Collaborative Engineering of Inter-Enterprise Business Processes

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ABSTRACT

Enterprise 2.0 and cloud computing are two of the last years most popular topics. Researchers and Business Analysts see great opportunities and potential for a kind of business application revolution. Unfortunately the revolution has not started yet due to different reasons – for example the lack of concepts for integrating new ideas into the already known principles. We are convinced that combining the power of cloud computing with principles of social networking and methodology of business engineering will open new horizons for the global value creation. This paper describes a concept how cloud computing technology can be used to support new ways of inter-enterprise collaboration using the example of logistics.

KEYWORDS: Collaborative Business Engineering, Cloud Computing, Enterprise 2.0, Distributed Modeling, Model Driven Architecture

1. INTRODUCTION

What exactly is "cloud computing"? Unfortunately the term is not clearly defined. All software and web services which are distributed throughout the World Wide Web are referred to as cloud computing.

Following this definition of cloud computing a lot of telematics solutions are included. Internet-based fleet management systems have been controlling thousands of vehicles for years. Millions of parcels are tracked and traced by the use of internet technologies. Seen from this point of view logistics industry has been an early adopter of cloud computing. It seems to be no coincidence, that internet based technology is highly interesting especially for this industry.

What is the reason for this? Logistics is particularly strong driven by globalization related changes. Outsourcing, insourcing and global relocations are growing business topics beyond the classical transportation, handling and warehousing. These topics in conjunction with the increasing cost pressure require more powerful and flexible IT systems. On the other hand term contracts are shortened year by year and cycles change extremely fast, which challenges traditional IT solutions. Relief can be brought by means of cloud computing.

There are some additional factors which have been neglected in the discussion so far. Cloud computing could be the basis for new innovative business solutions not only within the field of logistics. The vision behind cloud computing is the availability of infinite internet resources which can be completely and freely adapted to the actual demand without any delay. Considering the huge investments in the area of dynamic cloud infrastructure, this vision is slowly becoming reality.

Cloud computing creates a new, fast growing field for innovative business solutions, just waiting to be cultivated.

However, the currently discussed approaches are limited to just a fraction of possible ways, since the opportunities and risks of cloud computing are usually considered for pure software services and in the context of a single company only.

With cloud computing, it is secondarily a matter of providing and consuming "everything" as a usable dynamic service, whether it is computing power, accounting, simplest work done by human labor, a ready-made software solution or any other service. This extreme form is known as "Everything as a Service". Logistics represents the interface between the real world and IT solutions. Therefore, it seems to be an obvious idea to transfer the logical representation of logistics services from the real world as web services into the cloud. And who other than innovative logistics service providers could be more qualified to do this?

Right now several promising research projects are processing the scope of this issue in Germany. The goal is to define a standardized model of the logistics domain, to be used as a basis for intercompany definition of services in IT and real world. But this makes sense only if these services can be offered, searched, consumed and billed across companies.

If we succeed in bringing "everything as a service" into the cloud, whilst better supporting inter-enterprise collaboration, totally new business development opportunities will become reality. Business development within the field of logistics would no longer be driven by the customer only. Chances especially for small enterprises can rise.

Our vision is to design businesses simply by “Drag&Drop” in combination with the automatic generation of appropriate cloud software services in real time. Our approach starts from three basic ideas.

- First idea: New Business solutions should be developed model based. These models should be derived from a business idea and must include three parts: A business object/data model, a business process model and an organizational model. These 3 parts describe the enterprise architecture and are organized in business repositories.
- Second idea – an innovative method how to create the models: All specific models within the costumer business repositories are not developed in the green field. They are derived from a shared Business repository that contains proven reference models which are ready for use as pre-supplied model templates and can be adapted to the specific needs of customers.
- Third idea: The use of model driven software engineering concepts in order to generate suitable software services from the model, which can be deployed in „the cloud“ in real time.

2. STATE OF THE ART

The development of services within a dynamic environment featuring high uncertainties, and in collaboration with other companies, is an object of research. Early tools support a model-driven approach and different stakeholders. Most of these approaches for service engineering in digital ecosystems use the “Zachman Matrix”, a framework for enterprise software in combination with UML diagrams.
However, an interactive platform similar to Wikipedia (as a web site easily available for everyone, usable without any technical knowledge) for collaborative business engineering in heterogeneous and virtual teams is still lacking. A platform supporting the whole process of implementing an idea combined with a measurable success does not exist due to the poor understanding of the combination of open innovation and business engineering. In the past the need to open business engineering processes did not exist. Quite the opposite: opening was seen as a risk.

Open Innovation starts with the independent single player. It puts the interactive sharing of work between individuals in the center of attention. Open Innovation promotes the dissolution of rigid organizational boundaries within the inner circle and at the outer edge of the enterprise.

3. A COLLABORATIVE BUSINESS ENGINEERING PLATFORM

A synthesis of both approaches requires switching the "modus operandi" of the participating companies from reactive transmissions to active acts.

There is a scientific discipline that delivers methods for such an active creation of new businesses. Business engineering deals with the development of new business solutions arising from the transformation of the industrial to the information society. Business engineering represents the method-oriented and model-based engineering design for companies of the information age.

In order to take a business advantage from the tremendous technological possibilities of cloud computing, suitable cloud-computing solutions, tailored to the business developer and decision-makers of the companies are required. This clientele expects easily applicable solutions offering immediate benefits. So how would such a solution look like? Modern distributed modeling tools, providing suitable software engineering models, could represent the basis for a solution – provided they contain suitable models not only for software engineering but for business engineering, as well.

After three years of research we developed a platform, delivering the fundamentals to fit these demands. Figure 1 shows the architecture of the platform.

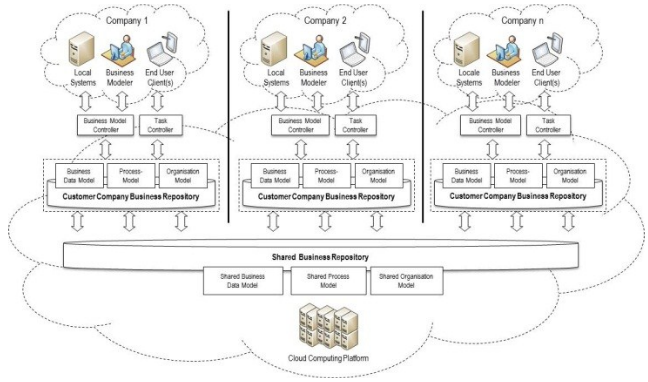

Figure 1: A cloud computing platform architecture for collaborative business engineering

The intended use:
Business users can apply a business modeling tool to create their own business models and to design businesses by "Drag&Drop”. The platform generates an executable prototype of the new business solution without any delay. After the successful completion of testing, the prototype can be transformed into a software solution, and automatically deployed into the cloud.

The process:
Distributed modeling and model-driven architecture are nothing new, neither is the creation of business applications by service compositions. But a closer examination of the most known examples shows that these are rather trivial.

In our opinion the road to success lies in the combination of three key factors:

1) Providing the “right” models,
2) Providing the right way of adopting/adapting the models,
3) Defining simple and complexity-restricting transformation rules.

The design of a suitable model:
UML diagrams are far too abstract and sophisticated to be understood in an intuitive way. Instead, we use a map, inspired by material flow diagrams, providing a synoptical view upon three aspects of value creation: resource flow, data flow and financial flow.

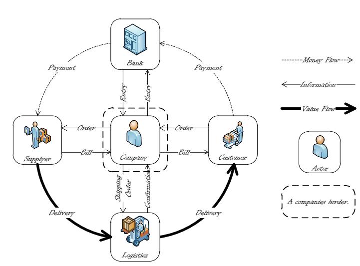

Figure 2: A synoptical cycle model of a companies business

In figure 2 a basic software map for a company is shown. It consists of essential business patterns, especially the relationship between a buyer and a supplier.

Additional three general restrictions exist:

1) All models are based on cycles.
2) All data structures are constructed on self-similar hierarchies of master-detail or parent-child structures.
3) All flows of money, information and material/value are modeled coherently.

These restrictions enable a formal definition of integrity rules which assure the consistency of a model even if it is changed. The fact that all models are based on cycles creates a great benefit: We are able to define implicit consistency rules and constraints, for example between Revenues and Expenses or between required and existing stocks. This has been the basic idea of enterprise resource planning systems and also (in our opinion) their main purpose.

The result features a form, identical to a map, which has been intented, and it inspires other ideas. Maps can be specialized in order to serve different purposes: There are geographical maps, political maps, maps for climate or time zones etc. Our map can be applied for different business modeling aspects: Imagine the physical structure of an enterprise in form of a political map, while the application or IT-Infrastructure can be imagined in form of a geographical map.

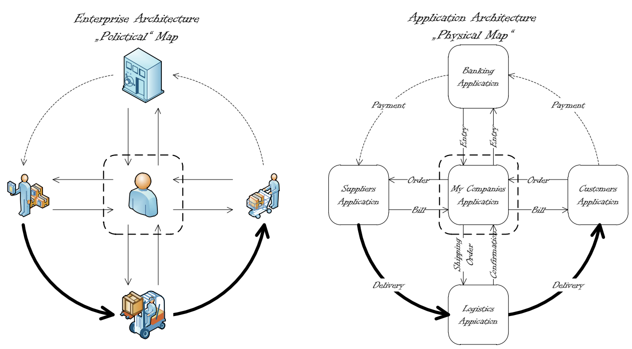

Figure 3: Similar maps for different aspects

The map can contain different types of boundaries:

- Boundaries of organizational responsibility,
- Boundaries of ownership in logistics and supply chains, as well as geographic boundaries of the real world,
- And last but not least boundaries of software systems and applications.

This is very important later when we automatically derive software services and components from our models. If more than one client has to be supported by a service oriented architecture, it is always a challenge to find the right functional cut.

The next step enables the decomposition of our model into a deeper level of detail. The decomposition is tool-supported. Our maps feature "zooming in", similar to Google Earth.

Let's start again with the initial software map of a company and let us interpret it as a context diagram. At the next decomposition level we integrate the company's organizational chart.

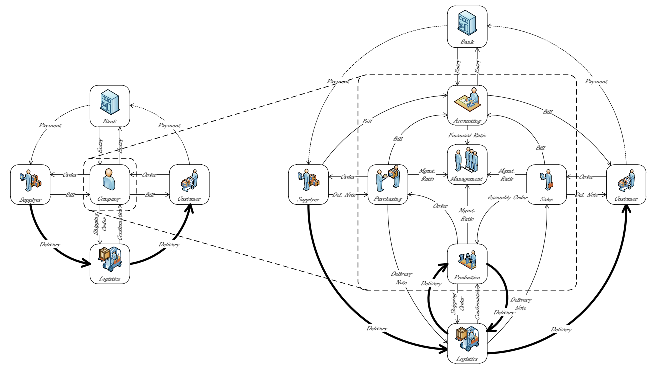

Figure 4: Organizational decomposition

Our platform provides a set of best practice templates for organizational decompositions. Additionally every company can adjust the charts by assembling and disassembling nodes or icons in the map.

So far the enterprise architecture and the organizational model have been discussed. Finally, a suitable process- and a business data model need to be integrated. A thesis states that a business process model implicitly defines its object model and vice versa.

Back to our minimal business pattern: There are three Business Objects: Order, Delivery Note and Bill. Obviously there must be a process step "write order" at the Buyers side, and the suppliers side has to feature process steps "accept order", "prepare delivery" and "write bill".

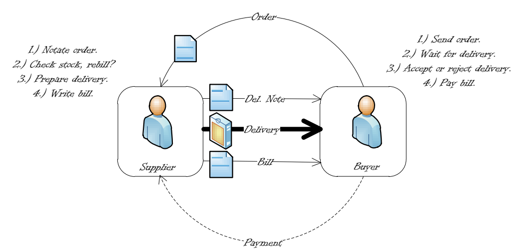

Figure 5: Objects and processes implicitly define each other

Our platform also features a built-in, predefined set of common Business objects and matching process steps which are adaptable and can be modified by adding new attributes as well as new process steps. A new process step always leads to a new state transition within one or more Business Objects. All state values and state transitions are modeled by State Transition Diagrams. Since all transitions are controlled at runtime by the built-in Task Controller modifications are possible without any programming.

The right way of adopting and adapting these models

Our models can be created by choosing and enriching a template with more detailed information. We apply the decomposition pattern in order to create holarchic[1] structures. All processes are derived from enterprise architecture templates. An apparent disadvantage is that processes cannot be created in a green-field-approach. However, this is not really a disadvantage! It enables us to define a set of straightforward patterns for transformation rules.

[1] A **holarchy**, in the terminology of Arthur Koestler, is a hierarchy of holons – where a *holon* is both a part and a whole. The expression was coined in Koestler's 1967 book *The Ghost in the Machine*.

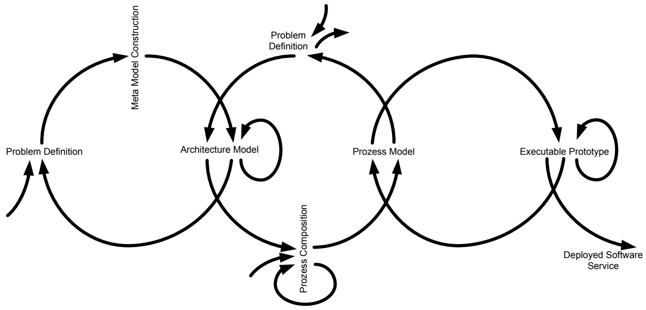

Figure 6: Three iteration cycles of model transformation

How do all the parts work together and how does the platform work? There are three main cycles of model transformation: The left one represents the reference model creation, the center cycle is about model adaption and the right one represents the transformation and execution of the model.

The left cycle is hidden to the user. It provides all the templates for business engineering. The user starts on top of the middle cycle. He answers an interactive questionnaire about his business. In the background, an initial software map of his enterprise architecture is created. The user can modify this map by assembling or disassembling icons and improve it by decomposition. Then the user can start to design a new business case by putting map icons into a process chain. A process model is generated. Data objects can be modified, data sources can be connected. This process model can automatically be transformed into an executable prototype, used for immediate simulation. If the simulation had been successful, the modeled software can be deployed on a cloud computing platform.

The models are always executable and are used to simulate the generated software enabling the testing of real situations.

Each company can create its own enterprise architecture model and the according processes. Since all model artifacts are derived from the same shared business repository they are compatible with the models of other companies. Therefore, one more step ahead can be done and model driven ad hoc projects in form of virtual organizations can be created. So the transformation of executable models to the appropriate project software becomes much easier.

The mission of the task controller component is to transform inter-enterprise process steps into service calls and to provide appropriate end-user interfaces. This transformation is strictly task-based within the context of the specific collaboration business. The trusted access to data, stored in the cloud can be assured, solving one of the major issues in conjunction with cloud computing.

This way, inter-enterprise collaboration is supported much easier. Business collaboration of a new dimension can come into existence.

4. SOLUTION TO THE PROBLEM OF ACCEPTANCE

How can the supposed risk of opening business engineering processes be transformed into a chance? A win-win situation for all potential stakeholders has to be created.

The basic idea is to consider Business Engineering processes no longer as pure technical processes but rather as innovation processes. Using this point of view, methods of innovation research and innovation management can be incorporated.

Two main challenges have to be solved in the context of Business Engineering. The first challenge is to track down ideas and inventions as the nucleus for innovations in all three dimensions of the integration process (see Fig. 12, below), evaluating positive and possibly negative effects on other dimensions. The second challenge represents the action of different people within all three dimensions on behalf of different individual experiences, goals and knowledge.

According to Everett M. Rogers, five factors play an important role for the successful implementation of innovations [1]:

1) The relative advantage of an innovation,
2) The compatibility with an existing value system,
3) The complexity and the perceived simplicity at initial contact with the innovation,
4) The trialability or the possibility of experimentation with the innovation,
5) The observability of the innovation.

All these factors contain strong social components completely hidden in classical business-engineering approaches. This gap is closed by the explicit consideration of the so-called "soft facts" and "soft skills". The soft factors (soft facts) include images, moods, but also knowledge and their subsequent behavior and practices (support / resistance). Soft skills are defined as personal attributes enhancing individual interactions, job performances and career prospects.

We selected several current approaches of other disciplines and combined them in an appropriate manner.

Approach 1: Business Model Canvas
The first approach is the "Business Model Canvas" developed by Osterwalder and Pigneur. [2]

This pragmatic but holistic approach focuses on the business idea as the originating cell of all business, driven by customer needs and represented by a value proposition.

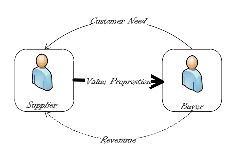

Figure 7: A business idea in software map notation

The Business Model Canvas structures a business idea into nine categories.

Key Partners	Key Activities	Value Proposition	Customer Relationships	Customer Segments
Who are our Key partners? Who are our Key Suppliers? Which Key Resources are we acquiring from partners? Which Key Activities do partners perform?	What Key Activities do our Value Propositions require? Our Distribution Channels? Customer Relationships? Revenue Streams?	What value do we deliver to the customer? Which one of our customer's problems are we helping to solve? What bundles of products and services are we offering to each customer segment? Which customer needs are we satisfying?	What type of relationship does each of our Customer Segments expect us to establish and maintain with them? Which ones have we established? How are they integrated with the rest of our business model? How costly are they?	For whom are we creating value? Who are our most important customers?
	Key Resources		**Channels**	
	What Key Resources do our Value Propositions require? Our Distribution Channels? Customer Relationships? Revenue Streams?		Through which Channels do our Customer segments want to be reached? How are we reaching them now? How are our Channels integrated? Which ones work best? Which ones are most cost-efficient? How are we integrating them with customers routines?	
Cost Structure		**Revenue Streams**		
What are the most important costs inherent in our business model? Which Key Resources are most expensive? Which key Activities are most expensive?		For what value are our customers really willing to pay? For what do they currently pay? How are they currently paying? How would they prefer to pay? How much does each Revenue Stream contribute to overall revenues?		

Figure 8: Business Model Canvas

For all nine parts of the model questions exist – which is quite compatible with our enterprise architecture questionnaire. We integrated these questions as a starting point for a new business engineering project.

Transforming the business model canvas into a software map notation will result in an initial collaboration model as shown in figure 9.

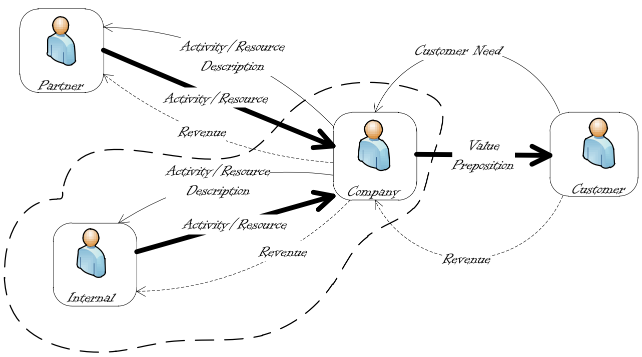

Figure 9: Business Model Canvas in software map notation

Various partners are now able to build a shared model for a virtual organization. All partners are represented by a software map icon which capsules the internal structure. The partners themself can develop their own enterprise architecture to fulfill the business needs of the collaboration.

This enables the building of value or supply chains and networks. The components of all models are derived from the same base and are compatible. In combination with the usage of special graphical visualizations for enterprise architecture, business processes and business models we address the factor "Observability". Software maps are special graphical representations of information, value, and cash flow. In contrast to existing visualization technologies they should be understood by "non-techies" without any prior technical or modeling knowledge.

Approach 2: Collective Mind Method

The second approach has been adopted from the "Collective Mind Method" developed by Köhler and Oswald for usage in software development projects. [3]

It points out that the key for success or failure of a project in software development is the formation of a common sense, the "Collective Mind". For this, the project design represents a key component – a joint assessment of project settings, project environment and project momentum formulated by all stakeholders together. The goal is the creation of such a joint project understanding – the collective mind – as a condition for the conscious control of the "soft" criteria for success.

The success factors in software development projects are the same as in business engineering projects because both define creative processes. Team effectiveness in creative processes depends on many factors. While the "hard" factors such as project planning, budgeting and quality management in recent decades were largely standardized and supported by tools, the consideration of "soft factors" (soft skills) such as communication, knowledge sharing, individual experience and skills is still largely unexplored and often ignored. It just seems to be a major key. Köhler and Oswald proof the increased project success in case a common project understanding, a "Collective Mind" is developed. The project design represents an essential component leading to a common project understanding as a prerequisite for the conscious control of the "soft" criteria for success. Project design consists out of a joint assessment of project settings, the project environment and the project momentum by all stakeholders.

When classifying types of people Köhler and Oswald use the typology of Myers-Briggs. This typology is often used in human resources management, due to the characteristic correlations between MBTI (Myers-Briggs Type Indicator) and vocational aptitude.

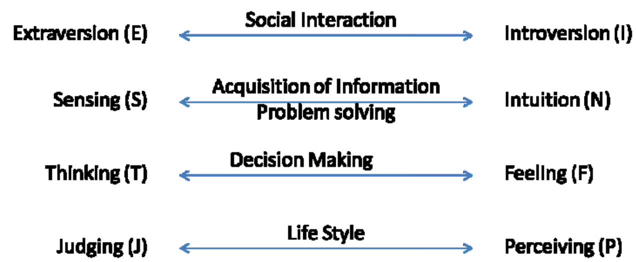

Figure 10: Dimensions of Myers-Briggs Type Indicator

Applying the MBTI classification not only to individuals, but also to organizations and companies in which they operate, a methodology for the formation of the Collective Mind and its implementation in targeted marketing is created.

To classify organizations Köhler and Oswald use an instrument called the Organizational Character Index (OCI) which was developed by William Bridges as an extension of the Myers-Briggs Type Indicator. OCI applies to organizations the same categories of extraverted, introverted, intuitive, etc. as the MBTI applies to individuals. It was developed in order to understand why a particular organization behaves as it does and what kind of "development" it needs. [4]

Köhler and Oswald developed an analogue classification for tasks and projects by the degree of innovation, mission, abstraction and management, distinguishing between four different types of projects:

- Inventor project (high level of innovation and abstraction),
- Missionary project (high level of mission and innovation),
- Master builder project (high level of mission, abstraction and management),
- Carpenter project (high-level of management).

As the names of the project types suggest, they require very different methods, different skill types and therefore different staffing. This seems logical and obvious, however appropriate tools for the support of these themes cannot be found on the market. Project management software focuses exclusively on economic aspects; most of the common tools for the change and process management feature a strict focus on rigid processes.

We recommend the use of an appropriate questionnaire to typify the task, the involved people and organizations. This will create the basis for building a data base of "soft facts", which can be used to generate proposals for the optimal staffing of a project. We can provide appropriate forms of communication and best practice process models patterns.

As a result of this project design tool, an optimally adapted template for the project implementation is generated. Considering the specific project conditions a suitably adapted process model will be provided.

We have generalized and expanded the Collective Mind Method and applied Business Engineering specific methods. The Collective Mind method provides the control and methods kit, which forms the methodological pillar representing the Collective Business Engineering and integrates the important soft factors into the framework.

Our approach to "Collaborative Business Engineering" is (by its structured nature) perfectly suited to develop special software tools for its implementation. Such tools must support the collection, processing, evaluation and development of all relevant informations and ideas as well as their relationships and interactions – representing a new class of business software.

The main advantage is the ability of permanent “Triability”, which is enabled by a completely model driven approach in conjunction with the automated transformation of all the models into prototypical software services in the cloud.

Besides modeling components for business models and business process models, components for modeling and controlling the project’s Collective Mind cover the whole life cycle of the innovation.

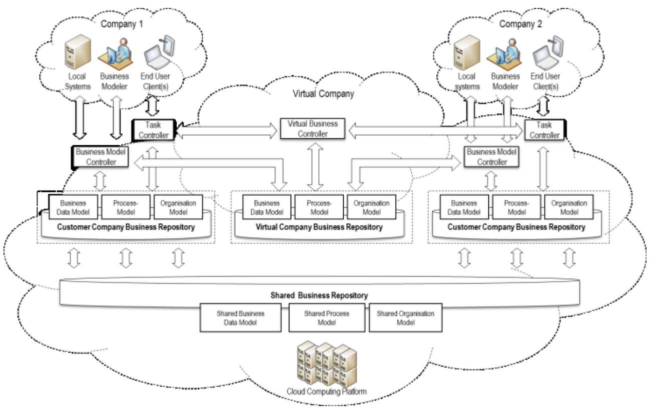

Figure 11: Collaboration at the platform using a virtual organization

How does the platform support this multiply interwaved process of collaboration? First, the initial business idea is transformed into a description of the target state, the necessary steps of the implementation and the resulting values. The model therefore describes the shared vision and mission and the desired organizational culture and provides the framework for policies, objectives and operational actions.

Each potential stakeholder or organization can define its own mission statement, used as an assessment criteria according to the Collective Mind Method within the following phases of the collaborative project.

In addition, all requirements derived from the initial idea have been formulated in form of user stories well known from agile software development. [5]

These user stories can be viewed and continuously evaluated by potentially involved stakeholders. They can be reevaluated if necessary – as soon as new knowledge is present. The open assessment allows the horizontal and vertical integration of all stakeholders by means of a transparent information exchange.

The possibilities for the assessment of user stories go significantly beyond established standards (namely assessing the costs and benefits). The stories can be evaluated by any number of criteria, as a function of different contexts, according to the corresponding mission statements. Its values can be weighted differently. This multi-criteria evaluation allows an active participation of all stakeholders, including those from different "cultures", because the symptoms of failures (different opinions) in large projects are visible early. In addition to the evaluation, all stakeholders can deploy new user stories or add links to the stories, enabling the early recognition of conflicting demands and the discussion of ideas. This approach succeeds by "preventing rather than curing". It supports a proactive handling of changing conditions and suppresses the delayed identification of problems or ideas.

The multi-objective evaluation mechanism also represents the basis for decisions and for the vertical integration dimension.

Managers receive unprecedented (because mathematically underpinned) support in uncertain (because complex) decision-making situations.

Figure 11 shows how this approach is implemented in the platform view. The Business Repository of a cooperative Business is build up by “Copy&Paste” of relevant parts of participant’s repositories. A special virtual business controller coordinates tasks between the participants and ensures the consistency of the virtual system. Note that the decisions of the virtual business controller are by no means arbitrary, but strictly based on the mathematical algorithm underlying the evaluation.

The model and software integration is necessary, but not sufficient to implement a successful collaborative business in reality. Engineering processes should be considered as innovation processes instead of pure technical processes. This way, methods of innovation research and management could be incorporated.

The result is a conceptual model of the integration process featuring three dimensions of integration and a life cycle consisting of four phases.

These phases reflect the regular lifecycle of a virtual organization. The horizontal dimension of the integration represents different organizational units or individuals, while the vertical integration dimension represents hierarchical structures within an organizational unit.

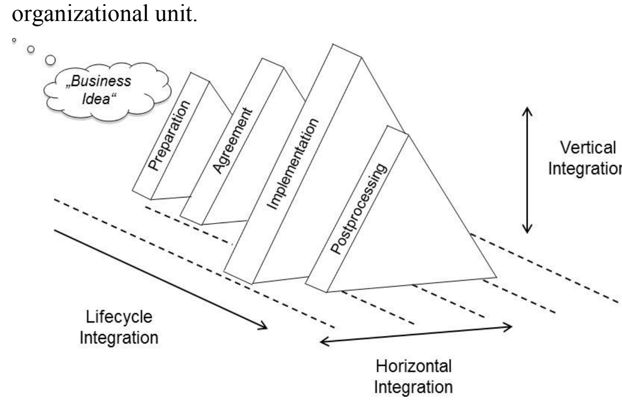

Figure 12: Lifecycle and integration model

As seen in Figure 12, collaborations are characterized by three integration dimensions. Decisions have to be permanently made within and between these three dimensions.

The project life cycle is the first (time-based) dimension. The choice of partners in the preparation phase is a very important decision, since it defines the cooperation of various companies and institutions which form the second horizontal dimension. Hierarchies within companies and institutions represent the third, vertical dimension.

All three dimensions build the frame for the synchronization and escalation mechanism. User stories form the basis of every decision making process.

All decisions are made by collective assessments. These decisions have to be reviewed permanently, since the success of the project is based on the summated, most essential decisions. A holistic view upon these decisions is required, since our approach will comprehensively document them for the first time.

Classically, decisions within businesses, companies and institutions are made on the basis of cost estimations only. We want to introduce additional evaluation dimensions, which are not only of financial but also, e. g. political, ethical or environmental nature. This requires the introduction of multidimensional and multi-criteria decision-making networks which can be treated by computer-assisted methods of numerical mathematics.

5. METHODOLOGY

The mathematical basis is the modeling of networks i. e. systems of nodes (such as individual actors or actions) and their connections (the inter-connection of nodes). In classical graph theory, the existence or absence of a connection between two nodes is relevant only. However, in real networks these connections are multidimensional: Between two actions or two actors there exist not only physical and monetary relations, but an action can produce marketing-related, confidence building, etc., i. e. "soft" effects.

Moreover, every action (and ultimately a project as a whole) features often not only one, but several objectives. In addition to direct economic considerations (profit concerns, achieving new customers), it focuses on strategic and political considerations (strengthen locations, initiate start-ups) environmentally-oriented ones (spare resources) etc.

All of these objectives have to be taken into account. Each COBE project has to consider multiple criteria. The underlying structure is, therefore, a multidimensional and multi-criteria decision network.

The analytical treatment of such networks is impossible. Instead, the net must be simulated, i. e. the impact of any action on the project objectives has to be pursued by computer-based methods of numerical mathematics. This includes

1) The calculation of effects,
2) The visualization of causal chains and
3) The optimization of procedures.

All three components together build the foundation of the Collaborative Business Engineering tool.

The calculation of effects enables the conduction of a cost / benefit analysis of various possible options in order to fulfill a customer request (e. g. choosing the stakeholders, taking into account interests and experiences of customers).

Visualization is a key component in our approach in order to integrate the "human factor" into the project implementation: it permits the illustration of the consequences of an action, would it be the change of a parameter (e. g. cost increase), or a subjective decision within the network, and thus contributes significantly to the increasing transparency of the project implementation.

Finally, optimization is the (automatic) search for the best solution or – more realistically – the automatic suggestion of a number of suitable solutions and the description of their respective advantages and disadvantages, so that the manager can select and implement one of them. A service to be provided can now be interpreted as a path within the network. Its cost is given, in the simplest case, by the sum of the costs of the nodes on this path.

To find the optimal solution for a given task is then the search for the best path which can be carried out by applying standard methods of global optimization.

To bring the described approach into function two things are necessary:

1) The comprehensive coverage of both the targets and the data of all involved stakeholders, i. e. the correct implementation of the preparatory phase as the base of the whole approach,
2) The realistic and up to date assessment of the various actions and their interrelationships. This requires a constant maintenance of data and a voting procedure on the assessment of the effects of an action – different stakeholders can have quite different points of view!

Moreover, the impact of real decisions is often not predictable. Rather, probabilities have to be provided by the decision makers, which in turn could be influenced by later decisions or by changes in the environment. The modeling of the network also takes this (probabilistic) aspect into account.

6. LEARNING FROM THE COLLECTIVE

Another new and important approach within this idea is the representation of best practice patterns via a recommender system. It means that we use and analyze information about projects, problems and solutions. We provide important information and solution drafts for new projects and situations, which are based on the experience of already existing users.

Recommender systems have been developed as a computer-based intelligent technique to solve the problem of information and product overload. Recommender systems are tools for the creation and dissemination of recommendations. The purpose of these systems is to filter information and to provide valuable recommendations for the user. At present, recommender systems are mainly used within the field of e-commerce, to introduce more products to the user.

The goal of the recommender system in this context is to work like a human brain. It should store the entire amount of existing data and the according results – especially the rating of the results of the project.

The stored data can also be analyzed for new projects featuring similar combinations and cases, enabling a provision of recommendations.

This recommender system can provide help and support based on the experience of other companies, as well.

7. SUMMARY AND OUTLOOK

This paper presents an integrated framework for the structured and tool-supported transfer of new ideas into products and services based on a multidimensional and multi-criteria decision network with special reference to the so-called "soft" factors.

The framework integrates market and business strategies, allowing a "hybrid innovation." Pure technology skills are accompanied by agile business models and attractive, emotional marketing activities.

The basis of the approach is the mathematical formulation of the underlying decision network. Particular challenges lie – in addition to the expected high number of information (requests, offers and services) – in the control of the network dynamics, i.e. the fast change of its structure.

The management of such dynamic, with probabilities weighted networks is very complex and places high demands on the supply of network data. In particular, it requires novel forms of visualization and user interaction.

The development of appropriate simulation, evaluation and optimization algorithms require further research. Research activities in this direction will be continued.

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