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An Architecture for Decision Support on Portfolio Design

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Abstract

Though organizations have more and more evolved into loosely knit structures and corporate alliances have therefore become central to most business models, only very few organizations systematically track the performance of their alliance portfolio. This paper is an exploratory paper aiming to present an architecture for decision support systems for the design of such a portfolio.

In this paper we start with an introduction on the complexity of measuring portfolio performance. We will then advocate the use of simulation as an inquiring system best suited for the design of an alliance portfolio. Since the support we intend to provide is aimed at the actual operational business level, sincere challenges are faced for an underlying e-architecture. We describe such an architecture, and propose a transformation of decision support systems from stand-alone, office-alike packages to distributed well-interweaved services.

This paper ends with the outline of a case on capital investment portfolio optimization. In this case we focus on the potential benefit we can make in choosing more advanced techniques for portfolio design.

1. Introduction

Since the 1990's, the internet has clearly transformed the very basic rules of competition in almost all fields of business. Most companies have re-evaluated their business models and are racing to adapt to the Internet, as either an opportunity or a threat [Kee99].

As organizations have evolved into loosely knit structures, corporate alliances have become central to most business models. According to studies conducted by McKinsey & company, only very few organizations systematically track the performance of their alliances. According to Bamford and Ernst [BE02] and Dyer [DKS01] doing so is namely not a straightforward task.

For this reason many feel that strategy is not enough. Strategy is easy and never fails. It is the linkage from strategy to seeing, understanding and evaluating operational consequences that forms one of the cornerstones of what might be addressed as "*Decision Support Systems Next Generation*" [KS03].

This paper proposes the development of such next generation decision support services for the management and design of alliance portfolios.

Section 2 starts with an introduction into the complexity of measuring a business alliance. In this section we will focus on the ill-structuredness and operational complexity of rational design in this problem field.

Section 3 introduces simulation as an inquiring system suitable for this problem. Section 4 continues with the notion that in order to design decision support systems capable of understanding and evaluating operational consequences, we must better support the "process of discovery", which inevitably leads to a service oriented distributed architecture described in section 5. A case describing a subset of the above problem field illustrates such architecture in section 6. It describes the challenges faced in the design of capital investment portfolios.

This paper ends with several conclusions focusing on the early results we have made with our research on the e-support of portfolio design and provides several angles for further research in de support of the broader scope of the actual alliance portfolios.

2. Measuring the Performance of an Alliance Portfolio

As described in the introduction, this paper focuses on the development of decision support services for the design and management of business alliances. The aim of this section is to illustrate why this is not a straightforward task. Bamford and Ernst [BE02] identify the following obstacles:

The first hurdle is agreeing on a common approach to the actual measurement. Though alliances are fundamentally about collaboration, different partners most likely have different aims. Reporting processes, information systems and sensitivity about sharing information are likely to obstruct easy measurement.

Secondly, the operations of the alliance are often entwined with those of the parent organizations. This makes the costs and benefits of the actual alliance difficult to track.

Finally, the measurement of benefits is a challenge because of the interdependencies with the parent organizations. Sales are for example often related to the products of the parent organization. Intangible benefits such as access to new markets and technologies and opportunities for learning should also be taken into account.

According to McKinsey & Company, three consequences typically result from the complexity of measuring the performance of business alliances:

First of all they mention the failure to measure the performance of individual alliances rigorously. Alliances are run by intuition and incomplete information; partners may not agree on the progress of their ventures and management cannot intervene to correct problems.

Secondly, organizations do not seem to recognize the performance patterns across their alliance portfolio. Bamford and Ernst [BE02] illustrate a major pharmaceutical company, which had so many slow launches that it was loosing $500 million a year from missed sales.

Finally management in organizations only have little idea to what extend the alliance portfolio as a whole really supports the common corporate strategy or purpose of their organization. Executives at a leading US airline, for instance, couldn't quantify the total revenue from their alliances five years after they made them a centerpiece of their international strategy and thus had no idea if the returns were positive.

In a time where alliances have become increasingly important for the strategy of organizations, under-investigating and therefore not providing insight in their performance, does not seem an appropriate choice.

Before we come to the design of an architecture for decision support in this context, we will first focus on the rationality of problem solving and see what deductive, inductive or other methodology best serves this problem field.

3. Simulation as an Appropriate Inquiring System

The first notion we make here is that the challenge of designing and managing an alliance portfolio is a typical example of what Simon[Sim77] addresses as a *non-programmed* and therefore *ill-structured* problem. Multiple actors with conflicting stakes, perceptives and rationalities perceive a novel challenge and at best pursue some *procedural rationality*.

Before we come to a suite for decision support services in the next sections, we start here with a general outline of the process of problem solving described by Mittroff et.al[Mit74].

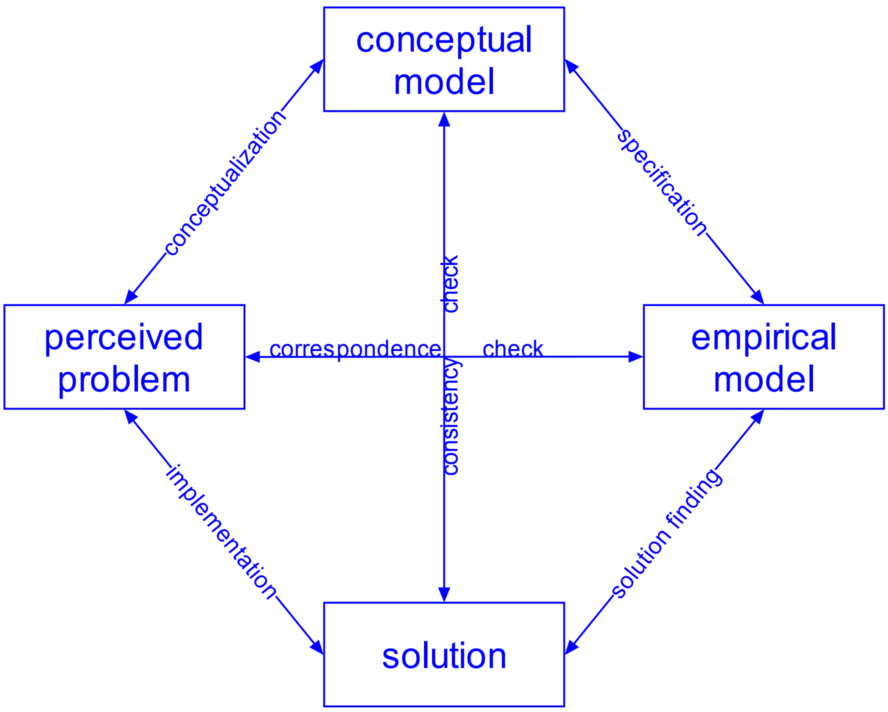

Figure 1: *The Process of Problem Solving*

In the process illustrated in figure 1 Mitroff identifies four *stages* linked by *activities*. The stages are the *perceived problem*, the *conceptual model*, which defines the variables that will be used to specify the nature of the problem in broad terms, the *empirical model* which specifies the conceptual model in terms of the system under study and the *solution*.

The activities illustrated in figure 1 are the *conceptualization*, the *specification*, the *solution finding*, the *implementation*, the *consistency check* and the *correspondence check*. A specific combination of these activities leads to the concept of a *modelcycle* or a *methodology*. The activities that make up a methodology can be supported with a structured set of instruments called an *inquiring system*. For the design of *inquiring systems*, Churchman[Chu71] describes five inquiring systems in order to understand the relations in systems under consideration. For ill-structured problems, Churchman advocates a *Singerian* inquiring system, which focuses on the expansion of substantive rationality on the problem by adapting the inquiring system endlessly, inductively and multi-disciplinarily.

Based on the research of Sol[Sol82], who introduced simulation as a Singerian inquiring system, we conclude that for the design of alliances in complex business environments (oil&petrol, airline, pharmaceutical, etc.), simulation and therefore an experimental approach is indeed the inquiring system best suited to increase our substantive rationality.

Though this section introduced simulation as a suitable inquiring for this problem field, we have noticed that its practical use in portfolio design is limited. Most simulation models are too strategic and do not provide but an indication to causalities. In order to provide support based on which problem owners can make decisions, we must feed these models with more detailed operational business data.

Many have therefore argued that the challenge of using simulation models is how to specify them. As we will argue throughout the next paragraph, currently deployed enterprise information systems have provided us with great opportunities to support this *"process of discovery"*.

4. Supporting the "Process of Discovery"

Since it directly supports the usage of operational business data, this paper advocates that a strong support of the process of discovery is *"the"* way to pursue next generation decision support. The *"process of discovery"* describes the meta-process of problem solving and describes how we conceptualize, specify, find alternatives, generate hypothesis, etc. The following examples illustrate the need for this support:

- An inductive model cycle expects problem owners to be able to specify hypotheses to be tested. If hypothesis do not spring from the brain of Zeus, where then do they come from? What in other words will be our hypothesis-generating process? Without defining this process, the collection of hypotheses and therefore the direction of the alternatives will clearly be bound to the creativity of the actors involved.
- After a preliminary hypothesis is formulated, how does simulation as an inquiring system assist in conceptualizing relations between subsystems? Is there mechanism to identify causalities based on statistical non-spurious correlations? If not, how can our inquiring system assist in potentially disappointing correspondence checks of complex systems under investigation?
- What mathematical analysis underlies the process of specification? By which rules are variables aggregated or reduced and how do we fill the semantic space created in our simulation model with actual attribute values and backdrops?
- Facing both the potential infinite amount of alternatives and the time constraints of decision-making, another issue is how an inquiring system might assist in choosing heuristics for an alternative-searching process. Possible heuristics for this purpose include the rules of depth first, breadth first and scan-and-search [Sim77b].

The challenge is now how to design these services and align them with the underlying organizational e-frastructure.

5. Decision Support eServices

Though the above paragraphs introduced relatively matured concepts, the internet has clearly given us the opportunity to rethink our strategies on the design of decision support systems and makes us see to what extend we can align decision support systems with the currently deployed multi-tier enterprise information systems. Based on this opportunity we came to the following requirements for an e-architecture for decision support:

- Design both simulation components and those components required to support the process of discovery as distributed independent services, capable of interacting with underlying enterprise information systems such as Enterprise Resource Planning (ERP), Financial Information Systems (FIS) or Customer Resource Management (CRM) suites.
- Abandon the concept of the all-in-one decision support system. Most currently deployed decision support systems are developed as an office-alike, monolithic software package. In order to create sustainable models based on the operational data of the underlying global enterprise we need models that are linked to enterprise information systems and therefore enable the direct interoperability between a simulation core and the enterprise information system.
- Enable decision support suites to present their animation, statistics and reports to distributed stakeholders. Since most modern organizations have introduced (intranet) portals to share information in a standardized format, decision support suites should focus on easy integration and adaptation of their output. As a result of these requirements, figure 2 presents a proposed architecture.

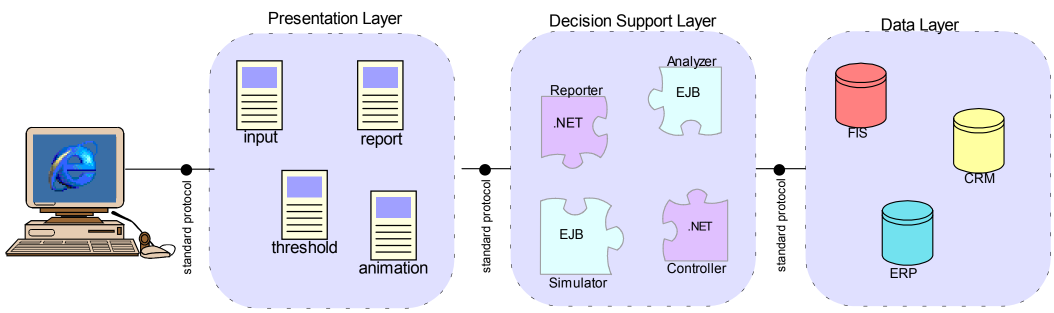

Figure 2: An e-Architecture for Decision Support

In this architecture we have followed the same multi-tier architecture underlying most modern enterprise information systems and designed a set of components providing a loosely coupled distributed decision support suite.

6. Alliance Portfolio Optimization with Respect to Capital Investment

In this section we illustrate a business case and show how simulation interweaved with an underlying enterprise information system provides what is addressed as a *"next generation decision support suite"*.

In this section we take an organization struggling with their capital investment portfolio. This subset provides a good overview of our research aims and discusses the core elements of future research on the broader design of business alliance portfolios.

We assume that our organization has a limited amount of cash to invest in 5 potential projects. Since the sum of these 5 projects exceeds the total amount of cash this organization can invest, it is forced to make decisions on its portfolio. We furthermore assume that all projects may start between now and 5 years.

In order to understand how to support decision making with respect to their portfolio, we start with some basic theory on portfolios.

Organizations normally evaluate their capital investment projects by estimating their "*net present value*" (NPV). Though it makes economic sense to undertake projects if their NPV is positive, it does not guarantee they will be funded. We therefore see a wide spectrum of approaches to determine how to allocate investment capital. The basis for most of these approaches is Markowitz's theory [Mar52] on *mean-variance* efficient portfolios.

Markowitz defined a portfolio as mean-variance efficient as it has the highest expected return for a given variance. The strength of this approach was that risk-averge managers became able to measure expected net outcome on the basis of its variance or risk.

Though the above technique is widespread in use, McVean [MVe00], April[AGK02] and others have shown the cracks in the foundation of this theory: the measured variance of return does not follow a normal distribution and therefore does not reflect risk accurately. April [AGK02] has furthermore shown that the inability to devise a more effective alternative has been due in large part to limitations in the technology of decision support suites. Based on the complexity of portfolio optimization, we conclude that simulation is well suited for this optimizing challenge.

Our first step is to create a conceptual model of our challenge. For this case we state come to the following challenge:

$$\underset{p}{Max}(P(E(NPV(l)) > \mathrm{A})), \psi_n > \mathrm{B}, t = \{0,1,2,3,4,5\}$$

Sign	***Description***
P	*Probability*
l	*Project participation level*
E	*Expected value*
t	*Discrete time starting point*
NPV	*Net Present Value*
A	*Goal value*
ψ	*n^{th} Percentile of NPV*
B	*Minimal goal value*

Equation 1: Conceptual Goal Function

Equation 1 clearly shows that we have abandoned a restriction on the *standard deviation*, but constrained on a *minimal goal function*. Though this proposed maximization requires severe computing efforts, results have shown a sincere increase in the expected NPV above *mean-variance techniques* [Mve00] [AGK02].

Our next step is to define which inputs we need for the specification of this NPV as a function of the set of project participation levels and time. Theory shows that in order to construct an accurate NPV, we need at least the expected return on a project, the correlation among the expected returns of the different projects and the individual variances of these projects. This is not a straightforward task. Especially in complex, large-scale projects, such as described in section 3, simulation is most likely needed to estimate this NPV value. Other techniques include data mining or agent based modeling. The optimization itself may be accomplished with Monte Carlo simulation, genetic algorithms, and several other techniques. Though we will not explain the advantages of one above the other, we want to point out the need for a service-oriented architecture that supports the interoperability of these techniques.

The next step is to question to what extend the architecture presented in section 5 can assist in this specification phase. In our research we are implementing all necessary components as distributed services. This makes direct integration with existing mining, forecasting and reporting packages available to our simulation and optimization. It also makes the feedback from optimization to the deployed enterprise information systems packages possible. Decision support services are thus provided in an environment directly attached to the underlying enterprise information systems and facilitate next generation decision support.

7. Discussion, Conclusions and Further Research

Though we have only recently started our efforts in the further integration of decision support tools in distributed enterprise environments, the results look more than promising. Because of the distributed character of this architecture, models could directly interact with distributed real-time data and provided more detailed predictions on the NPV.

Loosely coupled optimization made it furthermore possible to apply more advanced portfolio algorithms to the actual design. So far a distributed simulation, animation and reporting framework has been published under the name of D-SOL. The first results of an inductive, experimental approach to portfolio analysis have most certainly shown that the much is to gain from more advanced technologies than *mean-variance* analysis.

In this research we are putting renewed effort in designing a joint architecture for electronic business operations and decision support. Much of this was made possible due to the immense change in the way organizations nowadays store their transactions and keep their history in well-defined and increasingly open standards. It is the "*continuously updated history*" of these enterprise information systems that provides most substantive rationality on the ill-structured challenges faced.

We have made a sincere attempt to design, implement, and test distributed services capable of capturing business data and therefore at least partly automate the process of discovery. More quantitative cases must now assist in the further research.

8. Obtaining the DSOL Software

D-Sol is open-source software and published under the General Public License. More information can be found at http://www.simulation.tudelft.nl. The actual code can be downloaded at http://dsol.sourceforge.net

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