Business model representations

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Abstract

The problem is discussed how best to arrive at and express information system requirements from a business-oriented point of view.

It is argued that a suitable starting point is first to identify all *functionalities* (action capabilities) within an area. Joint consideration of production and information-oriented aspects leads to options for support by computerized systems. It is also shown that a *layered* business *meta-model* suggests a natural sequence of questions, triggering stepwise development of a business model that appeals to all stakeholders. Options for CASE *tool integration* of business and information system models are briefly considered.

Keywords

Organizational modelling, knowledge representation, information system design, requirements engineering

1 INTRODUCTION

How do information system ***stakeholders*** arrive at and express requirements? Most methods (or 'methodologies') recommend cooperative activity in which informally stated wishes are gradually refined into formal specifications (Olle, 1982, Olle, 1991, Pohl, 1994). Standards are beginning to emerge (Franckson, 1994, Laamanen, 1994, Singh, 1994). A variety of proprietary iCASE tools aim at offering ease of interaction (Comm. ACM, 1992). And research is conducted into ways of semi-automatic method improvement (Brinkkemper, 1990, Jarke, 1994). Yet, natural language rather than formal expression remains the predominant vehicle for exchanges between the ***business*** and ***information systems*** communities (Lyytinen, 1987, Comp. J., 1991, Opdahl, 1994).

The reason for this methodological anomaly lies in the disparity of interests. An organizational information user is concerned with the support provided. An 'IT' specialist, on the

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other hand, is interested in design techniques and the applications as such. The cultural difference between the two groups manifests itself by different professional jargon. In spite of decades of debate, no agreement seems in sight what precisely constitutes an 'information system' (Falkenberg, 1989, Lindgreen, 1990, Falkenberg, 1992). What is accepted is that it is intended to provide 'information' in some real world environment. But almost any text says that 'therefore' the system must 'model' (a relevant part of) that world.

While possibly true for 'data processing' systems, this is not necessarily the case for more advanced 'support' systems. For instance, a group decision support system (GDSS) consists of a set of communication tools and data capturing tools, besides the traditional data storage and retrieval tools. The latter concern input from the past. However, openness towards new forms of information and capability of abstraction are the truly essential aspects of any GDSS. In other words, it does not reflect today's world but that which one might encounter tomorrow. Furthermore, the system's networking and communication features are associated with the way of (co-) working, not with the object of that work. Such a system models what exists and how one works: business rules, staff guidelines and reporting relationships. It tells much about the organization itself. One might say that it represents 'organizational knowledge' *.

The basis for almost any new or evolving system's requirements lies in some combined view of ***things*** ('what is the system about') and ***actions*** ('what is the system's usage about'). These are related, but not necessarily in a simple way. E.g., an information system designer looks for ways of expressing results about things captured in the system ('information-from-data'). The business analyst, on the other hand, wants to know what must be done to achieve a basis for decision making or to support a specific task ('information-from-system').

This paper addresses some ***representational problems*** in this area. First, the views and informational requirements are considered of the 'strategic' and 'operational' functions in an enterprise. Next, the activity of 'information modelling' for the subsequent design stage is reviewed. Finally, the options are discussed for integrating or merely interpreting such views and models.

2 STRATEGIC AND OPERATIONAL BUSINESS VIEWS

Two examples may illustrate the informational problems associated with an enterprise's business view. In both cases, a global 'business model' is presented, as a context for discussing the information requirements. The first case concerns a productive company (engaged in manufacturing and marketing), the second one a service industry (a tour operator).

* Of course, an organization does not 'know' things in the same way as an individual person does. However, if one equates 'knowledge' with 'ability to make decisions', the analogy is compelling. It is our view that a simple information system already represents a certain amount of organizational knowledge (Verrijn-Stuart, 1994a). As far as stored data is concerned, this is evident. But the software/hardware systems that contain and manipulate it are essential components. After all, they possess the data selection and manipulation capability. Thus, jointly they provide a basis for conventional decision making, certainly if one also includes the established organizational 'procedures'. For advanced systems, all this is even more strongly the case.

Likewise, for 'office support systems' - such as text processors and spread sheet systems - the *way of working* is at least as important as *what* they are applied to (namely, *how* one treats text, sets of figures, etcetera). What is embedded here is organizational 'service capability'.

Two examples

For the manufacturing/marketing enterprise (Figure 1), a traditional short term question is 'what levels of raw material input and finished product output shall we choose?'. The answer depends, of course, on a variety of conditions and consequent pieces of information. E.g. plant and operator capacities, supply availability and price of raw material, expected market demand for finished product, prices that might be realized and so on. Other decision factors are: the enterprise's economic *objectives* (say, cost minimization or revenue maximization), its employment *policy* (say, steady vs flexibly adapted labour pool) and its environmental *goals* (say, some percentage improvement of toxic effluent compared to the previous period).

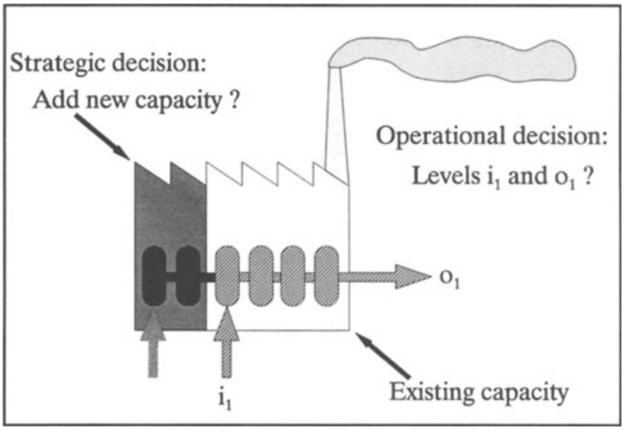

Figure 1: The 'real world' of a manufacturing & marketing enterprise

A manufacturing and marketing information system will 'model' the operations sketched by representing the (flexible) productive and labour capacities, recording raw material stock and usage data, production schedules, past and expected sales figures, etc. All these elements are 'things' from the 'real' world in which the enterprise is active. Some are concrete (tangible), such as the existing plant, the available labour pool, the input material and the output product. Some are abstract (intangible), for instance the plant 'capacity', the stock 'level'. Yet, all *data* recorded *about* real-world things (e.g. the i_1 and o_1 in the diagram) and any implicit cash flows are abstractions, as well. A distinction between concrete and abstract only assists in visualizing the business model, but all representations - where relevant for information and decision systems - are of the '**informational**' kind.

However, what about objectives, policy and goals? Almost certainly, they will not figure explicitly in the eventual information system, because they do not form data in the recording and/or decision sense. Treated as an operations research problem, objectives would appear in the 'objective function' of an isolated optimisation problem. Policy will be discussed in the development project sessions. Reporting facilities might be devised to monitor relevant operational data. Similar action may be undertaken to watch goal achievement. Even so, one would expect the business model that will form the basis for further design and construction activity to contain these aspects only in the form of textual (natural language) comments.

The same kinds of elements as discussed above would enter strategic planning studies. An added difficulty is that one deals with the entirely imaginary world of the future. Depending on the sophistication of the enterprise, explicit objectives modelling may take the shape of mathematical optimisation. In general, the aspects considered relevant will again be linked with '**informational**' representations of the physical components (machines, material, labour) and the financial aspects. Questions of policy and goal realisation probably remain implicit.

A further problem in arriving at usable and satisfactory systems is the difference in culture of the stakeholders. Each group emphasizes different aspects as foremost in their perceptions:

- management ↔ objectives, policy, goals
- operational users ↔ tasks, informational support
- information function ↔ data, processes, objects, software, hardware ...

Traditional information system development methods concentrate on the latter, providing some link to tasks and support, but otherwise leaving open the way in which parties discuss development. An appropriate solution to these problems may lie in the use of a slightly more formalised description (meta-model) for the business domain. We will consider the meta-model in the next section, after first addressing some more business-informational problems, which emerge from our second example.

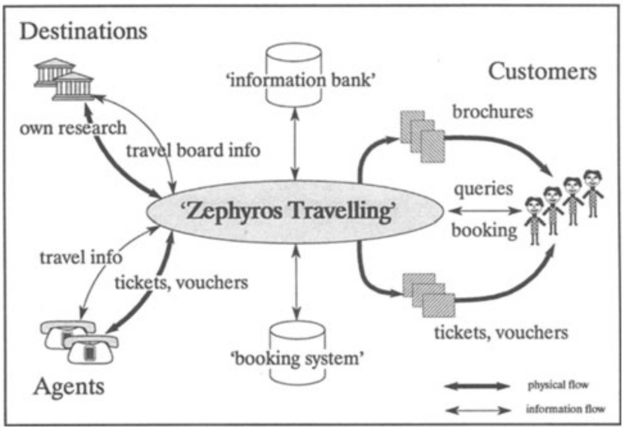

Figure 2: The 'real world' of a cultural tour operator

An entrepreneur in cultural tours, such as the 'Zephyros Travelling' organization illustrated in Figure 2, markets intangible (abstract) goods, namely travelling arrangements. His information support is of the typical 'office system' nature: ultimately, everything involves contractual documents that must pass through several stages of review, possible modification and ultimate acceptance. Soon, IT technology will allow all these to be handled electronically. This will take the form of video travel brochures and chipcard vouchers, and of videotext enquiries, booking, invoicing and money transfer. For the purposes of analysing the domain, today's way of working suffices.

While the customers, destinations, travel agent and transport companies are all very tangible entities in a physically real world, the objects that are relevant for the operator's 'core business' are descriptions: seat and room availabilities, enquiries, bookings, invoices and so on. Any support system is concerned with documentary and/or contractual evidence. We envisage two of these, namely an internal *information bank* (an up-to-date repository of tour and travel information) and a *booking system* (for registering and serving customers). Obviously, this subsumes an earlier implementation (and prior design) of such systems. We use the description as a basis for a component analysis of what the user (the tour operator) and the business analyst will encounter.

Whereas the entrepreneur in the first example is faced with a *continuous* planning and operating problem, the tour operator has to deal with *discrete* problems. His sources of 'raw material' are destinations (locations with one or more sites of interest, each serviced by one or more hotels with a discrete number of beds, etc.) and agents (who represent carriers with a discrete number of flights, with a discrete number of seats, ferries and cruise ships with a discrete number of berths and so on). What must be acquired from these sources is twofold: *information* about their offerings and (when sales are made) a transfer of *title* to selected offerings (rights to travel and sojourn, resulting in the issue of the respective documents, vouchers and tickets). Marketing takes the form of distributing attractive brochures (yet another document) to known potential customers, handing them out at travel fairs, leaving them in travel agent offices and so on. Achieving a firm sale means receiving documentary evidence (by fax or mail) of the commitment of a customer.

The activity of planning, preparing and selling the 'product' consists of collecting and distributing *references* to real-world things, not of those things themselves. The elements that go into a supporting system, therefore, are at least one step removed from physical reality. They may be expected to have a different nature from those of the first example. Thus, even the main business entity types are informational (the travel information, arrangements, rights, etc.). Furthermore, expansion does not mean adding more 'capacity' (that only applies to the operator's network and - possibly - staff), but finding more destinations and novel ways of travelling. The 'raw material' overshadows any productive infrastructure. What is needed is innovative discovery of further sources, an investment in something abstract! The resource being informational itself makes it difficult properly to distinguish it from what is carried by any informational support system, such as the operator's 'Information Bank' and his 'Booking System'. That is another reason for caution in defining what is the business system and what its informational support.

Information needs

These two examples show the need for analysing the business domain such that links to the information domain are established from a business-oriented point of view. In particular, one should be able to:

- highlight the support characteristics of any system proposals,
- highlight objectives, policy and goal related features, and
- express models in terms of concepts that are meaningful to all parties.

In the next section, we shall argue that this may be achieved by a description that starts from the full range of functionalities and leads to a layered model.

3 BUSINESS and INFORMATION MODELLING

It is common practice to view an organization as a 'system' within, but not isolated from, the external world it operates in. When a segment of that system is reasonably separable - for instance, the Manufacturing and Marketing divisions of our first example - some specific control (management in the general sense) is looked for, possibly with computer assistance. The term 'information system' in this context is slightly misleading, in that it suggests the existence of independent controlled and controlling systems. The only complex truly to be treated (and therefore *'modelled'*) as one whole is the organization with all its messages, control and recorded 'knowledge'. Its constituents are mere *sub*systems.

Functionality categorization

Our search is for an effective modelling approach for real world (or 'business') systems with internal control and information-oriented subsystems. An intuitive 'activity-oriented' way to break down the domain as a whole is to distinguish: *

- productive activity (the 'primary' or 'core' business)
- control, coordination and supportive activity (i.e. the rest)

A full business model must contain descriptions of all *functionalities* (or 'action capabilities') in both of these areas. Since *support-information* related activity - the ultimate subject of interest in this study - is part of the control-coordination-support category a further breakdown is called for. The categories of Table 1 were originally proposed in (Verrijn-Stuart, 1989).

(1) ***productive functionality***	(enabling production, according to objectives and goals)
(2) ***office functionality***	(enabling management and support)
(3) ***knowledge functionality***	(storage & retrieval of relevant permanent information)
(4) ***computational functionality***	(providing the service of computation)
(5) ***communication functionality***	(providing the service of communication)
(6) ***interfunctional functionality***	(providing links between functions)

Table 1: Organizational functionality categorization

The office function includes all functionality that helps the functioning of the organization as such. In that sense, it covers more than one normally associates with the concept 'office', namely both the regular office worker and the manager (line and staff). Excluded, on the other hand, are several functionalities that take place in a locality that one would call an 'office'. These comprise the collection and use of 'knowledge', the manipulation of recorded symbols, i.e. computation, and the two 'linking' functionalities of communication and the abstract cross-referencing between the other functions. These are placed in separate categories to highlight their distinct informational characteristics.

* Deviating from the traditional 'control-oriented' tripartition management - production - staff.

We now assert that a useful way of business modelling is:

(1) to recognise the **functionalities** appropriate to a specific situation and, subsequently,
(2) to formulate a number of **functional and interfunctional subsystems**.

In preliminary case studies (Ramackers, 1994a), it has been found that the above six categories indeed provide an effective starting point for *information*-oriented business analysis. They do not detract from any *business*-oriented efforts. See e.g. *Change Analysis* (Lundeberg, 1982) or *Business Process Re-engineering* (Glasson, 1994).

Besides the functionality categories, we also need a specific language to express various descriptions. Formal system 'models' are usually built from more elementary components. Most approaches to systems theory assume the existence of a number of atomic entities that somehow interact, or into which a given system may be broken down, see Klir (1969), Bunge (1977-1979), Wand (1990), Lindgreen (1990). The expressions we need, therefore, must be based on a 'meta-model' containing the concepts *system*, *component* and *interaction*. There must be other elements and constructs as well, since these three cater for construction and decomposition, but neglect further structural and dynamic features.

Business meta-models

What we propose, however, is not a new language as such, but a particular way of structuring a sequence of questions and answers leading to a recognisable business-oriented specification of information requirements. Our approach is inspired by the constructs in various techniques and the constructive ways of using them. We mention structured methods and standards (Ross, 1977, Laamanen, 1994), object role modelling techniques (Chen, 1976, Verheijen, 1982, Hofstede, 1993), object-oriented approaches (Assche, 1991, Martin, 1995), and various ontological views (Wand, 1990). One is free to use any choice of language, just so appropriate constructs may be achieved.

Level 0	*"What the business area is about, what nature of dynamics apply"*	
	(primitives):	**Object, Action, Time**
	(implied):	**Property, Rule, Agent, Actand, Causation, Time-points**
Level 1	*"What structure it is seen as having, insofar as relevant"*	
	(derived):	**Model, System**
	(implied):	**Systemic property**
Level 2	*"What components are considered, and what kinds of interaction"*	
	(further derived):	**Component, Interaction, State, Transition**
	(specializations):	**Component-category, Sub-model, Sub-system**
Level 3	*"General specification of derived support systems"*	
	(detail):	**Detailed elements**

Table 2: Business meta-model levels

Four levels of concepts are envisaged, linked with which are structurally similar construct development steps. The latter are triggered by questions that help extending one's description from very broad to more detailed relevance, successively (Table 2).

The basic level of our meta-model is formed by 'primitives', i.e. concepts accepted without further definition. Similarly, at level-0 one presents the initial 'broad brush' description of the domain to be modelled. Subsequent levels correspond to derived concepts, which are relevant in further model refinement. Part of the terminology is derived from the FRISCO Interim Report (Lindgreen, 1990), but slightly different choices are made.

Objects are assumed possessing zero, one or more *properties* (a primitive quality). The capability of being *active* (active object = 'agent') or *passive* (passive object = 'actand') is among the most relevant. Often, *rules* must be stated explicitly to define the value ranges or combinations of values that properties may take on. Rules may also represent objectives and goals. **Action** is a generic term for the 'origination' (or *cause*) of object property *changes*, including *births* and *deaths* of objects as such. Action is a primitive concept associated with our perception of the dynamic world around us. Singling it out is a matter of conceived semantics. **Time** is also a generic term for a semantic conception, namely the association of a linear scale of *points-in-time* on which we can position the 'occurrence' of observed (or even possibly imagined) property changes.

Employing level-0 concept types (including the conceptions of properties and of changes of property), one can construct global descriptions. Such a description is called a **Model.** Because descriptions, by their very nature, are limited in scope, they truly are 'abstractions' of the subjects covered. A composite subject (Lindgreen, 1990) is said to be a **System** if (1) it displays a perceived (or imposed) cohesion (according to some observer, the so-called 'system viewer'), and (2) it is characterised by at least one specific *systemic property* (which is possessed by the system as a whole, but not by any part of that system in isolation). Since business models describe specific domains as a coherent whole, they will have systemic characteristics. We will use the terms 'business model' and 'business system' interchangeably.

In classical systems theory, e.g. Klir (1969), a system may be defined by either:

- a full description of each of its components and the way in which these interact (a so-called **Universe-of-discourse-and-Couplings** or 'UC' definition), or
- the possible states of the system as a whole and any transitions allowed between them (a so-called **States-and-Transitions** or 'ST' definition).

The concepts *component* (part of a composite system), *interaction* (actions between objects, especially when they are parts of a system), *state* (collective values of the properties of all components of a system at one point in time) and *transition* (change of one state into another state) are obviously derivable from the concepts at level-0 and level-1.

The implicit concepts of composition and decomposition that link level-1 and level-2 invite further specialization, namely *categories* of components (according to their real world semantics), and specific *subdivisions* of models and systems. For instance, the business domain *functionalities* are described by sub-models of the total 'organizational model'. At level-3, final detailing occurs.

While the concepts in Table 2 jointly form the backbone of a full language, the level headings also suggest a specific way of using it in successive refinement steps:

- **Step 0** (corresponding to the primitive concepts *object-action-time*)
  Decide what the business domain to be modelled is about and what kind of dynamics apply [→ Level-0 models].
- **Step 1** (corresponding to the major derived concepts *model* and *system*)

Decide what structures are recognisable in the business domain or that may be imposed on its description [→ Level-1 models].

- **Step 2** (corresponding to the concepts *component*, *interaction*, *state* and *transition*) Decide what (physical, informational and other) components are to be considered and what interaction these experience within the structure at Level-1; next, determine what its dynamic characteristics are, in particular concerning its information streams required for task classes [→ Level-2 models].
- **Step 3** (corresponding to the lowest level derived concepts in the meta-model) Lay down a full **specification** for any subsystems to be embedded [= Level-3 model].

As said before, the multi-layered approach allows one to first describe a domain in very broad terms, refining the model until sufficient coverage is obtained. What is more important, the top-down analysis and the terminology appeal to both the information user and the business analyst, since one can frame a neat sequence of questions against an unobtrusive formal background.

The concept structure of Table 2 may be formalized explicitly in various ways *. We will not further elaborate it, though, merely use it - along with the functionality categories - as a pattern for arriving at the desired business models.

Application to the Manufacturing and Marketing Enterprise case

This case leads to a fairly straightforward *functionality* listing (see Appendix 1, Table A). Two productive functionalities are identified, *Manufacturing* (making material product) and *Marketing* (publicising and distributing material product), which may be treated as one integrated activity or as two separate ones. For the sake of simplicity, the latter situation is assumed. In other words, we concentrate on what is shown in Figure 1 only.

The support functionalities shown in Table A all apply for each of the two prime activities, except their mutual coordination, which obviously applies to both simultaneously. What is listed would emerge from initial consultation. Among areas for further analysis would figure 'Operational Planning' and 'Strategic Planning', including the corresponding support systems.

Of these, let us select the type (2) office functionality 'Operational Planning', which clearly requires simultaneous consideration of one of the type (6) interfunctional functionalities needed to coordinate *planning* and *operation*. This selection delimits our domain by stating (implicitly) a number of tasks and information links for actual modelling.

The successive business modelling steps for our chosen problem area may lead to results as shown in Appendix 1 [Table B]. Note how the decision to introduce optimized planning gradually evolves:

- step-0: planning is recognised as activity, cost minimization + labour stability as policy
- step-1: modelling of sub-domain (in context of all activity) → optimization
- step-2: rough detailing of optimization modelling and how it fits
- step-3: detailed specification (emphasizing usage, including policy monitoring)

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* An axiomatic formalization along these lines is being attempted by the FRISCO Task Group, private communication from that group; see also Oei (1994).

Paraphrasing these steps, one might say that they show how the 'chicken-and-egg' problem of arriving at the information-systematic characteristics of a cohesive Operational Planning System is tackled in practice. After an intuitive perception of department demarcations, one recognizes the main object of study as an input-throughput-output model, the primary purpose of which is to convert raw material into end product, according to demand needs and at minimum cost, while maintaining a stable work force. A full specification emerges at the end.

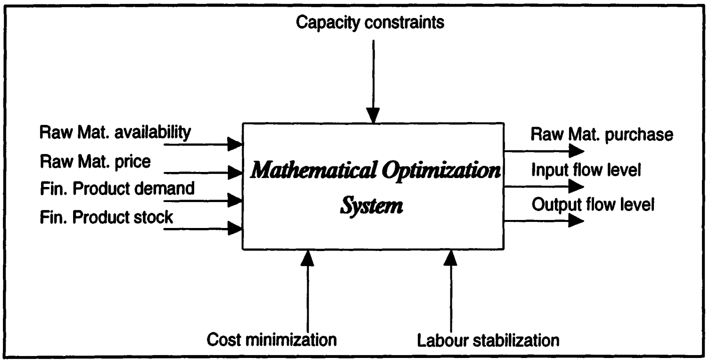

Figure 3: Operational Planning Optimization Model

Because the new optimization system consists of a single block fitting within an existing grouping of functionalities, a global diagrammatic representation remains fairly simple (Figure 3). The full level-3 specification will be a mixture of diagrams, mathematical equations and informational representations, supplemented by (textual) comment.

The user's manual would provide instructions for setting the semi-permanent constraints and policy parameters (capacity, cost, labour). While not taken up in our global discussion, some (or all) of the variable data might be handled on-line, especially the raw and finished product stock data.

Application to the 'Zephyros Travelling' case

This case, as presented, already has two computerized subsystems in place. Let us assume that these have been in operation for some time and the question arises what improved results might be achieved by <u>monitoring</u> and <u>adjusting</u> one's marketing <u>policy</u>. Marketing was said to take the form of ' ... distributing attractive brochures ... to known potential customers, handing them out at travel fairs, leaving them in travel agent offices ... '.

A simple way of finding out which channel is most effective is to make all enquiries and bookings refer to the 'triggering' brochure, e.g. by having encoded forms printed in or enclosed with the brochures. If these codes correspond to 'mailing list', 'travel fair X', 'travel agent Y' and so on, all responses may be classified quantitatively. The results may become even more significant if the destinations, geographic regions and time periods that figure in the reactions are considered as additional variables. On the other hand, one may be mixing too many different effects. Doing the exercise on a on-off basis may even be cost-ineffective.

Let us assume, therefore, that one's aim is to link in most the 'references' (linking enquiries and bookings, and the brochures that gave rise to them) into a modification of the existing support systems (the information bank and the booking system shown in Figure 2). Since we already observed the entire business to be informational itself, a full reappraisal is in order.

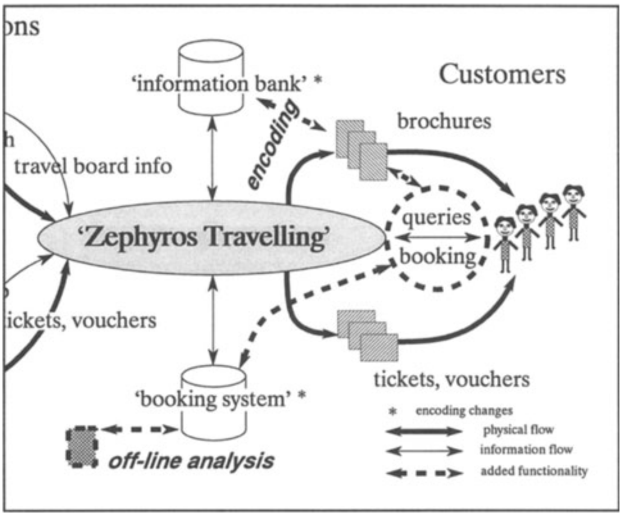

Figure 4: Marketing effectiveness analysis option

Because of the marketing emphasis (potential product and sales being interrelated), the two support systems are no longer independent. This added complexity may cause an unsurmountable divergence of views. For instance, the destination-researchers, brochure-writers, tour-marketeers and tour-administrators may feel dominated by an excessively centralized all-embracing system that they perceive as being under the control of the IT expert. The information systems specialist, on the other hand, may not know which party to support most, even fearing that the business area staff cannot understand the full informational cohesion. The potential complexity is evident from the functionality listing of Appendix 2, Table A.

A detailed analysis shows that at least three degrees of integration are feasible. In all the mechanism is assumed that one marks the brochures - produced from data in the 'information bank' - and that all enquiries and bookings use forms enclosed with these.

(1) integrated 'information bank'-'booking system', extended by Analysis Sub-system;
(2) 'booking system', extended by Analysis Sub-system;
(3) 'booking system' ← 'reference data' + querying capability by off-line Analysis System.

The first approach obviously requires major redesign (two existing systems to be integrated, 10 functionalities jointly involved). For the second approach this is much less the case. The 'information bank' only requires some extra encoding fields, but the 'booking system' is subjected to an actual extension as well - the same functionalities are affected, but no longer jointly. The third approach leads to very small redesign activity: encoding field extensions in the two systems, but no further changes - using the 'booking system' for analysis may be done by writing a simple 4GL extraction and statistical analysis program.

Selection of approach (3) is assumed for the business (re-)modelling shown in Table B. The items listed also suggest how a cost-benefit analysis may be incorporated. Modifications providing the additional market analysis support are introduced as broken lines in Figure 4, which is an extension of Figure 2.

The two examples illustrate the feasibility of modelling business aspects - including objectives, policy and goals - such that the informational aspects gradually emerge. One is especially helped by first recognising the functionalities in a broad context, then taking a stepwise approach to introduce increasing levels of detail. Guidance is provided by the line of reasoning, which is similar to the introduction of the fundamental representational concepts.

The steps described above also lend themselves to be incorporated in CASE tools. No matter what development routine is followed (classical 'life cycle', cooperative 'prototyping' or 'information planning + *i*-CASE'), various intermediate specifications need to be laid down, on which the stakeholders must agree. In current fully integrated development (*i*-CASE) systems (Ramackers, 1994b, Veryard, 1994), business-oriented comment is allowed, but any policy related matters are considered off-line.

One might conceive limited-integration development (*l*-CASE) environments allowing on-line interpretation of semi-automated views that reflect both informational and business aspects (Pohl, 1994). Updates would be admitted subject to consistency between the two areas. It may be achieved by reference to a checklist along the lines in the previous sections. First experience with prototype information planning tools suggests that useful documentation may be output as a byproduct of their regular use (Verrijn-Stuart, 1992, Verrijn-Stuart, 1994a).

4 CONCLUSION

In this paper, we argue the need for special attention to suitable business-oriented representations for use during the requirements engineering stage of greenfield and evolution projects. An important reason is the disparity of views and interests of various stakeholders. Especially managers and information users are not motivated by formal specification precision as such. Instead, they wish to address objectives, policies, tasks and support capabilities.

A way of achieving this in (advanced) information-oriented development projects is shown to lie in analysis and design guidance. The usefulness is suggested of distiguishing seven 'functionalities' and, subsequently, asking the following sequence of questions:

- *'What is the business area about, what nature of dynamics does apply?'*
- *'What structure is it seen as having, as far as relevant?'*
- *'What components are considered, and what kinds of interaction?'*
- *'What will be the general specification of derived support systems?'*

These are on a par with the levels that would underlie various conceptual frameworks, such as the one aimed at by the FRISCO Task Group, without imposing their explicit formality.

Two cases (manufacturing of material goods, and marketing the intangible 'cultural tour', respectively) show how this line of questioning assists in arriving at suitable 'development decisions' while maintaining a business-oriented view in the foreground.

The introduction of the same 'checklist guidance' discipline in CASE tools is considered feasible, but might be a long way off.

6 REFERENCES

Assche, F. van, Moulin, B., Rolland, C., eds. (1991) *Object Oriented Approach in Information Systems*, Proceedings of the WG8.1 Working Conference, Quebec City, Canada, October 1991; North-Holland, Amsterdam.

Brinkkemper, S. (1990) *Formalisation of Information Systems Modelling,* Ph.D Thesis, University of Nijmegen, Thesis Publishers, Amsterdam.

Bunge, M. (1977) *Treatise on Basic Philosophy: Vol. 3: Ontology I: The Furniture of the World*; Reidel, Boston, Mass.

Bunge, M. (1979) *Treatise on Basic Philosophy: Vol. 4: Ontology II: A World of Systems*; Reidel, Boston, Mass.

Chen, P.P. (1976) The entity relationship model: Toward a unified view of data, *ACM Trans. on Database Systems*, **1**, 9-36.

Commun. ACM (1992) Special Section on CASE in the 90s, **35**, 27-89.

Comp. J. (1991) Special Issue on Methodologies (Systems and Software), **34**, 97-185.

Falkenberg, E.D. and Lindgreen, P.L., eds. (1989) *Information System Concepts: An In-depth Analysis*, Proceedings of the IFIP WG8.1 Working Conference (ISCO-1), Namur, Belgium, October 1989; North-Holland, Amsterdam.

Falkenberg, E.D., Rolland, C., El-Sayed, E.N., eds. (1992) *Information System Concepts: Improving the Understanding*, Proceedings of the IFIP WG8.1 Working Conference (ISCO-2), Alexandria, Egypt, April 1992; IFIP Transactions A-4, North-Holland, Amsterdam.

Franckson, M. (1994) The Euromethod Deliverable Model and its contribution to the objectives of Euromethod, in Verrijn-Stuart (1994b) 131-149.

Glasson, B.C., Hawryszkiewycz, I.T., Underwood, B.A., Weber, R.A., eds. (1994) *Business Process Re-engineering: Information Systems Opportunities and Challenges*, Proceedings of the IFIP TC8 Open Conference, Queensland Gold Coast, Australia, May 1994; IFIP Transactions A-54, North-Holland, 1994.

Hofstede, A.H.M. ter, Proper, H.A. and Weide, Th.P. van der (1993) Formal definition of a conceptual language for the description and manipulation of information models, *Inform. Systems* **18**, 489-524.

Jarke, M., Pohl, K., Rolland, C., Schmitt, J.R. (1994) Experience-based method evaluation and improvement: A process modelling approach, in Verrijn-Stuart (1994b) 1-27.

Klir, G.J. (1969) *An approach to general systems theory.* Van Nostrand Reinhold.

Laamanen, M.T. (1994) The IDEF Standards, in Verrijn-Stuart (1994b) 121-130.

Lindgreen, P. ed. (1990) *A Framework of Information Systems Concepts*, FRISCO Interim Report, obtainable from Paul Lindgreen, Copenhagen Business School.

Lundeberg, M. (1982) The ISAC Approach to Specification of Information Systems and its Application to the Organization of an IFIP Working Conference, in Olle (1982) 173-234.

Lyytinen, K. (1987) Different perspectives on information systems: problems and solutions, *ACM Computing Surveys* **19**, 5-46.

Martin, J. and Odell, J.J. (1995) *Object-Oriented Methods.* P T R Prentice-Hall, Englewood Cliffs, N.J.

Olle, T.W., Sol, H.G. and Verrijn-Stuart, A.A., eds. (1982) *Information Systems Design Methodologies: A comparative Review*, Proceedings of the WG8.1 Conference, Noordwijkerhout, Netherlands, May 1982. North-Holland, Amsterdam.

Olle, T.W., Hagelstein, J., Macdonald, I.G., Rolland, C., Sol, H.G., Van Assche, F.J.M., Verrijn-Stuart, A.A. (1991) *Information Systems Methodologies: A Framework for Understanding*, 2nd edition. Addison-Wesley, Wokingham, England.

Opdahl, A. and Sindre, G. (1994) A taxonomy for real-world modelling concepts, *Inform. Systems* **19**, 229-241.

Pohl, K. (1994) The three dimensions of requirements engineering: a framework and its applications, *Inform. Systems* **19**, 243-258.

Ramackers, G.J. (1994a) *Integrated object modelling: An executable specification framework for business analysis and information system design*, Ph.D Thesis, University of Leiden.

Ramackers, G.J. (1994b), Model integration an model execution, in Verrijn-Stuart (1994b) 223-239.

Ross, D.T. (1977) Structured Analysis (SA): A Language for Requirements Definition, *IEEE Trans. on Software Eng.*, January 1977.

Singh, Ragu (1994) ISO/IEF draft international standard 12207, software life-cycle process, in Verrijn-Stuart (1994b) 111-119.

Verheijen, G.M.A. and Bekkum, J. van (1982) NIAM: An Information Analysis Method, in Olle (1982) 537-589.

Verrijn-Stuart, A.A. (1989) *The information system in the broader sense*, Dept of Computer Science, University of Leiden, Report 89-13.

Verrijn-Stuart, A.A. and Ramackers, G.J. (1992) Model Integration in Information Planning Tools, In: *Proceedings of the Fourth Conference on Advanced IS Engineering (CAiSE'92)*, (ed. P. Loucopoulos). Springer, Heidelberg, Germany; pp. 481-493.

Verrijn-Stuart, A.A. and Ramackers, G.J. (1994a) Embedded Organizational Knowledge: Requirements for and usage of conceptual information system models, *4th European-Japanese Seminar on Information Modelling and Knowledge Bases* (ed. H. Kangassalo), Kista, Sweden, May 1994.

Verrijn-Stuart, A.A. and Olle, T.W., eds. (1994b) *Methods and Associated Tools for the Information Systems Life Cycle*, Proceedings of the WG8.1 Conference, Maastricht, Netherlands, September 1994; IFIP Transactions A-55, North-Holland, Amsterdam.

Veryard, R. and Macdonald, I.G. (1994) EMM/ODP: A methodology for federated and distributed systems, in Verrijn-Stuart (1994b) 241-273.

Wand, Y. and Weber, R. (1990) Mario Bunge's Ontology as a Formal Foundation for Information Systems Concepts, in: *Studies in Bunge's Treatise on Basic Philosophy* (eds. G. Dorn and P. Weingartner), Poznan Studies in the Philosophy of the Sciences and the Humanities, pp. 123-150; Rodopi, Amsterdam.

7 BIOGRAPHY

Alex Verrijn-Stuart (Ph.D, FBCS) became acquainted with computers as a research physicist at the Royal Dutch/Shell laboratories in Amsterdam, in 1954. From 1958 to 1970 he participated in Shell's operations research and computing activities in Paris, The Hague, London, Abadan (Iran) and again London. In 1970 he was appointed a professor of computer science at the University of Leiden. His area of interest is 'Information Systems', with an application-oriented formal approach, leading to research into conceptual modelling, design methodologies and information planning. He became an emeritus in 1991.

APPENDIX 1: Manufacturing Division business modelling

Table A: Support Functionality listing

(2) **Office functionalities:**
- Factory management
- Plant Operation
▸Operational Planning◂
▸Strategic Planning◂
- Finance, Personnel, Training, etc.

(3) **Knowledge functionalities:**
- Staff (experience, in their heads, etc.)
- Record keeping
▸Market data [← Marketing Division]◂
- Computer-based databases (?)
- On-line access to external databases (?)

(4) **Computational functionalities:**
- Existing computers [list ...]
- Network and/or workstations (?)

(5) **Communication functionalities:**
- Mail room, messenger services
- Telephone and fax services
▸Coordination Manufacturing ↔ Marketing◂
- Company-wide e-mailing (?)

(6) **Interfunctional functionalities:**
- (information) systems supporting existing functionalities [list ...]
- (information) systems supporting potential functionalities [entries marked '?']
- (information) systems supporting designated functionalities [entries marked '▸◂']

Table B: Business Model [Operational Planning]

Level-0:	**Objects:**	Manufacturing division, Plant (current), Ops data (i/o), Supply/Demand -do-
	Actions:	Record keeping, Supply/Demand data acquisition, Planning
	Time scale:	[as required, say, daily/weekly/monthly]
	Rules:	[say] Cost-minimization, while Labour-level nearly fixed
	Agents:	Ops planning staff, Management and Liaison staff (contacts)
	Actands:	[various i/o] Data, Reports
Level-1:	**Model:**	Plant operations = 'input-throughput-output' flow (context: functionalities)
	System:	Flow ***Optimization*** model [based on literature or own knowledge]
	Systemic properties:	
		Optimization fitting within overall flow model and its data
Level-2:	**Component categories:**	
		functionality-derived tasks, specifically: optimization ***'Model'***, policy checking
	Interaction:	task related information flows and triggers
	Sub-models:	***'Model'***, with input/output support
		[say] Commercially available computer package
		[say] Self-contained computerized service
		[say] Workstation operation
	States/Transitions:	dependent on usage of 'Model' (see Time Scale, above)
Level-3:	**Details of** ***'Model-System'***, including user's/operators' documentation specification	
		[user's documentation stressing policy operation 'signals']

APPENDIX 2: Tour Operator business re-modelling

Table A: Functionality listing

(1) **Productive functionalities:**
- Arranging cultural tours
- Selling cultural tours
- Operating cultural tours

(2) **Office functionalities:**
- Keeping in touch and making arrangements with tourist boards (re sites, hotels)
- Keeping in touch and making arrangements with travel agents (re transport)
- ►Supporting the preparation of brochures (on behalf of sales organization)◄
- ►Support via 'information bank'◄
- ►Operating 'booking system'◄
- ►Marketing Analysis section◄
- Finance, Personnel, Training, etc.

(3) **Knowledge functionalities:**
- Researching destinations (sites of interest, hotel accommodation)
- Recording/maintaining tourist board information
- Recording/maintaining travel agent information
- ►Storage/retrieval of relevant data in 'information bank'◄
- ►Storage/retrieval of tour/participants data in 'booking system'◄
- Staff (experience, in their heads, etc.)

(4) **Computational functionalities:**
- [say] Office network

(5) **Communication functionalities:**
- Mail room, messenger services
- Telephone and fax services
- Linkup with international travel booking systems
- ►Coordination Research/Sales/Operations/Office activity◄

(6) **Interfunctional functionalities:**
- ►Feeding and using 'information bank'◄
  (researchers, tourist board contacts, tour arrangers, brochure designers, etc.)
- ►Input to and use of 'booking system'◄
  (sales department, operations department, invoicing, etc.)
- ►Marketing enhancement by combined use of 'information bank' and 'booking system'◄
  (combining entries marked '►◄')

Table B: Business Model [marketing relevant aspects, additions to assumed original model]

Level-0:	**Objects:** Marketing section, Destination data, Brochures, Query/booking data **Actions:** Record keeping, ***Additional encoding, Data analysis*** **Rules:** [general objective] ***'improved marketing effectiveness'*** **Agents, actands:** as before
Level-1:	**Model, system:** as before, with additional ***Off-line analysis*** (support system)
Level-2:	**Component categories:** functionality-derived tasks, specifically: ***encoding*** + ***analysis*** **Interaction:** ***(additional)*** task related information flows and triggers **Sub-models:** ***(additional)*** system linking in, but otherwise independent **States/Transitions:** dependent on usage of ***Off-line analysis*** (support system)
Level-3:	**Details** of encoding fields, 4GL program / analysis system [↔ ***modification effort***]