applied to a baseline process. It is an important aspect to assess.

#### 15.2.1 Divergence between the baseline "Process as practised" and the prescribed process

It is most important that the baseline process "as practised" is captured. In the analysis phase an investigation of the reasons for divergence may be highly useful.

### 15.3 Sub-phases of baseline process capture

| STAGE | INPUT | OUTPUT | VERIFICATION |
|---|---|---|---|
| 1 Familiarisation | Discussion with managers Documents | None | N/A |
| 2 Identify work-groups and key process participants | Discussion with managers Documents | Text | None |
| 3 Identify activities | Semi-structured interviews with key participants | Text | |
| 4 Organise text into Process Charts | Output from 2 &3 | Process Charts | |
| 5 Link activities according to dependence | Process Charts, and semi-structured interviews with participants | Dependency diagrams | Interviews with key participants |
| 6 Build activity diagrams | Output from 4 and 5, plus structured interviews and documents | Activity diagrams | Interviews with key participants |

#### 15.3.1 Familiarisation

This is a necessary phase for process engineers who are not part of the focus group. They may need to learn the "language", or conceptual framework used by the people from whom they have to learn about the process.

#### 15.3.2 Identification of work groups and key process participants

In processes where there are a large number of people performing similar roles it is not practicable to interview all process participants.

#### 14.3.3 Relationships of objectives

All would be very neat and simple if organisational objectives formed a hierarchy, such that objective A would met by achieving B and C, which would be met by achieving D,E,F, and G, etc. However, in practice the situation is far more complicated. Objectives may conflict, or they may interleave, such that a sub-objective contributes to the achievement of more than one higher-level objective.

## 15.0 Baseline process capture

### 15.1 How important is the capture of the baseline?

Great stress was laid in the early days of Cookbook on the capture of the baseline process. We still view this is a most important part of the method, as long as there is a baseline process in existence. Evidently there will be situations where a group is attempting something completely new. Our experience has also shown, however, that there are situations where there has been some attempt to organise activity towards the achievement of goals, but these goals and the ways of achieving them are so ill-defined that there can hardly be said to be a “process” in place at all. In these situations it will be necessary to call a halt to attempts to produce models of the baseline at an appropriate moment.

### 15.2 Data Gathering, Organisation and the Process of Abstraction

Data gathering can easily fall into one of two traps - either too much raw data being collected, taking an excessive amount of time, and being very difficult to process, or being very rushed and incomplete.

What we have observed in practice has been modellers building up a model of the process in their heads, then trying to get it down on paper in the diagrams. All the raw written data from the interviews was used only in helping to build up these mental models, and to help other modellers who hadn’t been present at the interviews to build up their models. there was no real attempt to work on, or develop this data in any formal way. The sheer bulk of the data worked against this. It was however present as a check and a fall-back.

The method which we present below for the capture of the baseline process attempts to provide a more structured approach. We suggest a cycling through a series of frameworks, using the Process Charts, Dependency Diagrams, and Activity Diagrams. The early processing of data (by the use of these notations) is regarded as essential, if the intervention is not to be bogged down under the weight of data.

In interviews we emphasise the value of first hand data (what the interviewee does), as opposed to second hand data (what the interviewee is responsible for getting someone else to do), or third hand data (about what someone else entirely does).

Besides this, the process definition helps determine the extent to which two enactments should be viewed as enactments of the same process.

Also it is essential to the efficient functioning of any process that the participants are clear as to what their process is supposed to achieve and how their work contributes towards this.

In this area, perhaps more than any, it is important for the modellers not to create their own answers, but to help clarify those of the managers concerned. Process modellers are not business strategists.

## 14.3 Obtaining the Process Definition

This may proceed by:

- Examination of documents
- Unstructured discussions with managers
- Workshops and discussions based on SSM techniques

### 14.3.1 Process boundaries

These may be initially sketched out along organisational lines, i.e. the work done by the staff answerable to a particular manager may be deemed to be the focus process. However, this is only a rough and ready guide, and not in itself sufficient. The acid test as to whether any particular activity is part of a given process or not, is whether it contributes towards the objectives of that process.

### 14.3.2 Process objectives

It may be that a clear and coherent statement of the process objectives can be quite readily obtained from the client or process owner. However, it is still important to check this with the other parties (clients, owners, and participants). It is not uncommon for there to be disagreement about the details of the objectives. Also there may be occasion to revise the statement as the study progresses.

The obvious starting place is the examination of relevant documents. These yielded plenty of high level or “mission statements” of objectives, but little which would indicate what the output of the process should be. Discussions with managers revealed a consensus that, in general terms, their business was the production of systems integration information, but it was felt by both sides that a tighter definition than this was required. Latterly we have introduced a more structured approach based on Soft Systems Methods.

## 13.1 Evaluation of what is achievable in terms of different types of benefits

### 13.1.1 Possible potential benefits

Cost-cutting by:

- cutting out activities
- cutting out waiting time
- cutting out interactions (especially across organisational boundaries).

Improved manageability of the process

Improved product definition, and improved product

Better targeting of resources

### 13.1.2 Relation of anticipated benefits to type of process

The owner of a mature process might look for optimisation - cost-cutting, pruning, and stream-lining. On the other hand, in an immature process we might look for gains in consistency, manageability, improved product definition, and improved product.

# 14.0 Process Definition

## 14.1 What does it do?

It is based on the Soft Systems idea of a “root definition” and it does the following:

- Defines the objectives of the process
- Defines the boundaries and interfaces of the focus process
- Categorises the focus process

## 14.2 Why is it necessary?

- To determine what is required of the process
- To scope the investigation
- For evaluation of the process

A most important part of any PM study lies in obtaining a clear definition of the process, in terms of what the process exists to achieve. It helps in scoping the study, in deciding which activities are part of the process and which interface to it; it helps the modellers understand the process; and it is essential to the evaluation of the process and in process redesign.

owner'. Often in hierarchical organisations a manager at one level may make certain changes to the process, but more radical changes need to be referred upwards.

### 12.3 Use

Scoping - depth and breadth of study

Resource allocation (particularly manpower)

Defining the relations between actors in the study - engineers, clients, owners and participants

Providing a framework for their communication

Placing the study in the organisational context

Defining constraints

### 12.4 Form

The study definition is a communication and consensus-forming activity. Typically it will be performed through meetings and the production and distribution of a regularly updated document set detailing objectives and the state of the study.

### 12.5 Output

A definition of the aims of the study, a plan for their achievement, identification of the players of the major roles, and their responsibilities in the study.

### 12.6 Change

The activity needs to be revisited during the course of the study, as many aspects of the definition may change. In particular the objectives may change as the study proceeds. It may, for instance, be impossible to tell at the start of a study whether the process will only need optimising, or whether a complete redesign will be required.

## 13.0 Risk and Benefits analysis

Brings together the process owner's priorities on types of process improvement with the findings of the modellers, and the desires of the participants

Ensures the risk level is always acceptable

should be an on-going activity, and on later iterations some stages will require very little work. For instance the target process may have become the baseline process for the next iteration.

A high degree of concurrency is desirable and should be attainable between the above phases, although they should commence in the above order. In particular process evaluation needs to start as early as possible

# 12.0 Study Definition

Checkland and Scholes report that for SSM "... it was found useful to think of an intervention in a problem situation as itself being problematical."[CS90] The implication of this is that the process engineer needs to understand the structure that underpins his/ her involvement in a work environment.

## 12.1 Objectives

The main objective of this activity is to obtain and maintain a clear definition of the purpose of the study. Experience has shown that this purpose is often only understood in very general terms at the outset of the work by any of those involved. It may be expressed as a desire "to improve the process", or "to see if there is scope for improvement".

## 12.2 Roles

There may be different parties involved in the study, all with their own interests, and their own ideas about what would constitute improvement to the process.

The following roles have been identified as occurring in any study:

- process engineers - those undertaking the study
- clients - those who commissioned the study
- process owners - those with the power to implement changes to the process
- process participants - those whose work is part of the process

It is important for the working out of the objectives of the study, and for the smooth running of the study, to identify who is playing each role, their organisational relationships, and where their interests lie. The same people may play several (or indeed all) of the roles. Indeed commonly the clients are the process owners. However, all groups involved will have their own interests, and these need to be reconciled as far as possible. Where they cannot be reconciled (if, for instance, the process owners wish to cut the number of process participants) then the differences at least need to be known in order to be smoothly managed.

### 12.2.1 Identifying the role players

It should be noted that roles may be played by groups rather than individuals. The only role where there is likely to be a problem identifying the player is the 'process

# Part 2

## 10.0 Use of the PADM

The method was initially designed for our own use, i.e. for the external expert coming in to an organisation for a one-off project. However, we have attempted to develop it in such a way that it is usable in all forms of intervention.

Evidently the balance of effort between the various component activities will vary according to the type, and the particular circumstances of the intervention. In some cases an activity may be completely absent - for instance if a new process is being designed there will be no baseline to capture or evaluate. However, this will be the exception rather than the rule, and we would recommend that the activities all be at least visited, and periodically revisited, to make sure not only that there are answers to the questions raised in those areas, but that the answers remain applicable.

## 11.0 Component Activities in the Engineering Process

The following activities have been identified as the major elements in any process engineering exercise:

- **Study definition**
- **Risk and Benefits analysis**
- **Process definition**
- **Baseline process capture**
- **Process evaluation**
- **Process development objectives definition**
- **Target process design**
- **Process development route**
- **Specification of Requirements for Automated Process Support**

These phases are designed on the basis of the intervention being done on a ‘one-off’ basis, or for initiating process development. However, process development

We see SSM [CS90] as a providing a set of potentially very valuable techniques in the critical areas of process definition and target process design. The "root definitions" used in this method equate very closely to process definitions, and provide a way of organising, examining and analysing the objectives which drive a process. SSM provides a way of moving from these definitions to "conceptual models of a system", which we can equate to high level process descriptions.

We are currently investigating other ways in which systems thinking can be applied to process modelling.

## 9.0 Forms of Process Engineering Intervention

Three different forms of process engineering intervention have been identified as being appropriate in different circumstances.

- One-off projects
- Regular projects
- Continuous process

### 9.1 One-off projects

As process engineering is a skilled activity, one-off projects to analyse and improve a process will usually need to be carried out by outside experts.

### 9.2 Regular projects

Alternatively the process may be revisited on a periodical basis.

### 9.3 Continuous Process

As indicated above we believe that process engineering may in many organisations best take the form of a continuous process, linked to monitoring and control. The process engineer then would be a member of the organisation, and quite possibly a process participant.

procedure manuals and/or the managerial (process owner) view of the process. This was recognised to be inadequate in that it failed to capture essential detail about how things were ***actually*** done as opposed to how they ***theoretically*** were supposed to be done. The refinement of this involved the outside process experts spending a lot of time interviewing process participants and analysing the data gained. It has also been necessary using this approach for the outsiders to understand a lot about the process before significant progress can be made.

A much more efficient way of working is to get process participants to do as much of the actual modelling as possible, with role of the outside process engineers being one of ***guiding, facilitating, and co-ordinating.*** There are a number of advantages to this:

- A reduction in costly time and effort required of outside process engineers.
- Increased participant awareness of process
- Transfer of process engineering skills to process participants, leading to an increased ability of groups to reengineer their own processes
- Increased buy-in to the process engineering process by staff. This buy-in can be critical to success
- Increased commitment to their own process from participants.

## 8.6 Process design is a socio-technical activity

The process designer is engaged in the examination of the activities of organisations, which will, in large part, be carried out by people. The social and technical aspects of these processes are inseparable. The designer may pay no attention to the social aspects, but the social aspects will be affected by the technical ones, and will in their turn affect them.

## 8.7 The Use of Soft Systems Methods (SSM)

It can be seen through investigation of the emerging theoretical structure of process modelling that it has much in common with Soft Systems Methodology. Systems theory identifies the world as containing structured wholes or objects. Components of the structure are potentially or actually involved in complex inter-relationships. Soft systems theory applies these concepts to ‘unstructured,’ complex problem areas where human perceptions and relationships have a significant impact and there is unlikely to be a simple, single solution. Process modelling uses the concept of ‘process’ as a framework for exploring and describing the relationship between parts of a system in a way which is especially suited to work activities. Thus the following quote might equally apply to systems thinking or process thinking:

“....an approach to a problem which takes a broad view, which tries to take all aspects into account, which concentrates on interactions between the different parts of the problem.”

It is in fact Checkland’s description of a systems approach [C81]. Process modelling is different in that through the concept of process it has a prescribed framework intended for meaningful, objective oriented exploration of the work activity sub-system of the greater systems world.

- Identity of Inputs: Each enactment of the process should use inputs of the same type
- Identity of Outputs: Each enactment of the process should produce outputs of the same type
- Regularity of inputs/throughputs

#### 8.2.1 Amalgamated processes in a model

There can be a place for such models, but we need to be aware when we have one. They can mislead one into thinking one has a unity.

### 8.3 Concurrency in the Process Modelling Process

The naive model of process modelling process consists of a series of stages which are passed through on the way to production of a process model, which is then analysed, and acted on. Each stage has a deliverable which forms the basis of the next. it became apparent during the course of this project that it would be much more fruitful to view the PM process as consisting of a number of ***concurrent*** activities. This helps the modeller come to terms with the fact that the baseline process they are examining is a real-world process, subject to the exigencies of the organisational situation in which it occurs, and thus is in a state of continual change. This change would be occurring to some extent even if the modelling were not being done, but is accentuated by the fact that shortcomings in the process will be made visible to the participants during the modelling.

In the real world in which businesses operate there is often pressure to enact improvements of a tactical nature quickly, without waiting for a baseline model to be drawn up, analysed, the strategic changes to the process to be agreed, the target model to be drawn up, and the approach to implementing changes to be determined. Of course, rapidly implemented changes have a higher risk of proving unsuccessful unless their ramifications are analysed, and so a limited tactical level run through of the "later" activities may be needed. Also these changes may eventually be superseded by changes decided on in the strategic context, but they will still often be worth making in the interim.

### 8.4 Process Engineering may be a Continuous Process

The PM process is often seen as a ***terminating*** process, i.e. a number of stages are gone through, a result is achieved (an improved process) and then the PM stops, until it is felt necessary to go through it again. A PM method should indeed be capable of being used in this way, but in many situations, especially those subject to rapid change, it is more valuable to see PM as a ***continuous***, non-terminating process, similar in nature to planning and monitoring processes, and linked to them.

### 8.5 Client Participation in the Process Engineering Process

Concurrency goes hand in hand with an approach whereby the main actors in the process engineering process are the owners and participants in the process being modelled. Early approaches to process modelling worked exclusively from

## 7.5 Data dictionary

The tool must provide a data dictionary.

## 7.6 Capacity to run simulations

The tool should be able to provide dynamic analysis of the model, including the running of ‘what-if’ scenarios which will show such things as bottle-necks, traffic levels, and resource use under different loadings of the process.

# 8.0 General Guidelines for Process Engineering

## 8.1 Process Modelling

Process modelling consists in finding pattern in activities. It is done by abstracting from the flux of the everyday actuality. At the highest level of abstraction we have the process model for all processes, at the lowest a model which is only instantiated once. The objective of the process modelling process is to work towards the production of the most specific model on which agreement can be obtained that “when we want to achieve X, we do this” - that this model reflects a pattern in the activities. There may be further caveats and limitations - “when we want to achieve X and the conditions are Y, and the input is of type Z, we do this”.

There is no lower limit on the width of applicability of a process model, but evidently the tendency will be that the more widely applicable it is the more useful it will be.

Too loose a model leads to activities “rattling around” inside it

The model must be at an appropriate level of generality

The model at its level must provide the information sought.

The model must be:

- (a) unified
- (b) seamless - as decomposition proceeds it should be evident into which higher-level box the lower-level activities fit - no “holes” in higher level

The key part of the process may be difficult to analyse, or even to see. It is easy to get distracted by the more visible bureaucracy - reports that have to be written etc.

## 8.2 Unity of Process

It can be important to determine whether one is dealing with one process or several How do you decide whether you have one process or more than one? The following are possible guides:

- Unity of Objective: If the objective of the process cannot be formulated in such a way as to cover all instances, then there is more than one process.

- identify supply operations, receive operations and step interface operations
- define the operation pattern
- define each operation for each single step object
- identify supply operations, receive operations and step interface operations
- define the operation pattern
- define each operation

# 7.0 Tools to Support the Process Engineer

## 7.1 General requirements

Tool support for the method is seen as being extremely important for process engineering carried out on the scale, and to the depth of detail which we envisage. Without computer support the sheer amount of data will become unmanageable. The IPG at Manchester is working on the development of such a tool, to satisfy the requirements listed below.

The tool has to facilitate the input of information, facilitate the task of organising that data into a process model, help ensure the consistency of that model both logically and through time, provide analysis of the process including simulation of the behaviour of processes under user-specified conditions, and provide easily-comprehensible views of the process from a variety of perspectives.

The tool may be regarded as comprising three integrated aspects:

- diagramming editor
- database
- analysis and simulation

## 7.2 Multiple views on data

As has been mentioned above (Section 6.1), we believe a multi-perspective approach to process representation is essential, and we see these views being integrated through linking all objects to activities.

## 7.3 Decomposition / Hierarchy building

It is important to be able to produce diagrams representing the process with differing degrees of granularity. Process owners and managers, and process engineers, need to see the overall pattern of the process without getting lost in the detail, yet detail may be vital in designing a process that works efficiently (or at all). The tool needs to support the creation of a hierarchy of diagrams, and ensure consistency between the levels. Thus the diagrammer should be able to select any activity from a diagram and decompose it into its constituents.

## 7.4 Version control

The baseline process being modelled and the target process being designed are both likely to be undergoing constant evolution. Consistent updating of versions will be a necessity which the tool must aid.

## 6.4 Base Model

Base Model (BM) [SW91] is an approach developed for specifying concurrent object-based systems. BM provides a framework allowing specifications to be written in a systematic way. A temporal logic semantics is given for each specification construct. Such mathematical foundations provide the basis for formal reasoning of BM specifications.

BM provides the following constructs:

- composed agent object
- composed step object
- single agent object
- single step object

A composed agent object consists of a collection of agent objects that may perform steps (activities) in parallel. Each contained agent object may be either a composed agent object itself or single agent object.

Similarly a composed step object consists of a collection of step objects that may be performed in parallel. Each contained step object may be either a composed step object itself or single step object.

A single agent object contains some encapsulated variables that may only be accessed by the operations provided by the object. There are three types of operations: supply, receive and step interface.

- supply operations send artifacts to other objects
- receive operations receive artifacts from other objects.
- step interface operations are the interfaces for the agents to access the step objects.

Each single agent object has an operation pattern which restrict the orders in which the operations may be executed.

A single step object also contains some encapsulated variables that may only be accessed by the operations provided by the object. There are also three types of operations: supply, receive and step.

Supply and receive operations are the same as in agent objects.

A step operation models an actual activity to be performed.

A single step object also has an operation pattern which specifies the order in which its operations may be executed.

A BM specification is constructed by repeatedly following the guideline below:

- identify agent objects
- identify step objects for each single agent object,

- the process LOGIC, in terms of CONDITIONS for ordering activities,
- INTERACTIONS between the person or role-type and other persons or role-types,
- and ATTRIBUTES of the activities, in terms of such items as TIME REQUIRED, DURATION, RESOURCES USED.

Not all of this information need be represented in any one diagram - the diagram is built up according to need. For full details see Appendix 1. An example is given in Figure 2.

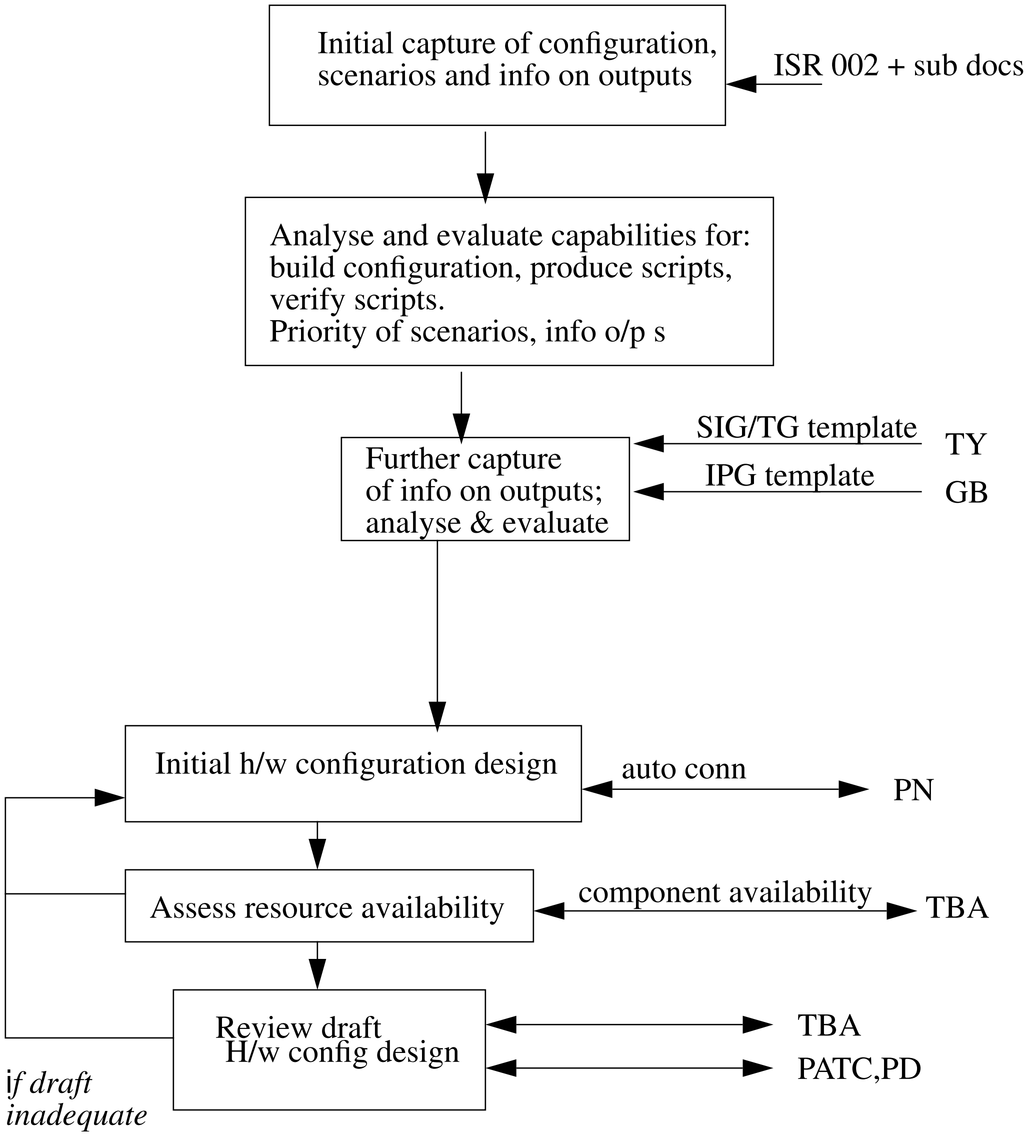



Figure 2.

## Example High-level Dependency Diagram

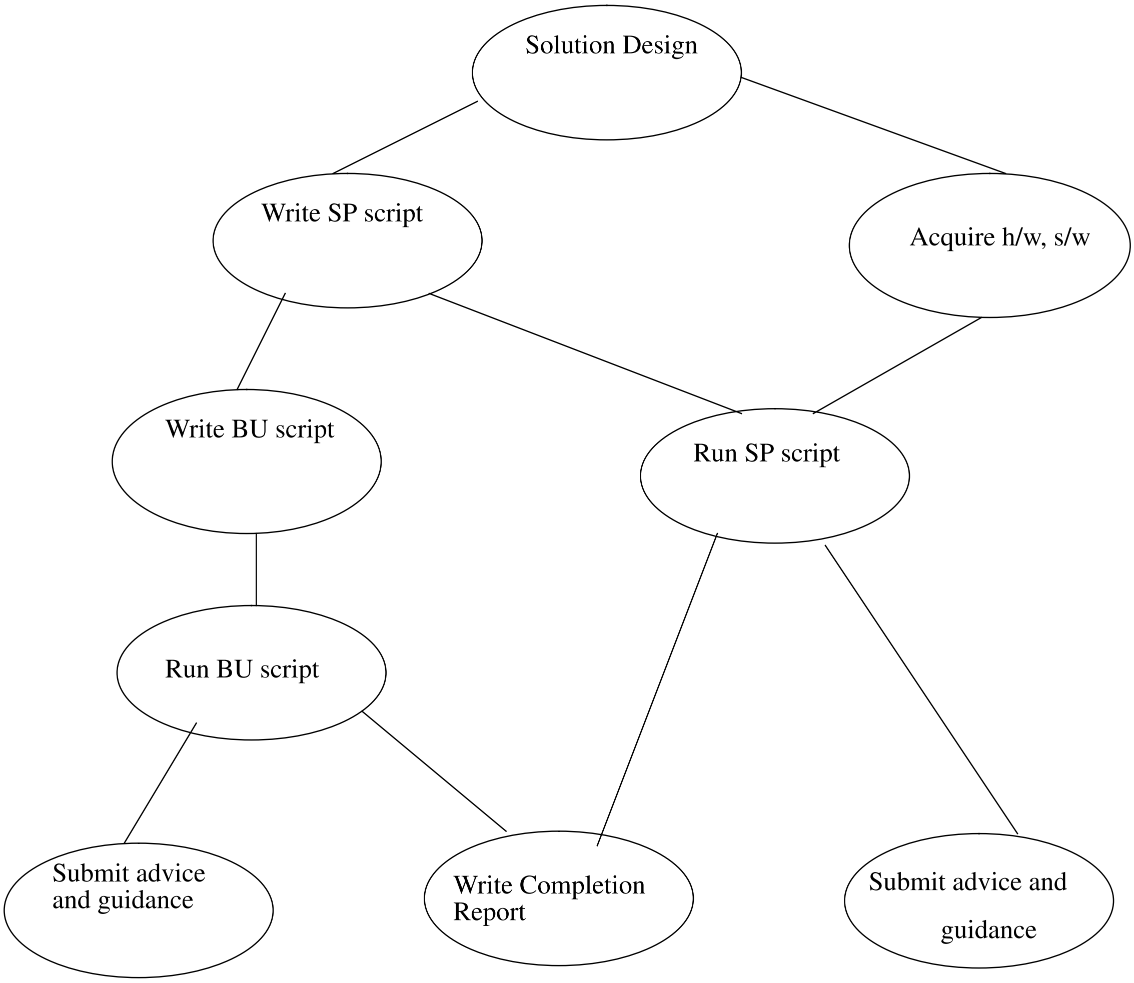



Figure 1

#### 6.3.2 Activity Diagrams

Activity diagrams are built up from observed activities. They capture:

- DEFINITIONS of the activities,
- ORDERING of the activities (including ITERATION and CONCURRENCE),

the process of their construction is always worthwhile in that it raises issues valuable to the development of understanding.

Their main advantage is in showing sequence in actions, and for showing interactions. Some problems were encountered in developing RADs due to difficulties in defining roles in a way which made sense to the process participant and yet fitted the demands of the notation. (See discussion of Role above.)

At a more detailed level of the process, especially in processes which are complex, with a great deal of iteration or conditional branching the RADs could become difficult to read, and had to be broken down, and then the pattern of interactions is lost. Unfortunately there are no facilities for decomposition.

#### 6.2.3 Data Flow Diagrams

Data flow diagrams are good for showing relation between activities and data. The Process Modelling Cookbook cites Ashworth and Goodland [AG90] who state; "The data flow diagram is a meeting point of the analysts and users." The use made of data flow diagrams has been restricted to the early stages of the modelling exercise; and then the notation has not been rigorously applied but used in a loose way to show general flows and activities. They have been used to structure the thoughts of the process modellers and have provided a means for communication between modellers and participants.

### 6.3 New diagramming techniques used

Two main diagramming techniques were used in this study - dependency diagrams and activity diagrams.

#### 6.3.1 Dependency diagrams

Dependency diagrams depict the observed minimum set of sub-processes necessary to the achievement of the objectives of the process. They are very informal, simply showing the main sub-processes, and loosely indicating sequence (time running down the page), and dependency, in that a sub-process may not be completed before one above it to which it is joined by a line. An example is given in Figure 1.

# 6.0 Systems for Representing the Process

## 6.1 Multi-perspectivism

### 6.1.1 The need for multi-perspectivism

As detailed above, a large amount of data concerning the process needs to be represented. This cannot be humanly understood when presented all at once.

### 6.1.2 Problems with multi-perspectivism

The major obstacle to the use of different perspectives in the representation of a process is the problem of consistency between them.

### 6.1.3 Integration of perspectives

Activities, which may be regarded as sub-processes, are the key. All other entities involved in the process are related to them. This is the theoretical basis of the Activity diagram (see below, Section 6.3.2).

## 6.2 Notations

### 6.2.1 Process Charts

These may be used either in interviews, in order to structure the interview, or post interview to structure the information obtained.

The Process Modelling Cookbook specifies that Process Charts should be the first notation used in a modelling study. It was then envisaged that these could be used actually during the interviews to help provide structure. In practice it was found that they were more useful when used after the interview for structuring the information gained.

In an effort to make the charts more easily useable the design was revised several times. Some variations provided less structure but were more easily used in an interview. Others were more structured and less easily used in an interview. The preferred design was one which provided a high degree of structure. This was liked because it provided concise and reasonably complete descriptions of jobs. However it required that the modeller be disciplined about the recording of interview information.

### 6.2.2 Role Activity Diagrams (RADs)

The Role Activity Diagram (RAD) represents processes as grouped and ordered activities (roles) with interactions between them. They are specifically process oriented having been developed to describe the modelling paradigm adopted by IPSE 2.5 technology. A number of interpretations of the RAD have been developed; notable are the Cookbook RAD and the STRIM RAD developed by Praxis.

RADs were found to be suited to high level modelling. They were used after conceptual diagrams, ‘loose’ data flows or process charts to try and solidify understanding of the process. They have sometimes proved very difficult to construct, but

Responsibility accorded to a position within an organisation for the execution of certain types of activity.

Pattern of behaviour exhibited by an individual occupying a position within an organisation, by virtue of their position in the organisation.

## 5.4 Interactions

It is important to identify interactions in the process model, as they are very often hold-up points.

Different classes of interaction may be identified:

- human-computer interaction
- datastore mediated
- document (message) passing
- human- human interaction
- asynchronous/synchronous
- multi-party
- physical meetings
- organisational distance (same group, same dept., same division)

Interactions are recognised as a prime cause of delays in process but some types cause more problems than others - in particular interactions which require synchronous human-human interaction.

It may also be important to show the reasons for interactions. Cutting down the number of interactions may speed up the process, but care must be taken only to cut those which are redundant.

There may be interactions between identified roles but the roles are performed by the same individual. These need to be identified.

- Computer support.
- Artefacts (e.g. reports & facilitators e.g. email)
- Resources
- Conditions.

## 5.2 Activities

Activities are elements of a process. Usually they may be regarded as sub-processes and further refined into their elements in turn.

## 5.3 Roles

The concept of "role" within a process has prompted much debate. It is a concept which it is very difficult to do without, yet it is understood in a variety of different ways, even within the process modelling community. One problem is that the word is in common use, where its meaning is vague. There is a need to clearly define its meaning in the process engineering context, so that roles may be readily identified, be consistent, and be meaningful to process participants.

The concept is used to:

- 1. group activities
- 2. group agents (and abstract away from individuals)
- 3. link activities to agents
- 4. indicate interactions between agents

On many occasions there is a major problem in attempting to reconcile these uses.

Another problem: do we wish role to

- indicate identity of agent - activities A,B,C must all be performed by the same person
- indicate identity of agent-type - activities A,B,C must all be performed by person of the same grade and/or skills (e.g.) a systems analyst grade 2.

### 5.3.1 Responsibility

The concept of responsibility is very closely connected with that of role. Process participants generally seem themselves as having roles in their organisation which accord with responsibilities for the carrying out of certain types of task.

### 5.3.2 Definitions of Role:

"The responsibility for enacting a process or subprocess definition. An agent, when enacting a process, is referred to as assuming the process role." [FH93]

## 5.0 Vocabulary.

Process modelling is concerned with the representation of activities that contribute towards the fulfilment of some goal. Primarily then there is the question of *what* happens. Note that this does not necessarily imply that the concern is 'What do people do?' Machines contribute too. Secondly therefore there is the question of *how* do things happen (i.e. what facilitates them; people, mainframes, slide-rules etc.). We need to be concerned with the how of process behaviour if we are to contribute to IT design, process enactments etc. We also need to be able to recognise the patterns of predictable behaviour which exist within processes and hence need concern for the *when.*

The *what*, the *how* and the *when* shape the vocabulary which is needed to represent processes. The Process Modelling Cookbook has been described as being able to reference the following vocabulary:

- People.
- Activities
- Roles
- Interactions
- Objects (resources e.g. reports & facilitators e.g. email).
- Conditions.

Within this framework the Cookbook is able to consider the sequence and selection of activities and the data flows between them.

### 5.1 Lessons for a PM vocabulary.

The case studies have contributed the following feedback to the vocabulary of the Cookbook:

The vocabulary has been largely validated although the following components are missing:

- a way of showing the iteration of groups of activities.
- a better way of representing the role of the database in the process (i.e. better than the existing object flow notation).
- a means by which early impressions of the process can be captured and described using very simple vocabulary.

The proposed vocabulary is as follows:

- Activities.
- Tasks.
- Roles
- Responsibility.
- Interactions.

- Initial - not possible to produce baseline model. May move straight from process definition (see Section 14) to target process design. May be parts of the process which are necessarily unformalisable. Need to look to provide formal framework around these parts, to facilitate work and monitoring.
- Repeatable - modelling of the baseline in itself, even without redesign, will bring advantages, facilitating monitoring and evaluation. Look at the definition of ROLES. Baseline model building based on wide discussion with participants.
- Defined - Baseline modelling may be based much more on document examination.
- Managed - Baseline modelling is more likely to need to include metrics
- Optimising - Designing the process to facilitate change is likely to be a major consideration.

#### 4.8.3 Limitations of the Process Maturity Framework

As stated above the Process Maturity Framework is concerned specifically about the software process, so it must be applied with care to other processes. Having said this, it has been criticised [BM91] for being based on an extreme form of the factory model. If we look at the process types delineated above (Section 4.3) we see that this is only one (production-line) of many types of process.

Most of the detailed suggestions about grading processes, and suggestions as to how the process may be progressed to a higher level are software-specific. Again they have been subject to some criticism in [BM91], but for most processes they have limited applicability in any case.

#### 4.8.4 The PADM Maturity Framework

We are working on the development of our own maturity framework, looking at the following factors:

- How well-established the process is.
- How formalised the process is.
- How volatile (subject to major upheavals)
- The rate of change of the process.
- How well the process as enacted matches written procedures.

In describing the form of a process, we would need an indication of complexity, stability, rigour, life cycle, repeatability, clarity of rationale, extent of informal working and its accordance with culture.

How this process evolves could be deduced from a knowledge of its control structure, its centre of change, its mechanism of change and susceptibility to environmental influences.

Its alignment with the organisation needs a knowledge of the distribution of participants, their intellectual level, their familiarity with the process, the nature of automated support and degree of formality.

## 4.5 Process Drivers

By process drivers we mean the pressures which create work and cause it to flow through the process. In service processes this comes immediately from requests for service, in production processes usually from order books or anticipated demand. In either case the process answers a need, and ultimately no evaluation of a process can take place without reference to its value in supplying these needs.

## 4.6 Technicality of Process

Skill level required

## 4.7 Critically of the Process

What are the consequences of failure of the process?

## 4.8 Maturity of Process

### 4.8.1 The Software Engineering Institute's Process Maturity Framework

Humphrey [H88] has proposed a five level maturity framework for the software process. The levels form a progression, with the assumption that the highest level is the best for all software processes. He proposes that the identification of an organisation's place on the ladder will suggest the most appropriate types of improvement for their process. Evidently if such a framework could be reliably applied it would be extremely useful to the process engineer.

The five levels suggested are:

- 1. Initial. An ad hoc process without any formal procedures. Not repeatable.
- 2. Repeatable. Intuitive. The process depends on individuals.
- 3. Defined. Qualitative. The process is institutionalized.
- 4. Managed. Quantitative. The process is measured.
- 5. Optimising.

A thorough exposition and critique of the framework is beyond the scope of this document. The framework is designed for the software process rather than general organizational processes, and our examination of it has led us to conclude that for more general the useful lessons may be better drawn from a short examination of the general principles rather than looking at the details of its application to the software process.

### 4.8.2 Usefulness

The framework does seem to reflect progression, mainly in terms of increasing formality of process. But not all process types may be amenable to movement to highest levels, e.g. design.

In the context of the PADM the following observations may be made about processes at each of the maturity levels:

#### 4.3.2 Project and Production-line

In the archetypal production-line process, such as car manufacture, the units produced may be regarded as identical, and the production of one unit follows the same pattern as the production of another unit down to a very low level of detail. In project working, such as civil engineering, each product is unique in important respects.

#### 4.3.3 Design and Building

For almost any product, from a bridge, to a book, to a piece of software, there is a design process, and a process of building, or instantiating the design. Economies are achieved by building many products from a single design.

Design risk v Replication risk.

#### 4.3.4 Output-oriented v state-oriented

Some processes achieve optimisation by maximising the ratio of output to resource consumed. Others are concerned with the achievement of an ideal state (e.g. all customers are content, all bills sent out are accurate).

#### 4.3.5 Case-handling

Many professions use case-handling processes, such as doctors, lawyers, social workers. The “case” may often correspond to a client of the process owner, and be made the responsibility of a particular process participant. Responsibility is typically a very important aspect of these processes. There may be certain actions which have to be performed in particular circumstances or serious penalties are incurred. However, the details of cases may be very different and the particulars of the handling vary widely. Also cases can be long-running, and lie dormant for long periods.

#### 4.3.6 Work-package handling

A wide range of processes, usually services, are based on the handling of work packages. A typical example would be a Customer Services department providing computer systems maintenance. Requests for service are received centrally, given a job number, then passed to the appropriate team for action. Work-packages are of more limited scope than cases, are more routine to handle, less critical, and finished more quickly. There is a greater need for monitoring the progress of packages, because they will often be transferred between people and teams, and typically will spend more time than cases in states where they are not the responsibility of a particular individual.

### 4.4 Moving between paradigms

Organisations may sometimes be in a position to change the process paradigm they use. For instance, an insurance company might move from a work-package paradigm, where each customer claim or request for new insurance is treated separately by a team with a specialist function, to a case-based approach where staff have a case-load of customers, and deal with all their needs.

#### 3.11.2 The process may be tied to a conceptual framework

It may be impossible to see the process without using the conceptual framework of the process participants, yet radically re-viewing the process may entail restructuring that framework.

#### 3.11.3 The process is liable to be changing during the study.

Even without the disturbing influence of the investigator, many processes undergo steady change. Evidently this will make it difficult for the process engineer to draw up a consistent picture of the process.

#### 3.11.4 The act of investigation itself changes the object of study

The act of investigation makes the participants more aware of their process, and aware of aspects of it which they will have previously completely overlooked. There are two ways in which this can bring change to the process. Firstly the participants may simply see that some of the things they are doing are unnecessary, or might be done better in another way. Secondly they may ascribe different meaning to what they do, which will bring changes in behaviour.

# 4.0 Categorisation of Organisational Processes

## 4.1 The need for categorisation

The most successful approach to process development will vary considerably according to the type of process under consideration. Hence it is vital for the process designer to be able to categorise their process as quickly as possible.

## 4.2 Levels of Process

All processes may be divided into base processes and meta-processes which control or monitor base processes.

## 4.3 Types of process

Product is the major determinant of process.

### 4.3.1 Service-providing and Production.

The important distinction from our point of view is the relative importance of input and output for the two types of process. Also that service is essentially reactive - the service-providing process can only commence in response to a request for service, whereas products can be stored up.

## 3.8 Definitions of Process

Feiler and Humphrey [FH93] define it as "A set of partially ordered steps intended to reach a goal".

"A process is a set of logically related activities producing an output which satisfies a customer need" -KPMG

"A repeatable, partially ordered set of activities to achieve an objective"

"An organisational process exists when, in a given set of circumstances, the same set of activities is carried out. It is an observable regularity.

## 3.9 Articulation

Articulation is required to fit the pattern to the particular circumstances with which the actor is confronted. "Articulation consists of all the tasks needed to co-ordinate a particular task including scheduling subtasks, recovering from errors, and assembling resources" according to Gerson and Star [GS]. We need to understand the articulation occurring in any given work situation in order to bridge the gap between objectives and practice. That is to say, if our model of the activities going on in an organisation only includes those directly related to the achievement of objectives, then if we try to match the model to what is actually going on in the office, the fit will be very uneasy.

## 3.10 Place of processes in defining the organisation

Processes are important in defining an organisation. An organisation's identity is not only dependent on WHAT it does, but also on HOW it does it.

## 3.11 Problems facing the Process Engineer

### 3.11.1 The process engineer is dealing with a socially constructed reality.

A process is a way of conceptualising what goes on, an abstraction from the flux of the concrete.

"What goes on" depends on the meaning given to it by those acting in it. There is no possibility of obtaining an "objective" view.

Therefore there can be problems in identifying processes - what constitutes the identity of a process, such that one should say that event X is part of process A rather than B.

## 3.6 Components of Processes

### 3.6.1 Processes consist of sub-processes

Processes may be viewed as being composed of sub-processes down to whatever level we choose.

### 3.6.2 Do atomic actions exist?

Feiler and Humphrey define a "Process Step" as "an atomic action of a process with no externally visible substructure". They also define "process" as "a set of partially ordered steps". This idea of atomic building blocks is very attractive in that it makes for simplicity, and once we have our "process steps" then we know we have all the detail we could need. However, the idea of an action which is in itself "atomic" is a nonsense - any action can be broken down into components if we are so inclined, and as we get more and more detailed we will lose the regularity necessary in order to identify a process at all.

We can choose to take a certain level of breakdown of the process as comprising our "steps", beyond which we will not go, but this will be our choice, not a property of the actions themselves. In fact there is no need for the concept of an "atomic action".

## 3.7 The Inter-relation of Processes

### 3.7.1 Process hierarchies

The view that processes are made up of sub-processes implies the existence of hierarchies of process. However, in practice we find that a process may be part of two super-processes, so we do not end up with processes forming tree-graphs.

### 3.7.2 Process relations

Where 'p' is a process:

p1 consists of p2 +p3 + p4 (composition)

p3 is part of p1(inclusion)

p3 is part of p5 and of p6: (intersection)

p1 is an alternative to p2 (alternation)

p1 + p2 are alternative to p3 + p4 + p5 (multiple alternation)

p1 depends on p2 (dependence)

p1 depends on p2 and p3

p1 and p2 depend on p3

happen. We are looking for patterns of change, and general rules covering those patterns of change.

A process is an observable regularity, i.e capable of being observed.

#### 3.2.1 Processes may be one-off, or repeating.

We are interested in repeatable processes. When we model a process we are concerned with the repeatable features, with the identification of patterns, not with history.

### 3.3 Identifying processes

#### 3.3.1 The search for unity

It can be important to determine whether one is dealing with one process or several. What is it that permits us to say of a collection of events/activities - “these constitute ONE process”?

#### 3.3.2 The identity of the process

How do you decide whether you have one process or more than one? The following are possible guides:

- Unity of Objective - If the objective of the process cannot be formulated in such a way as to cover all instances, then there is more than one process.
- Identity of Inputs
- Identity of Outputs
- Regularity of inputs/throughputs

### 3.4 Organisational processes are purposeful

The MIT programme “Management in the Nineties” [SM91] defines business processes as “a sequence of interdependent tasks and functions which together produce outcomes that contribute to the (business) success of an organisation”. This definition emphasises the purposeful nature of organisational processes.A process is a means to an end. It is always directed toward the achievement of some goal or objective. Sometimes this objective is to produce a product in a very obvious, even physical sense, but the process may also be about the achievement or maintenance of a state. It is not always easy to identify the objective a process.

### 3.5 Organisational processes rely on the co-ordination of people’s efforts

A process is an ordered and ***coordinated*** set of activities for the attainment of a particular goal.

## 3.0 The Nature of Process

### 3.1 What is a process?

#### 3.1.1 The need for definition

The term "process" is commonly used in a wide variety of contexts. We talk of biological processes, such as the growth of an organism, mechanical processes, chemical processes, computational processes, and also of social processes, such as those which go on within organisations. The meaning of the term is not well defined. If there are to be disciplines such as Process Engineering or Process Modelling then it is most important that a definition with as much precision as possible is agreed.

#### 3.1.2 Ontology

There are:

1. events that happen (the actual)
2. patterns of events
3. descriptions of actual events
4. descriptions of types or patterns of events
5. prescriptions for how a particular event (or sequence of events) should occur
6. prescriptions for event patterns to achieve certain aims
7. computer programs which control or guide events

The term "process" as commonly used may be found on occasion to refer to any of the above. It is important to know what is being referred to when the word is used.

#### 3.1.3 The Process as Practised and the Process as Prescription

One very important distinction is the one between the process as practised and the process as prescription. The process may exist in the form of "We do A, B, and C in order to achieve X", or in the form of "They should do D, E, and F in order to achieve X". Models of these may be quite different even for the same group of people attempting to achieve the same ends. (The models *may*, of course, coincide). The term "model" is commonly used in both cases. We distinguish the "baseline process model" from the "target process model".

### 3.2 Regularity in change

We are interested in organisational processes, but it is worth looking more generally at what these have in common with other types of process. All processes involve a *change* from an initial state to a finishing state. If we are interested in process then we want to answer the question *how* that change comes about. And thus we are interested in relating the specific instance to the general type of change, whether in order to understand what did happen, predict what will happen, or affect what will

- suitable notations for process descriptions
- a method for capturing, analysing, and redesigning processes
- tools to support the method
- Process technology
- Guide to enactment systems

## 2.4 Process Modelling

### 2.4.1 What is a Process Model?

"A model is an abstract representation of reality that excludes much of the world's infinite detail. The purpose of a model is to reduce the complexity of understanding..... a phenomenon by eliminating the detail that does not influence its relevant behaviour." - Curtis, Kellner, and Over.

Thus a process model represents some aspects of the process of interest. The form of the model should be chosen to best match the purposes for which the model is required. Obviously the search is on for forms which will suit a wide range of purposes, but it is important to be aware of the tension in requirements. For instance, person-to-person communication about a process will require much less formal models than machine analysis of a process.

### 2.4.2 What does the process engineer need process models for?

- understanding processes
- communicating about processes
- reasoning about processes
- analysing processes
- comparing processes
- evaluating processes
- measuring processes
- to aid design of processes
- to work out the requirements for IT support for processes

### 2.4.3 How is process modelling different?

"Process modelling is distinguished from other types of modelling in computer science because many of the phenomena modelled must be enacted by a human rather than a machine" - Curtis, Kellner, Over.

### 2.4.4 Process Modelling Method

Process modelling, like any form of modelling, can be either a *descriptive* or a *creative* activity - we can either describe the process as it is occurring, or prescribe the way in which we would like to see it happening. In most serious applications both these aspects are necessary, and their facilitation must lie at the heart of any process modelling method.

### 2.2.4 Enacting the process - People and Machines

The social aspects of process are inter-linked with the technical

People are better than machines at dealing with unforeseen exceptions to process

People are intelligent - machines are not

People act for reasons - machines have no reasons or objectives or opinions about their instructions

### 2.2.5 Conventional Support for the Process

"Process modelling techniques should be used in mainstream IT development to capture the dynamics of an organisation, ensuring that the human system within which the IT system is embedded is properly considered, and plans are in place to change it where necessary, in parallel with IT implementation" -T J Huckvale, IOPENER 5.

## 2.3 The Business Process Engineer

Thus there is a need for process engineers, engaged in the design of organisational processes, capturing the dynamics of the organisation, ensuring that the human system within which the IT system is embedded is properly considered, and developing plans to change it where necessary, in such a way that developments in IT may be smoothly integrated and capitalised upon.

Process engineering is concerned with the problems of capturing and describing human-oriented systems. It seeks means of improving the real world process being modelled, and this improvement can be accomplished in various ways: by better understanding and by assessment of the process, by controlled change of the process, or by computerized support for the execution of the process.

Process engineering links business concerns to the concerns of the IT developer, to ensure optimal processes, making the best possible use of IT.

A process engineer needs....

- to understand what a process is
- to be able to categorise the process of interest
- to be able to succinctly describe process behaviour
- to understand the process of process development
- the tools to describe, analyse and evaluate processes
- to select suitable enactment vehicles
- to program processes for execution if appropriate

So it is necessary to provide....

- a theory of process
- a classification system for processes

## 2.2 The IT Perspective

### 2.2.1 Supporting the Process

Computer systems are moving from the position of being tools used for well-defined and limited purposes to being highly-integrated parts of the overall system of the organisation. Indeed the rapidly-developing process support technologies such as ProcessWise Integrator are bringing us to a situation where people may be viewed as “process inhabitants” in a system largely computer-driven. It is not sufficient to design such a computer system in isolation. It has to be integrated into its context from the outset.

In today’s business conditions there is an increasing need for organisations to be able to change rapidly.IT must support this.

In order to achieve a satisfactory fit of information systems in the organisation the non-automated parts of the process need to be as well understood as the automated.

### 2.2.2 The Process Perspective to IT Development

Standard IT systems development concentrates on entities - it views activities and processes as being carried out in order to transform entities. In fact, in most work (except production) entities are important only in order to facilitate activities - it is what is done which is important.

If the IT developer concentrates on the entities involved, they will come up with a model of how to develop those entities.

Michael Hammer [Ham90] cites the memorable case of Ford accounts payable section which achieved a 75% head count reduction through process redesign. This would not have been possible using standard SAD techniques based on data modelling - the previous system would simply have been automated. The radical re-engineering was only possible by taking a process perspective, and looking at the *purpose* behind the process.

### 2.2.3 Process Technology

The past few years have seen the development of a whole new class of IT systems, known variously as Process Technology, Coordination Technology, or Process Enactment Technology, foremost amongst these being the ProcessWise Integrator. These provide a framework for co-ordinating people and tools, and seek to automate parts of the process.

If you are to automate a process, you must automate the right process. As Hammer [Ham90] points out, simply automating the baseline process (the process as it exists prior to the automation) may at best be a missed opportunity, and at worst lock the organisation into outmoded ways of working. In order to make the best possible use of process technology it is necessary to design an optimal process, taking account of both the automated and non-automated parts of that process.

# Part 1

## 2.0 Who needs a Process Analysis and Design Method?

### 2.1 The Business Perspective

#### 2.1.1 Process Improvement

Attention to process is increasingly being seen as the way to improved performance and a better quality product across the whole spectrum of organisations. Improving process is seen as a way to:

Better quality product

Increased efficiency

Increased effectiveness

Reduced costs

Increased process flexibility

Improved staff satisfaction

Process development occurs either organically, as staff make changes to cope with changing circumstances and environment, or in a planned way. Both are necessary in different circumstances. The PADM facilitates planned development, achieved through modelling of the processes in the area of interest.

#### 2.1.2 Business Process Reengineering

Business Process Reengineering involves a radical redesign of organisational processes. It entails going back to basics and examining what the processes are really trying to achieve, then redesigning them so as to be as efficient as possible, even if this means the breakdown of old functional boundaries and the restructuring of the organisation.

# 1.0 Introduction

This report draws on a wide range of work performed by the Informatics Process Group (IPG) at Manchester University. Part of this work has consisted of theoretical investigations, but all the ideas have been tested out through a series of case studies.

## 1.1 Structure of the Report

The report comes in two parts. The first part looks at the context within which the Process Analysis and Design Method will be used, and the theoretical and practical constructs on which the method will draw. The second part outlines the method itself.

## 1.2 Terminology

The process modelling field is still in the process of developing the specialised terminology it requires. Many words and phrases in this paper are used in a specialised sense. Where our usage differs from standard I have attempted to investigate and explain the meaning. We have drawn extensively on the definitions drawn up by Feiler and Humphrey [FH93], but in places have felt compelled to use expressions in a radically different sense. In these cases I have attempted to make the differences clear.

# Report on a Process Analysis and Design Method

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