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USING REFERENCE MODELS WITHIN THE ENTERPRISE RESOURCE PLANNING LIFECYCLE

ERP-specific reference models describe on a conceptual level the structure and functionality of enterprise resource planning solutions. However, these models focus on depicting executable processes and do not take into account tasks related to business engineering, system selection, implementation or change. This paper discusses how reference process models can be used within the entire ERP lifecycle. All phases of the ERP lifecycle have individual requirements for the management of the relevant knowledge. It will be shown how extended reference models can serve as a knowledge repository for enterprise resource planning. This paper includes several pragmatic recommendations for managers involved in ERP projects.

Enterprise resource planning (ERP) can be defined as customisable, standard application software which includes integrated business solutions for the core processes (eg, production planning and control, warehouse management) and the main administrative functions (eg, accounting, human resource management) of an enterprise (Rosemann 1999, Klaus, Rosemann and Gable 2000). Synonyms for ERP are enterprise systems, enterprise-wide systems, integrated vendor software, integrated standard software packages, and enterprise application systems.

In financial accounting, ERP provides solutions for general ledger, accounts payable, accounts receivable, bank management, consolidation and asset management. These sub-modules are closely integrated with other modules. An integration exists between the logistical functions of procurement and sales regarding vendor and customer data management, including vendor evaluation and credit management. Further, the logistical processes of invoice verification and billing are integrated with accounts payable and accounts receivable. Other connections may involve human resource management, payroll, travel management, and controlling and managing costs.

To enable ERP to be configured and used efficiently, components such as implementation tools (procedure models, reference models, customising guidelines, project management software), workflow functionality, tools for the development of add-on modules and system administration, and office suites are usually embedded.

Currently, the main ERP vendors are SAP, J.D. Edwards, Oracle and PeopleSoft. The GartnerGroup (1999) forecasts that the ERP market will be greater than $20 billion by 2002 (with a probability of 80%). More than 50% of this will be ERP service revenue, while the total ERP licence revenue will amount to about $9 billion. The GartnerGroup estimates that more than 90% of *Fortune* 500 enterprises have purchased a module or a set of modules from an ERP vendor. Half have

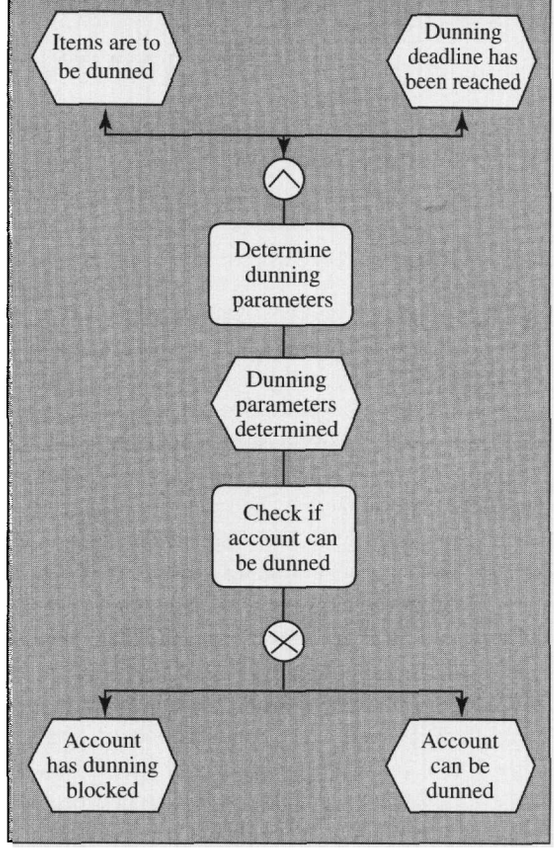
made a commitment to one vendor, while fewer than 20% have gone live. The SME market is identified as the main customer group, as more than 50% of these enterprises have not yet selected a next-generation ERP. For 2000 (2001, 2002), the GartnerGroup predicts market growth of 22% (25%, 28%). These figures show that ERP initiatives are among the biggest investments to which enterprises are currently committing.

Reference process modelling

Enterprise resource planning systems offer business solutions for typical functional areas such as procurement, materials management, production, sales and distribution, financial accounting and human resource management. These functions are typically individualised for industries such as automotive, retailing, high-tech, etc. Consequently, ERP software tends to be very comprehensive and complex. This is mirrored in the software documentation, which was often measured in metres before online documentation was developed. To improve understandability, ERP vendors have developed reference models which describe the functionality and structure of the system. ERP-specific reference models exist in the form of function, data, system organisation, object and business process models, although the latter is by far the most popular type. The importance of process models results from the increasing popularity of process-oriented management concepts such as business process engineering (Hammer and Champy 1993) or process innovation (Davenport 1993), which led to the development of several new process modelling approaches (eg, Kim 1995).

ERP-specific reference process models describe on different levels of abstraction the main ERP processes, ie, the sequence of supported functions. Examples of these processes are procurement, recruitment and payment. Depending on the underlying methodology, these models include details about the control flow (including AND/OR splits or joins), the involved system organisational units, input and output data and business objects. Further, it is usually possible to refer to the relevant part of the online documentation and on the lowest level of abstraction even to the corresponding ERP transaction. The description of the control flow in a process model is significantly different from a data-flow diagram; a model that depicts a business process describes a sequence of necessary activities. Figure 1 shows an extract from a simple ERP-specific reference process model — a part of the dunning process within SAP R/3 Accounts Receivable. The model describes the procedure for generating and sending out reminders to customers with outstanding payments. This includes the specification of the parameters, the selection of accounts and items, grouping open items and the creation of dunning notices with an update of the customer master data. Similar models can also be found in other ERP solutions. The modelling technique in this case is the event-driven process chain (Scheer 1998). It consists of events (hexagons) and functions (soft rectangles) as well as control flow connectors (AND, OR), which describe the joins and splits of a process. Figure 1 shows an AND-join (first connector) and an exclusive OR-split (second connector).

FIGURE 1: EXTRACT FROM SAP'S REFERENCE PROCESS MODEL "AUTOMATIC DUNNING"



It has to be stressed that these models are designed for the end-users of the ERP system, and not only for the implementation team. End-users benefit from these models as they comprehensively and quickly inform about the relevant software functionality. These reference models are part of every ERP solution and do not have to be purchased separately. Surprisingly, however, few companies are using these models. One motivation of this paper is to increase the awareness of the models and the benefits of their application.

The existence of these reference models also highlights a difference from the traditional software development process. Instead of starting from scratch and continuously adding functionality, ERP solutions require a narrowing of the scope of the system. Especially in the area of financial accounting, it can be expected that most of the required functions are available in ERP packages. Thus, it is possible to select the necessary functions and to decide during the configuration process between alternatives (eg, reporting in financial accounting or controlling). In comparison with the development of software, the ERP imple-

mentation process has a different starting point. It starts with the "big picture", which is then reduced to the relevant part. Reference models can be used as a convenient description of this big picture.

Although these models have contributed significantly to the understandability of the software functionality, they still have weaknesses.

- As the models are focused on process execution, it is not obvious what *configuration alternatives* exist. The analysis of a process model shows what is possible in general, but not what might be a recommended alternative. They represent functionality from the viewpoint that the entire system is used.
- Besides the lack of transparency about possible choices during the configuration process, it is also not clear what *consequences* a configuration of one process has on other processes.
- Reference models concentrate on the elements that are of importance for the specific ERP system. *Enterprise-individual* aspects of the organisation, business objectives or manual tasks are not depicted in these models. They do not include any references to the knowledge that is involved or required.
- Moreover, the models do not have any link to the actual process execution. Thus, it is not possible (eg, in the form of model attributes) to evaluate the current process performance expressed in key performance indicators such as processing time.

ERP software has been accepted as the state-of-the-art solution for the core business functions of at least medium-sized companies. Especially in well-structured areas, such as financial accounting, which do not depend on industry-specific requirements, it seems not to be cost-effective to develop software from scratch. Nevertheless, most current literature focuses on the classical system analysis and design process for software development. The ERP lifecycle is significantly different from the software development process. Evidence for this is in the importance of reference models, but also in the requirements for knowledge management. This paper presents insights into the ERP lifecycle with a focus on the use of reference models and on lifecycle knowledge management.

INSTEAD OF STARTING FROM SCRATCH AND CONTINUOUSLY ADDING FUNCTIONALITY, AS IN TRADITIONAL SOFTWARE DEVELOPMENT, ERP SOLUTIONS REQUIRE A NARROWING OF THE SCOPE OF THE SYSTEM.

THE LIFECYCLE OF ENTERPRISE RESOURCE PLANNING

In comparison with the research conducted on software development and related systems analysis and design activities, the management of ERP has received little academic attention (Heever and Erlank 1997, Klaus, Rosemann and Gable 2000). One result is the absence of an accepted ERP lifecycle model. Several models have been developed for the traditional software engineering process (eg, waterfall model, spiral model) but corresponding ERP lifecycle models are non-existent.

Further, most of the work until now has concentrated on implementation issues. An overview of ERP-related research in June 2000 (Klaus, Rosemann and Gable 2000) showed that about 30% of publications deal with implementation issues. This corresponds with the focus on ERP systems by the trade press, which also deals mainly with implementation and associated issues. Several publications (Bingi *et al* 1999, Holland *et al* 1999a, Stefanou 1999, Sumner 1999) attempt to identify critical success factors of implementations. Shanks *et al* (2000) strongly recommend taking national cultural issues into account since critical success factors may vary depending on the country in which an implementation is carried out.

Implementations have also been investigated through case studies with varying objectives: to describe the impact of ERP on job characteristics (Pawlowski *et al* 1999); to explore strategic options open to firms beyond the implementation of common business systems (Holland *et al* 1999b); to make recommendations on how to maximise the benefits from ERP (Niehus *et al* 1998) or how to avoid ERP project failures (Scott 1999); to identify issues of alignment (Smethurst and Kawalek 1999, Volkoff 1999), business process re-engineering (Slooten and Yap 1999), and change management (Pérez *et al* 1999); to assess the ambiguous role of large systems as both catalysts for and inhibitors of change (Mahrer 1999); to analyse the special challenges of ERP implementations outside the business world (Sieber and Nah 1999). Implementing ERP with or without BPR has been surveyed and analysed (Bernroider and Koch 1999). Theoretical considera-

tions have focused on global business processes (Basu and Palvia 1999) and IT architecture options (Chan 1999), as well as on enhancement of process engineering and development methodologies (Sato 2000). The analysis of current publications shows also that case studies are dominating the research methodology.

Only few publications discuss ERP beyond the cost-intensive system implementation phase and try to develop a comprehensive lifecycle model. The following list gives an overview of some ERP lifecycle models.

- Bancroft (1996) proposes an ERP lifecycle with a concentration on the early stages that includes focus, as-is, to-be, constructing and testing and actual implementation.
- Gable *et al* (1998) suggest a lifecycle that consists of the consulting process, selecting the ERP software, implementing the software and learning and knowledge transfer.
- Ross (2000) discusses in an analysis of the perceived organisational performance into design, implementation, stabilisation, continuous improvement and transformation of ERP.
- As one suggestion for a consolidation of some of these models, Shanks *et al* (2000) propose to distinguish between planning, implementing, stabilisation and improvement.
- An example of a software-specific approach is ValueSAP (SAP 2000), a framework of methodologies, tools, knowledge and programs. ValueSAP aims to increase the benefits derived from SAP's ERP solution during the entire lifecycle and consists of the three phases of discovery and evaluation, implementation, and operations and continuous improvement. The embedded AcceleratedSAP (ASAP) focuses more on system implementation. ASAP's roadmap includes the five sequential tasks of project preparation, business blueprint, realisation, final preparation and going live.

These approaches have in common more or less detailed treatments of the pre-implementation and post-implementation stages. However, most of them lack an explicit stage for the use of the system. This is surprising, as this is the longest phase of the ERP lifecycle and the one in which the organisation is supposed to benefit most from the ERP system.

Process models in the ERP lifecycle

The ERP lifecycles described above can be consolidated and simplified to four phases: business engineering, system selection, system implementation, and system use and change. The following discussion focuses on how process models and ERP reference models can be used in these phases.

Business engineering

In addition to tasks specific for project management (such as forming a project team) the business engineering phase includes the creation of an awareness of the required IT and organisational change, the documentation and analysis of the current situation and the development and selection of possible process improvements. Although this phase is independent of specific ERP solutions, it usually includes a general comparison of integrated ERP solutions with best-of-breed-approaches (Dewan *et al* 1995, Light *et al* 2000). This decision is a strategic one and can be made before the detailed selection of systems.

Process modelling has a critical role in the business engineering phase. Beyond the central aim of documenting the current business, including weaknesses, it helps to develop a common understanding of the domain. The appropriateness and acceptance of process modelling can usually be tested in a pilot. In order to "unfreeze" the organisation, it is recommended that a process be depicted with many organisational and IT interfaces such as invoice verification or customer complaints handling. These first process models have to demonstrate that they offer a new way of understanding the business and, particularly, of identifying weaknesses.

After the formal project kick-off, but before the more comprehensive documentation of the current processes (as-is modelling) takes place, a careful consideration of the advantages and disadvantages of as-is modelling is required. These are listed in Table 1.

TABLE 1: ADVANTAGES AND DISADVANTAGES OF AS-IS MODELLING

Advantages
• Same problem understanding
• Same terminology
• Supports acceptance for the project (unfreezing)
• Base for a migration strategy towards the redesigned processes
• Completeness of to-be processes can be evaluated
Disadvantages
• Results of as-is analysis can be used as to-be, if no or only minor changes
• Shows weaknesses and restrictions
• Results are obsolete as soon as new processes are designed/implemented
• Danger of narrow-focused process design (thinking in constraints)
• Time and money consuming

The core benefit of as-is modelling is that all project members develop the same problem understanding and terminology. During the discussion of possible improvements, the as-is models serve as a kind of a benchmark and completeness check. Parts of or complete as-is models can often be declared as to-be models, if no major process changes are required or possible. Finally, descriptions of existing processes highlight weaknesses and the potential for improvements, but also existing constraints. Models that depict many weaknesses may convince the project team to follow a process-oriented approach. On the other hand, intensive as-is modelling carries the danger that the project team will lose the capability of "thinking out-of-the-box". Further, as soon as new models are valid, as-

is models only document history. As-is modelling can also become time and cost-consuming as it requires general agreement among participants. This is not necessarily the case for to-be models.

As-is and to-be process modelling can become a complex task, as the number of designed models usually grows quickly. For example, in a former project with a facility management company belonging to the German Telecom, we designed more than 600 process models. It is necessary to find adequate mechanisms to reduce and manage this complexity. One efficient way is to develop high-level *business process frameworks*, which describe the core business and support processes of a company.

These business process frameworks depict functions and not organisational units. The objective is to structure the business independently of the organisational and IT resources in a very transparent and process-oriented way. Consequently, it is recommended that for the naming of the functions, terms are used that do not correspond with existing organisational units. As the first level of a process modelling project, business process frameworks serve as the entry point to all underlying models. This could be realised in an Intranet-based environment with hyperlinks to the underlying process models. These frameworks allow positioning of the functions that are influenced by the implementation of a new ERP solution. In past projects, these frameworks have proved to be quite stable and do not change significantly with the change from the as-is analysis to the to-be perspective.

System selection

Process models that describe the core requirements of a company are input for the system-selection phase. It is more important to have a precise description of the critical and unique requirements than a complete description of all processes. In general, it can be expected that ERP software supports typical business processes such as basic payment procedures or order processing.

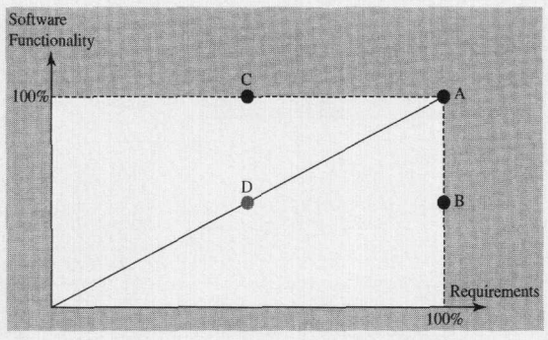
The selection of ERP systems follows existing procedures for software selection but highlights the potential for process modelling. A major benefit is that the existence of certain functionality is checked, and that the ERP software is confirmed as supporting the desired sequence of functions.

A strong motivation for ERP vendors in developing reference models for their solutions was to support the model-based selection of their systems. In such an approach the enterprise-individual models are compared with the ERP reference models. Such a model comparison has to deal with

- different levels of abstraction in the models;
- different scope (length and width) of the processes;
- differences in additional information (organisational units, input data, documents, related transactions); and
- different naming.

These are also arguments for ensuring that the process models, at least until the beginning of the ERP selection, should not be too detailed and comprehensive. Independently of how the individual and the ERP-specific reference models are compared, the different situations plotted in Figure 2 can be distinguished. Point A represents the ideal, in which the requirements of the company are fulfilled through the complete use of software functionality. Point B offers additional opportunities. As the requirements are fulfilled, but the ERP software functionality includes potential beyond the requirements, the initial requirements might be redefined. Point B describes the situation in which ERP software and its promise of at least "better practice" contributes to business improvement. In contrast to this, point C describes the opposite situation. Although the software is used up to its functional limits, the requirements are not fulfilled. Usually, these are individual business requirements. A decision is then required on whether the processes should follow the restrictive software or *vice versa*. This decision can only be based on knowledge about the strategic importance of the process. Many companies in this situation decide to obey the principle that "processes follow software". Finally, point D is the case in which the requirements are not fulfilled, but the software is not yet completely utilised. This is a temporary situation. An example of this would be a procurement process in a company that currently runs only the financial accounting (accounts payable) module of an ERP. As soon as the procurement module is implemented as a part of materials management, D would change to one of the three points A, B or C.

FIGURE 2: ALTERNATIVE SITUATIONS DURING THE SYSTEM SELECTION PROCESS



This approach takes into account that ERP software will offer new, unknown, but often better solutions than those designed during the business engineering stage. Consequently, the most appropriate ERP solution is not the one that supports the defined requirements in the best way, but the one that goes beyond satisfying the requirements and adds to the business. The results of these process comparisons are, in weighted form, input for the entire software selection process.

System implementation

Once the system is selected and necessary project management tasks are completed, system implementation and the required organisational preparation can

take place. One critical task is system configuration, or customising. This requires process models which are more detailed than the ones designed during the system selection.

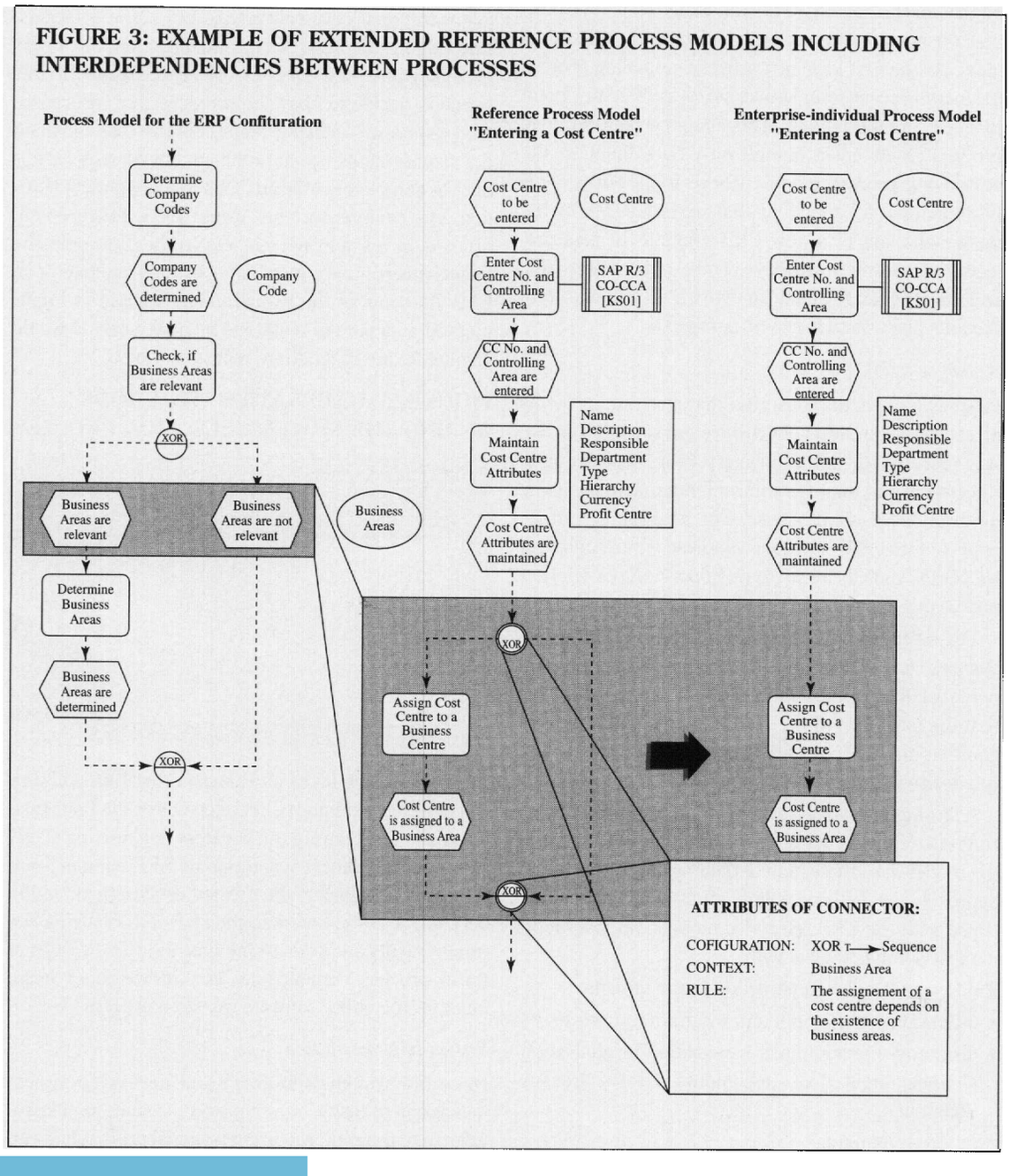
As a system has been selected, it is possible to use existing ERP-specific reference models. Various implementation tools (eg, ARIS-Toolset) offer comfortable navigation through the ERP-specific reference models and enable changes to be made to these models. In most cases the changes influence only the process documentation and not the system configuration.

Available reference models focus on a description of the *execution* of processes. This is important, for example, for the documentation of the new processes for system users. The project team, however, is interested in a process-oriented description of the possible *configurations* of the ERP processes. This would support the discussion of alternative process scenarios and further integrate the ERP implementation into the process improvement project.

In describing the inherent customising opportunities and constraints, two extensions of existing reference modelling techniques are suggested. First, reference process models could be enriched with further symbols so that the customising potential becomes transparent. Second, process models can be linked to highlight dependencies between processes. In both cases, event-driven process chains (Scheer 1998) will be used as an example.

The objective of this extended modelling technique is to describe alternatives in one reference model. As an example, the optional system organisational unit "business area" within SAP's financial accounting solution (SAP-FI) is used. Business areas in SAP R/3 are defined as "the organisational unit in external accounting that corresponds to a selected area of activity or responsibility within an organisation to which the

FIGURE 3: EXAMPLE OF EXTENDED REFERENCE PROCESS MODELS INCLUDING INTERDEPENDENCIES BETWEEN PROCESSES



value movements entered in financial accounting can be assigned" (SAP online documentation).

Although business areas are defined in SAP-FI, they are a part of most SAP modules. Consequently, the decision about the business area influences many processes in several areas of SAP R/3. This influence however is not shown in the SAP reference process models.

Figure 3 (left side) includes a model for the relevant configuration process, in which the decision about the use of business areas is made. This process is strictly sequential as long as mandatory organisational units are configured (eg, for the names of legal entities the SAP term is "company code"). Decisions about optional organisational units are depicted as "check functions". After the decision has been made (eg, "business areas are not relevant"), the configuration process for the organisational units takes place automatically.

Entering a new cost centre is a process which depends on the decision about the business area. If the business area is active, every cost centre has to refer to a business area. Therefore, the configured model either includes the assignment of a cost centre to a business area, or it does not. The reference process model "entering a cost centre", however, has to depict both possibilities. Consequently, a special new connector — the "XOR" connector in two circles — is required, which includes a reference to the configuration process in which the decision has to be made. On the other side, the configuration process model is linked to the operational processes that depend on the customising decisions (Figure 3, model on the right side). Thus, it is possible to clearly identify the influence of a particular customising decision. This example shows how reference process models could be extended to include more information about actual customising possibilities and process interdependencies.

System use and change

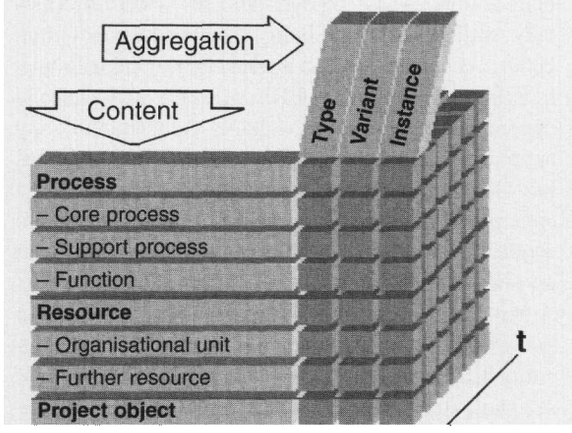
In this stage process models are helpful for end-user documentation. The standardised process reference models have to be extended with individual organisational units. These models can be offered on the Intranet with links to relevant ERP transaction or ERP online help.

Further, process models can capture relevant process attributes during ERP use. The standardised process execution within ERP systems enables simple database queries in order to get useful process performance data out of the system. These data can be clustered in three areas, which are all maintained over time:

- *Process-related data* are directly linked to the business processes and include information about the time, the costs or the quality of a process. A possible indicator for the process quality might be the number of customer complaints. This data can be further differentiated by process type (core or support process, entire process or single function).
- Data related to the *resources* include information about the utilisation of the involved organisational units, roles and further resources (eg, printer) and their appropriateness.
- Finally, the *objects* that are processed, such as orders, invoices or payments, can be analysed and potential complexity drivers can be identified. These can be, for example, the characteristics of incoming invoices that are continuously incorrect.

Such data can populate parts of a data warehouse dealing with process performance indicators. Figure 4 shows the logical design of such a process performance database. Besides the content (process, resource or object) and the time, it can also be differentiated in a third dimension, whether the data are on the level of a process model (type), for a variant of this model (eg, domestic vendors) or for one specific instance (invoice 4711).

FIGURE 4: DIMENSIONS OF A PROCESS PERFORMANCE DATABASE



In this case, ERP software has the role of a knowledge repository from which relevant data can be easily extracted. These process-related performance indicators can be embedded in comprehensive EIS approaches like the balanced scorecard (Rosemann 2000).

The *system change phase* includes minor system modifications, such as a stabilisation (Ross 2000) that directly follows the going-live date, or major changes triggered by organisational changes (eg, acquisition of a company), external changes (eg, introduction of GST), technical changes (eg, introduction of a Web-based user interface) or product-driven changes (new ERP upgrade). Change can be differentiated as anticipated change, emergent change and opportunity-based change (Sieber and Nah 1999).

Process (model) change management requires a precisely defined responsibility for the models. Only with someone in charge of the process models can it be guaranteed that they are continuously maintained. A typical approach is to offer the process models on an Intranet and to expect that these models will be used for various purposes such as human resource management, controlling, quality management, etc. at any time. If the process models are available on the Intranet, it is possible to receive feedback about necessary or possible changes or to discuss potential changes in a related newsgroup. Further, related doc-

uments (texts, presentations, calculations, etc.) can be attached. Process models are therefore not only of temporary use during the definition of the requirements, but can serve as a continuous process-oriented knowledge repository that consolidates relevant information around a process description.

THE ERP KNOWLEDGE REPOSITORY

This section shows how ERP reference process models can be extended with symbols that represent knowledge. The extension allows the combination of process and knowledge management in the context of ERP systems. It will become obvious what knowledge is required in which processes.

"On one hand organisations want to reduce the engagement of costly consultants, but on the other hand hardly any organisation has the internal knowledge and skills to implement an ERP system successfully without external help" (Haines and Goodhue 2000). Companies with an interest in evaluating, implementing or upgrading ERP software are typically dependent on external consultants. Consequently, any approach towards the better management of ERP knowledge targets this dependence. Current reference process models, however, merely document the sequence of activities. The models do not show what knowledge is required for the configuration or the execution of a process. As information about the required knowledge is absent, companies tend to hand over the entire ERP project to external consultants instead of selecting those processes that they could customise on their own. This increases overall project costs.

To structure the relevant ERP knowledge, a comprehensive framework has been developed (Rosemann and Chan 2000) which can serve as a concept for a knowledge repository. The ERP lifecycle is a part of this framework. The other two dimensions are the types of knowledge and the knowledge lifecycle.

Types of knowledge

An intensive literature review was conducted to identify the knowledge required for ERP management. This review included case studies and papers discussing the critical success factors for the implementation of ERP (Bancroft 1996, Clemons 1999, Davenport 1996, Gable *et al* 1997, Gable 1998, Gable *et al* 1998, Gable and Stewart 1999, Mahrer 1999, Parr and Shanks 2000, Scott 1999, Slooten and Yap 1999, Sumner 1999). These publications mentioned similar areas of knowledge, highlighting the need for this knowledge to be made explicit and organised into a manageable form. From the literature reviewed, five different types of knowledge needed for the successful management of ERP software are identified:

- Business knowledge
- Technical knowledge
- Product knowledge
- Company-specific knowledge
- Project management knowledge

Business knowledge

This type of knowledge covers the business issues in the management of ERP. Business knowledge is indispensable as ERP software is only a tool to support business needs. Typical business challenges during an ERP project include restructuring the chart of accounts, the cost centre hierarchies or the various master data. Business knowledge includes:

- expertise in functional areas such as general ledger accounting, purchasing, sales, human resource management, strategic planning;
- knowledge specific for an industry (eg, relevant chart of accounts) or a certain region (eg, laws);
- methodological knowledge such as business process management, communication policies, document management;
- knowledge about needs and strategies for training and education;
- knowledge about the organisational culture, leadership, motivation, etc;

Business knowledge in this sense is general knowledge. Company-specific knowledge uses parts of it in a specific context. However, business knowledge is far more comprehensive as it also includes knowledge about business practices and methods which are not used in a company. New staff members, who may be recruited for an ERP project, typically have business knowledge but no company-specific knowledge.

Technical knowledge

Technical knowledge in an ERP project includes knowledge used in the selection, configuration and use of database management software, the sizing of the hardware, network management, add-on programming, client-server architectures, performance measurement, and so on. This knowledge can be further distinguished as ERP-specific technical knowledge (eg, knowledge about the interrelation of an ERP system and a database system) and ERP-independent technical knowledge such as general network management.

Product knowledge

Most current ERP solutions are comprehensive and highly complex packages which place enormous importance on product-specific knowledge. This includes knowledge about product architecture, the functionality and constraints of the application, the implementation methodology, the release strategy or the ERP-specific programming language. Thus, this area of knowledge combines business, technical and project management knowledge.

Company-specific knowledge

ERP software is selected, implemented, used and changed in the context of a specific company. ERP cannot be managed successfully without a precise understanding of individual company characteristics. This is why the participation of the end-users is a critical success factor for ERP implementation projects.

This type of knowledge also includes company-specific business and technical knowledge, and company-specific product knowledge (eg, knowledge about existing legacy systems).

Project management knowledge

A project is defined as an endeavour to create a service or product in a certain time with limited resources. The implementation of an ERP system in an organisation is a challenging project and requires project management for between six months and two years. It seeks to achieve outputs conforming to milestones and project objectives (Weiss and Wysocki 1992). Duncan (1996) describes project management as an organisational approach to the management of on-going operations. One main challenge for the project manager (who often does not have detailed business, technical, product or company knowledge) is to bring project members together along the different stages of the project in a way that they together represent the required knowledge.

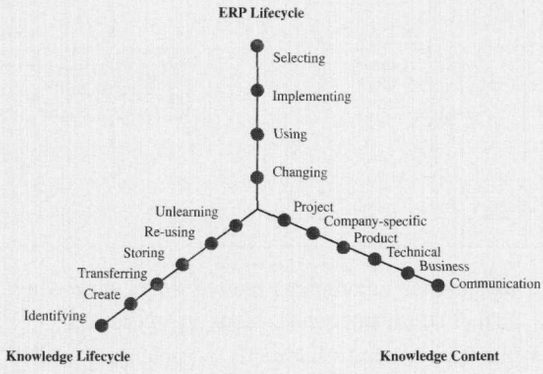
Knowledge lifecycle

The core of knowledge management is the organisation of processes in which new knowledge is developed, distributed to those that need it, made accessible for future use or reuse and the conscious process of unlearning. Based on the literature reviewed on knowledge management (Choo 1998, Davenport 1998, Dove 1999, Gable, Scott and Davenport 1998, Leonard-Barton 1998, Myers 1996, Nonaka and Takeuchi 1995) a knowledge lifecycle consisting of identifying ⟶ creating ⟶ transferring ⟶ storing ⟶ (re)using ⟶ unlearning knowledge has been derived (Rosemann and Chan 2000).

The first phase requires the *identification* of the critical knowledge. Critical knowledge is defined as knowledge that is both important and essential. This knowledge has to be created if it is not available. The main value-adding activity of knowledge management is the transfer of knowledge. The next phase requires the knowledge being stored. The medium for this storage may be print or electronic or it may even exist in the form of an analogy. The important determinant for the successful transfer of knowledge is that the knowledge is effectively captured and can be easily conveyed at a later time. It is then crucial to transfer the knowledge back into the organisation, where it can be *reused and reviewed*. The knowledge lifecycle is an ongoing process. Knowledge should be constantly accessed and renewed according to the organisational needs and relative to time. It is useful to note the process of *unlearning*, whereby the organisation lays aside its old knowledge by considering it as obsolete. Unlearning can be differentiated into explicit and tacit unlearning. Explicit unlearning includes a controlled process of deleting explicit knowledge (like user documentation of an old ERP version). Tacit unlearning takes the form of "learning to forget", ie, disremember old techniques and ways of doing tasks in preference for new methods.

To overcome the missing link between ERP-specific reference models and knowledge management, the use of extended reference process models is again suggested. These will make it possible to identify what type of knowledge is required in which processes. The suggestion is to add further knowledge objects (Scheer 1998). These information objects are connected with the functions of a processs and represent explicit or tacit knowledge. Figure 5 shows how they can be structured.

FIGURE 5: AN ERP-RELATED KNOWLEDGE FRAMEWORK

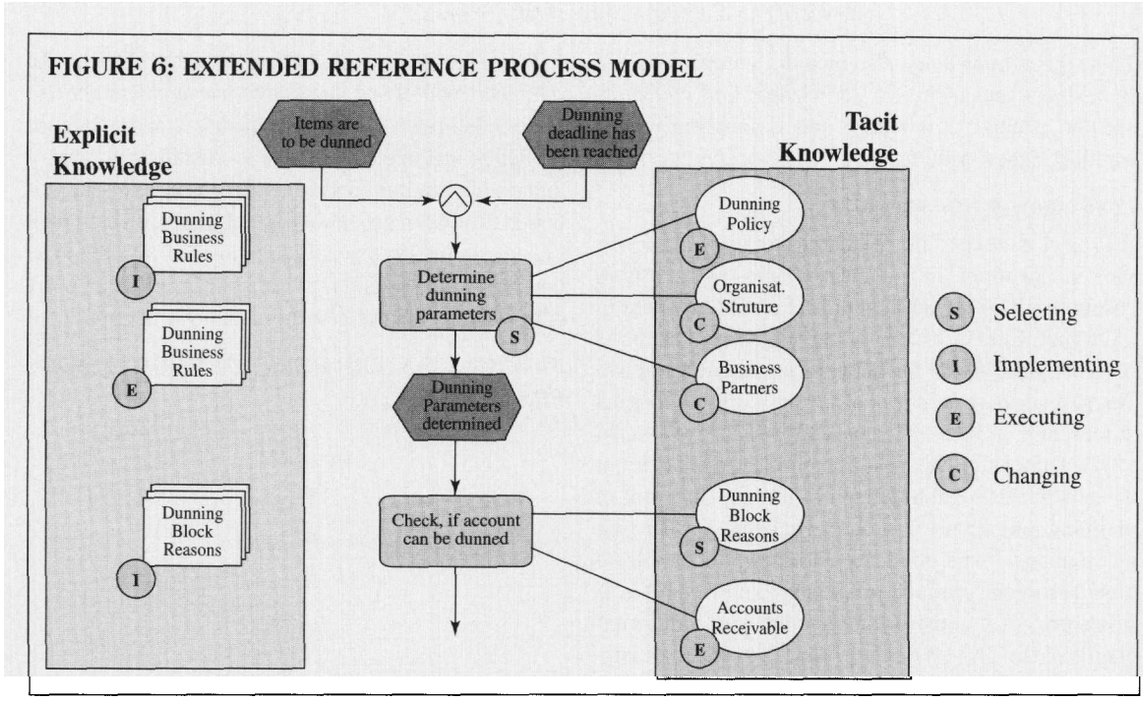


Following the ERP lifecycle, the knowledge objects have an index, which can be B (business engineering), S (system selection), I (implementation), E (execution) or C (change). An "I", for example, indicates that the responsible project team must have knowledge about the configuration of the product or process. This information is only important during the implementation stage. After the configuration of this process the knowledge necessary to perform the activities of a process ("E"), as well as the change management knowledge ("C") becomes relevant. Figure 6 shows how available ERP reference models (see also Figure 1) can be extended with information about knowledge.

Extended reference process models can be used for the following purposes:

- An *ERP provider* might offer these comprehensive models to provide customers and implementation partners with information relevant to knowledge management. The information objects describing explicit knowledge could be linked to documents, online help, Web links or even seminar offers. This would allow involved consultants and customers to evaluate how difficult the implementation of the process will be. Overall, it would be obvious that many customising decisions are rather simple (eg, definition of interest rates within the dunning process) and do not require the involvement of expensive external consultants.
- An *implementation partner* can use these models as a starting point for its own ERP-related knowledge management. Documents from various projects could be added, making it possible to access relevant knowledge. A typical query could be: How is the process usually configured in this industry? New process model releases from an ERP provider would be evalu-

FIGURE 6: EXTENDED REFERENCE PROCESS MODEL



ated and the knowledge required would show where further consultant qualifications are necessary.

- Finally, a *company* that wants to implement the ERP solution gets important information about what kind of knowledge is required in which process. This reduces the information asymmetry between consultants and customers. For every relevant process, the necessary knowledge for system configuration and the corresponding organisational and IT changes can be easily identified. This provides important information for the selection of staff members to be involved in the project. After implementation, the models show what knowledge is required for the execution of the processes. The models can be continuously extended with enterprise-individual documents and store all knowledge materials related to the business processes.

CONCLUSION AND OUTLOOK

Current research on ERP focuses on implementation issues and still lacks agreement on a comprehensive ERP lifecycle model. Enormous resources are invested in ERP implementation, but these efforts drop rapidly after the going-live date. This paper proposes the increased use of extended reference process models to manage ERP entirely.

A second wave of process modelling efforts can be observed, based on the fact that many companies struggle to demonstrate that they are getting value out of their ERP implementation. Often they are aware that the ERP software is not used in an optimal way, eg, that they are not using all relevant ERP functionality. Process modelling activities based on ERP-specific reference process models might be an efficient approach to re-document, analyse and improve existing processes.

Two further developments in the ERP marketplace demonstrate the increased importance of process modelling in the ERP context.

After most of the *Fortune* 500 companies implemented ERP (GartnerGroup 1999), the relevant market moved towards small and medium-sized enterprises (SMEs). SMEs, however, typically have less methodological know-how about process modelling and a lower budget for related consultancy. Reference process models can help to bring these companies up to speed with software functionality. They also serve as a starting point for a more individual process documentation of the company.

Another important new market for ERP vendors will be the support of processes that go beyond the scope of one enterprise. Concepts including customer relationship management and supply chain management require new ways of designing models for collaborative business processes. First approaches exist already which describe the interrelation between the business partners in terms of process flow and also the exchange of services and products.

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