

CAUSAL CROSS-IMPACT ANALYSIS AS STRATEGIC PLANNING AID FOR VIRTUAL ORGANISATION BREEDING ENVIRONMENTS

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Virtual Organisation Breeding Environments (VBEs) are known as an enterprise network creating virtual organisations (VOs) on occurring business opportunities. Whereas a VO is created dynamically with a limited time horizon, such a VBE is created for medium or long-term existence. Thus, a VBE needs besides operational also strategic planning. Strategic planning for organisations is a topic since the 50ies of last century, but research in the application to networked organisations is very limited. This paper analyses strategic issues, which might occur for VBEs in difference to not-networked organisations followed by the description of an approach, how strategic planning in a VBE could be supported. This approach is based on causal cross-impact analysis and provides a modelling framework for strategic objectives and a simulation component to generate strategic scenarios.

1 INTRODUCTION

Today's manufacturing systems are subject to enormous pressures because of the ever changing market environments showing e.g. discontinuities in trends and globalisation. Manufacturers have responded to these conditions by forming collaborative relationships to suppliers, distributors and even customers (e.g. Jagdev and Thoben, 2001). When two or more enterprises collaborate, they form a collaborative (enterprise) network. Two basic types of collaborative networks are represented by Virtual Organisations (VOs) and by Source Networks (Kürümlüoglu et al., 2005):

- A **Virtual Organisation** (VO) is a temporary consortium of partners from different organisations established to fulfil a value adding task, for example a product or service to a customer. The lifetime of a VO is typically restricted: it is created for a definite task and dissolved after the task has been completed. A synonym for VO is the term *Virtual Enterprise*.
- A **Source/Support Network** is a more stationary, though not static, group of organisational entities which has developed a preparedness to collaborate in case of a specific task / customer demand. Another name for such a network is *Breeding Environment*.

The relationship between these two forms is that the Breeding Environment prepares the instantiation of VOs. It acts as an incubator for a VO. From the VO point of view, the VO is created when a business opportunity occurs. In order to perform the actual value creation task, the VO can be created from scratch (collecting cooperating partners from an "open universe" of enterprises) or through a *VO Breeding Environment* (VBE, see Figure 1).

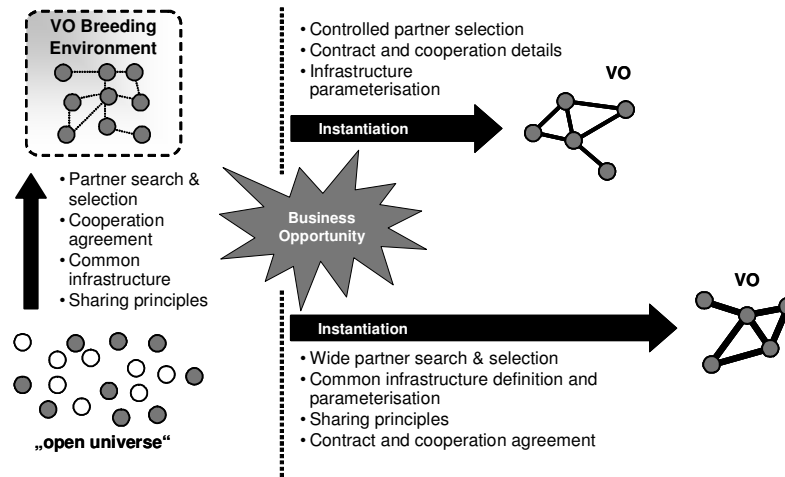


Figure 1: Two Ways to instantiate VOs (after Camarinha-Matos and Afsarmanesh, 2003)

The lifetime of a VO is generally short and depends on the complexity of the value creation process and could be described by the three phases setup, operation and dissolution. In comparison, the lifetime of the VBE is generally long-term. From a perspective of planning, the VO needs operational planning during its operation phase supported by some tactical planning during the set-up and dissolution phase. In difference to a VO the VBE needs strategic planning due its long-term existence. Corporate strategic planning and strategic management is still an subject of research, but has never given much importance to the role networks play (Sturm et al., 2004). A networked organisation like a VBE has some pre-conditions, which may denies the transfer of common strategic planning methods to the network application area.

2 RELATION TO EXISTING THEORIES AND WORK

2.1 State of the Art in VBEs

The concept of having a VBE for the instantiation of VOs is subject of analysis for a couple of years (e.g. Camarinha-Matos and Afsarmanesh, 2006). A VBE can be defined as “an association of organizations and their related supporting institutions, adhering to a base long term cooperation agreement, and adoption of common operating principles and infrastructures, with the main goal of increasing both their chances and their preparedness towards collaboration in potential Virtual Organizations” (Camarinha-Matos and Afsarmanesh, 2006).

The life cycle of a VBE includes the stages or phases a VBE goes through. It starts with its creation, continues to its operation and possible dissolution. In fact, a VBE is a long-term alliance, and considering its valuable bag of assets gradually collected in the VBE, its dissolution is an unusual situation. Instead, it is much more probable that the VBE goes through another stage, a so called metamorphosis stage, where it can evolve and change its form and purpose. On the other hand, it is the case that only during the operation stage of the VBE, the VO can be created.

Figure 2 shows a VBE during the operation phase. It continuously creates VOs in different configurations and for different durations. Each of the VOs goes through the three phases of setting it up, operation and dissolution.

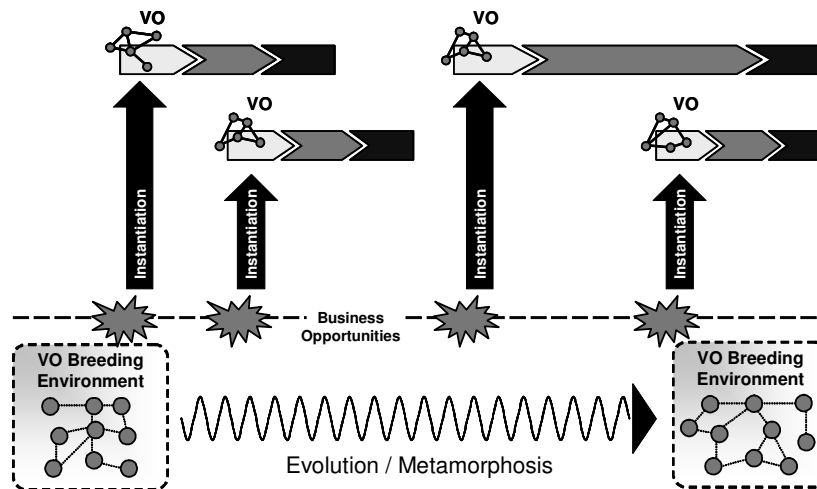


Figure 2: Continuous Instantiation of VOs by a VBE in Operation Phase

Evolution and metamorphosis of the VBE may be driven by random or in a planned and controlled way. Camarinha-Matos and Afsarmanesh do mention a long-term strategy behind the VBE, but the responsibility to develop and implement the strategy has not yet been assigned to one of the roles identified within a VBE. Several roles have already been identified including the member, administrator, opportunity broker, VO planner and coordinator (Camarinha-Matos and Afsarmanesh, 2006).

The *VBE Administrator* is a role performed by a member organisation, which is responsible for the VBE operation and evolution, which includes promotion of co-operation among the VBE members, filling the skill/competency gaps in the VBE by searching and recruiting/inviting new organisations into the VBE and the daily management of the VBE general processes, conflict resolution, preparation of a bag of VBE assets, and making common VBE policies, among others.

The responsibility of the VBE administrator needs to be extended by strategic management tasks, when the long-term evolution and metamorphosis of the VBE should occur in a planned and controlled way.

2.2 State of the Art in Strategic Management

Mintzberg stated that a strategy is best described as a five-tuple, where each dimension starts with a “p” (the 5 P’s of strategy): plan, pattern, position, perspective and ploy (Mintzberg, 1994). For the following of this paper, the planning dimension is considered to be central. Planning has two main aspects:

- Identifying the long-term (strategic) objectives of the organisation.
- Setting up a (strategic) action plan to be implemented by the organisation in order to reach the objectives.

Sturm et al outline, that the process of strategic management, which is including the strategic planning, becomes a tedious and time consuming dialog in a network, because the members might have controversial interests and there is a need to find compromises and broadly accepted solutions. The pre-conditions, which makes the execution of a strategy process in a network context to a lengthy procedure are: (1) decentralisation, and volatility of decisions, communications and resources, (2) inconsistency of interests and (3) novelty of coordination processes (Sturm et al., 2004). This applies to open networks, but, this might not apply to VBEs due to:

- An enterprise joining a VBE has to sign an cooperation agreement. Assuming that this agreement regulates the basic responsibilities, procedures and rules of cooperation, the members shouldn't have very controversial understandings.
- The members of the VBE follow a common objective, otherwise they wouldn't join together into a VBE.

From this point of view, the VBE seems not to be that different to other forms of long-term organisations, for whom strategic management is – of course – an issue. And this opens the discussion, which of the traditional methods and tools of strategic planning apply best to VBEs.

3 APPROACH TO STRATEGIC PLANNING IN VBES

In a traditional enterprise, the forms of strategy are (e.g. Jagdev et al., 2004, pp 11-12):

- **Corporate Strategy:** Is the overall business strategy of the enterprise based on the vision and mission. The corporate strategy guide the single business strategies.
- **Business Strategy:** The enterprise divides their activities into Strategic Business Units (SBUs). For each SBU an own strategy is developed and implemented.
- **Functional Strategy:** The functional strategies concern individual business functions and processes, e.g. human resources or marketing.

These three forms of strategy are strictly hierarchical, meaning that the functional strategies are strictly in line with their business strategies and all business strategies are compatible with the corporate strategy. The direction of governance is top down (see Figure 3, left hand side). The right side of Figure 3 provides a comparison with the levels of strategy in a VBE. The corporate level strategies are still top down, but within the VBE, the direction of governance is bottom-up.

The strategies of the single members of the VBE must be compatible with the overall VBE strategy. If not, most probably there is a conflict in the objectives of the VBE compared with some objectives of the respective member. Such conflicts need to be resolved to ensure smooth business operation of the VBE and all its members.

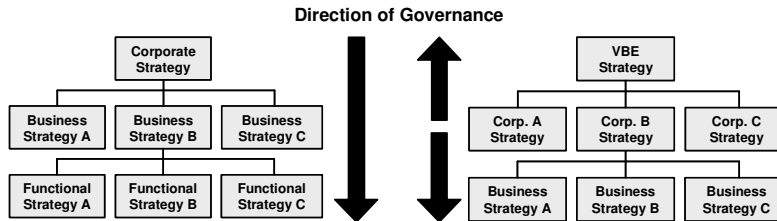


Figure 3: Corporate Strategy and VBE Strategy

Like a traditional enterprise, a VBE has internal resources to be applied in value creating processes (in VOs), and it is operating in an environment (market), which has external factors influencing the success of the VBE. Differentiating external and internal influences leads to the idea of using the *SWOT Analysis* (SWOT = Strengths, Weaknesses, Opportunities, Threats), which is often used to start a strategic analysis process. A SWOT analysis should be followed by another step to process the identified factors and prepare a plan.

Due to the dynamics of the external (e.g. fast changing or disruptive trends) and the internal (e.g. development of skills connected with new member entrance) factors, an approach is needed, which allows the adaptation of plans to changing situations during the course into the future. This is fulfilled by scenario techniques. A well known method to create scenarios is *Cross-Impact Analysis*.

Therefore, the proposed method to develop strategies for a VBE follows two steps:

1. **SWOT Analysis** to identify the internal and external factors.
2. **Cross-Impact Analysis** to inter-relate the factors and to create and simulate scenarios.

As both methods are best applied in group settings, a VBE should establish a *Steering Committee* to support the strategy process. In smaller VBEs, each member can have an own delegate in that committee. For larger VBEs the number of committee members should be limited, but it needs to be ensured, that each of the VBE members has a representative to allow the integration in the strategy process. The steering committee should be chaired by the *VBE Administrator*.

The following chapters show some initial results, when applying this methodology to a generic VBE.

Table 1: Generic SWOT Analysis

<p>Strengths</p> <ul style="list-style-type: none"> • Very fast reaction time on occurring business opportunities • Self-regulation: adapting the number and quality of members to fit requirements • Very good preparedness for business opportunities 	<p>Weaknesses</p> <ul style="list-style-type: none"> • Time consuming processes, if not perfectly coordinated • Members might be competitors • Members prioritise own objectives compared to the VBE strategy
<p>Opportunities</p> <ul style="list-style-type: none"> • Increase of the number of VOs created per time unit • Competitive advantages by <ul style="list-style-type: none"> ○ cost leadership ○ innovation leadership 	<p>Threats</p> <ul style="list-style-type: none"> • Not having the market requested competences/skills in the network • Competing VBEs do constitute • Customers want to have a single enterprise to deliver the solution

3.1 Application of SWOT Analysis

A SWOT analysis is applied to assess the strengths and weaknesses (internal factors) and the opportunities and threats (external factors) of an organisation (Jagdev et al., 2004). A brainstorming session with colleagues at the institute BIBA revealed the strengths, weaknesses, opportunities and threats of a generic VBE. The most important are listed in Table 1.

3.2 Application of Causal Cross-Impact Analysis

Scenario techniques are based on two principles (e.g. Gausemeier et al., 1998):

- **Systems thinking:** Organisations must perceive their environment as a complex network of inter-related (external as well as internal) factors.
- **Multiple futures:** Organisations should not reduce their strategic thinking to one exact prognosticated future. Instead, alternative future scenarios should be created and considered during strategic planning.

The scenario generation approach adopted by BIBA is based on causal cross-impact analysis (Krauth et al., 1998; Duin, 1995), which has first been developed by Olaf Helmer (Helmer, 1981; Helmer, 1977). Up to now, BIBA included several enhancements to the causal cross-impact analysis method according to requirements identified during various research projects: delayed impacting, threshold impacting, expression variables and a technique for structuring and managing scenarios in a tree. BIBA implemented a cross-impact modelling and simulation software package called CRIMP for Windows, which allows the interactive set-up, simulation and evaluation of causal cross-impact models (Duin et al., 2005; Krauth et al., 1998; Krauth, 1992).

The basic idea of cross-impact analysis is to get a systemic picture of the rough structure of a complex system supporting long-term planning and assessment tasks. In difference to other simulation approaches like system dynamics, causal cross-impact analysis is not used to generate prognostic data, but to analyse effects over and above a business-as-usual scenario provided by the end user.

The end-user (the steering committee, who will commonly develop the model) generates different scenarios by applying action vectors (representing different strategic options) and/or setting uncontrollable events, which might strongly influence the system under consideration.

Causal cross-impact modelling is based on a discrete time model. The time period under investigation is divided into single time steps called scenes. Each scene represents a time span, e.g. a year, a quarter or a month. The end of the total time period under consideration is called the time horizon.

The basic elements of a causal cross-impact model are trend variables representing the elements of a system (like levels or stocks in system dynamics (Sterman, 2000)). For each trend variable the user is asked to provide an estimated business-as-usual development coupled with an uncertainty factor called volatility.

Event variables in a causal cross-impact model describe events which are not under the control of actors of the model, but which might have a strong influence on other variables (trends or events) in the case of their occurrence. The user is asked to provide occurrence probabilities for event variables.

Action variables are under the control of actors and represent their manoeuvring space in decision making. If an actor invests in an action, the variable develops an intensity with which it might influence other system elements (trends or events).

These variables are inter-related by defining cross-impacts between them spawning up the cross-impact matrix as demonstrated in Figure 4. The cross-impact matrix consists of six different areas or sub-matrices: One sub-matrix collects all impacts having a trend variable as source and destination, one for trends on events and so on.

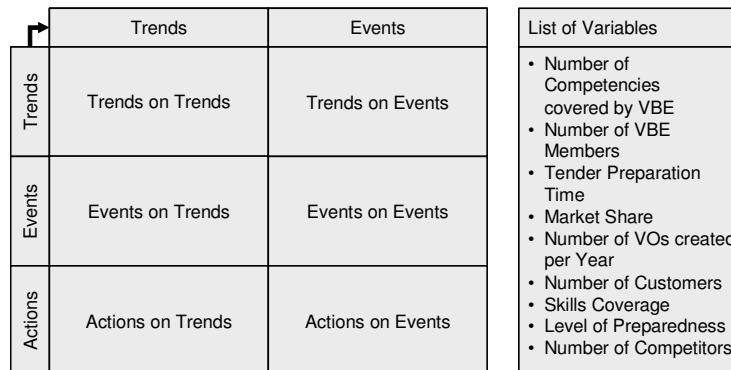


Figure 4: Structure of the Cross-Impact Matrix (Duin et al., 2005) and Examples of Variables

Figure 4 also shows some examples for variables involved in the cross-impact matrix and extracted from the SWOT analysis result. A cross-impact is a coefficient, where the absolute value indicates the strength of the impact and the sign indicates its direction. A positive sign means that a deviation in the source variable will cause a deviation in the same direction of the destination variable for the following scene. A negative impact would cause a deviation in the other direction.

Users can generate explicit simulations by setting actions or letting events occur and watching the results of the simulation. Each pattern of action settings and event occurrences defines a specific scenario describing how the target variables are affected in comparison to their business-as-usual development (Figure 5).

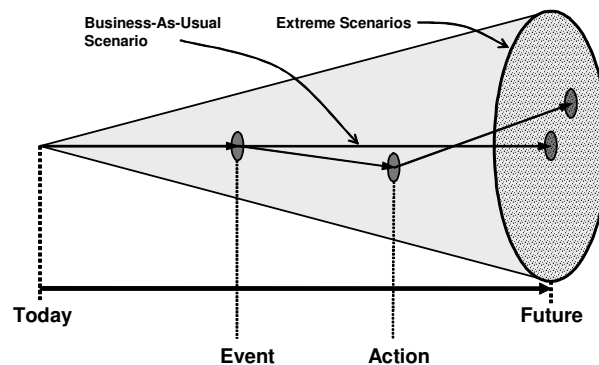


Figure 5: Scenario Funnel with Business-As-Usual Future and another Path

4 CONCLUSION

This paper analysed strategic issues, which occur for generic VBEs in difference to not-networked organisations. This analysis is done by applying SWOT analysis followed by the usage of causal cross-impact analysis and its application to strategic planning. This approach has been applied to a proto-typical generic VBE.

Future research should include the application of the presented approach in different real world VBE contexts to validate the appropriateness of the solution and the generic findings.

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