Die Bedeutung des Asset Managements als Finanzdienstleistung hat in den vergangenen zwei Jahrzehnten massiv zugenommen, dies sowohl in Bezug auf die Volumina der verwalteten Vermögenswerte als auch im Hinblick auf das heute erbrachte Leistungsspektrum.

Im Zentrum des modernen Asset Managements stehen die Strukturierung, Verwaltung und Steuerung von institutionell organisierten Vermögenswerten und damit Finanzdienstleistungen, welche den Gesamtprozess des Vermögensmanagements umfassen. Vor diesem Hintergrund behandelt das vorliegende Buch fünf Kernthemen, welche im Rahmen des Asset Managements im aktuellen Markumfeld von zentraler Bedeutung sind. Es sind dies die Funktion von Finanzmärkten, die adäquate und bedürfnisgerechte Strukturierung von Kundenvermögen, die Wahl und Umsetzung der Anlagestrategie, die Angemessenheit des Risikomanagements im Portfolio sowie die umfassende Unternehmensanalyse.

Aufgrund der besonderen Verdienste von Prof. Klaus Spremann auf dem Gebiet des Asset Managements ist das Buch zugleich ihm gewidmet.
Abstract

In the meantime there are different legal requirements for the corporate governance of enterprises related to risk management. The statutory audits directive of the European Community [AuditsDirective06, Article 41] requires that the audit committee of the enterprise . . . shall, inter alia . . . monitor the effectiveness of the . . . risk management systems . . . In the international financial reporting standards [IFRS7.33(b)] it is required that the enterprise . . . shall disclose: (a) the exposure to risk and how they arise; (b) its objectives, policies and processes for managing the risk and the methods used to measure the risk; and (c) any changes in (a) or (b) from the previous period. To fulfill these requirements enterprises have to establish effective risk management systems.

Although risk management is a broadly discussed topic for about two decades it is still unclear how risk management systems should be designed, implemented and monitored for effectiveness. Furthermore it is not clear in which scientific discipline this topic is actually located. In industrial research the operational risks and their measurements and in financial research the measurements of the financial risks are addressed. But a systemic object and process orientation towards risk management and effectiveness considerations is missing in both research fields. In this article this gap is filled by using the cybernetic management framework out of the engineering sciences. It allows the consistent derivation of different management process variants for separated risk management processes as well as for integrated risk management processes. The framework provides a clear guideline to translate management into action and hence ought to be valuable for all who are responsible either for designing and implementing risk management systems or for monitoring their effectiveness.
1 Problem Statement and Overview

An enterprise is engaged in different business activities along its value chain. According to the flow of the materials and services there are acquisition, conversion, revenue and financial business activities that are needed within a manufacturing enterprise to generate value. The ensemble of these four business processes constitutes the enterprise value chain. In Figure 1 the business activities are modeled as activity nodes in form of rounded rectangles. The start and the end of the activities are indicated by the filled and the crossed circles. The commodity flow through the enterprise that is associated with these activities goes from the left to the right side. According to the duality principle of business and financial economics this flow is accompanied by an equal valuable cash flow in the opposite direction. The composition of all four business activities comprises the enterprise value chain.

Figure 1: Business Activities in Enterprise Value Chains

Figure 1 shows the interrelations between business economics at the upper part and financial economics at the lower part. The business activities are managed at the business level relative to operational and financial objectives. At the enterprise level the different business units are coordinated and strategically aligned. Figure 2 contains the different business activities in the rows and the different management domains are arranged in the columns.

The purpose of this article is to show how risk management can be integrated into the business as well as the enterprise management. Such a comprehensive integration of risk management is not that easy as there are many different aspects that have to be taken into account in the different business, enterprise and management domains. Instead of a single integration approach
different integration considerations have to be taken. To handle this diversity a *meta management framework* is taken which includes the essential elements of all traditional management systems (e.g. supply chain management, customer relationship management, quality management, risk management, strategic management, performance management, financial management, liquidity management, asset and liability management and portfolio management). In order to be applicable in different management contexts the management framework must allow flexible implementations so that the peculiarities of the different contexts can be taken into account.

![Figure 2: Business and Enterprise Management – Risk Management Integration](image)

The meta management framework is based upon cybernetic ideas why it is called *cybernetic management framework*. There are three cybernetic principles that are of special importance:

- feedback principle
- control and communication principle
- double loop principle.

The first two principles lie at the heart of the traditional cybernetics definition introduced by Wiener [Wiener48]. The double loop principle is central to the 2\textsuperscript{nd}-order cybernetics that was established by Foerster [Foer03] in the 70s of the last century (see also Scott [Scott96]). In the literature the three principles
are dealt with normally quite separated so that their combined consideration should deliver interesting and beneficial insights. It will be shown that the integration of the three concepts can be reached by a strict object and process orientation where the operational and managerial activities are modeled together with the corresponding information flows. The combined modeling of objects and processes is possible in the recently developed unified modeling language [UML07]. UML is a modeling language for object oriented systems where objects and activities can be combined in UML activity diagrams.

The cybernetic management framework is founded upon activity diagram modeled management processes so that the framework translates management into action. The generic cybernetic management process can be applied in different management contexts. The generic management process perspective allows a comprehensive and activity based view on each management system under consideration. In this article the cybernetic management framework is applied to the risk management context. This application is reached by specifying the needed managerial activities and selecting the appropriate information flows including the needed risk measures and operational as well as managerial rules. To achieve an integration of the risk management into the business management processes the cybernetic management framework is applied to business performance management processes. Finally the cybernetic management framework is applied to strategic management processes in a way that risk management considerations are included also in the management processes at the enterprise level.

The cybernetic management framework gives a mental meta model for designing and implementing cybernetic management processes in different management domains. As such it should be beneficial to all who are responsible in their functions as managers, IT designers and implementers or controllers for the design, implementation and well functioning of risk management systems over time.

This article is structured as follows. First an overview of the research fields related to the integration of the risk management into the enterprise management is given. Then the cybernetic management framework is defined via three pillars that are founded upon the MGT-Activity-diagram. The cybernetic management framework is then applied to the risk management domain. After that the risk management is integrated into the business management via establishing a proactive performance management and into the strategic management by using a proactive open loop management. Finally the paper gets concluded
and an outlook to the design and implementation of enterprise management information systems is given.

2 Related Research Fields

The audits directive of the European Community was established to improve the confidence into the functioning of the financial markets. This directive requires from the audit committee of an enterprise to monitor the effectiveness of risk management system: … the audit committee shall, inter alia: … (b) monitor the effectiveness of the company’s internal control, internal audit where applicable, and risk management systems; … [AuditsDirective06, Article 41].

In the international financial reporting standards (IFRS) it is required that enterprises disclose their financial risks and give more detailed information on their risk management systems by explicitly specifying the management objectives, policies and processes: Qualitative disclosures – For each type of risk arising from financial instruments, an entity shall disclose: (a) the exposure to risk and how they arise; (b) its objectives, policies and processes for managing the risk and the methods used to measure the risk; and (c) any changes in (a) or (b) from the previous period. [IFRS7.33(b)].

In Finance there is a long tradition in measuring financial risks. The mathematical definition and measurement of risk is the starting point of modern finance that goes back to the seminal paper of Markowitz [Mark52] on portfolio selection. In the portfolio theory the rate of returns of assets are modeled as normally distributed random variables where the mean specifies the expected rate of return and the standard deviation specifies the uncertainty surrounding the mean. The portfolio theory is normative by using utility functions and deriving optimal allocations for the assets held in the portfolio.

Based on the work of Markowitz considerable progress was made in the refinement of risk definition and risk measurement considerations. In contrast to this progress it is interesting that the conceptual approach to risk management did not change that much. In the neoclassical tradition the main objective in the portfolio selection framework consists out of optimizing the trade-off between one period expected profit and risk. Accordingly the mainstream finance literature on risk management (see e.g. [Hull09]) addresses predominantly the problem of defining risk measures and optimizing one period re-
turns. In the future, and as a consequence of the financial crisis of 2007–10, it seems desirable to overcome one-periodic modeling. However, any type of consideration of a hyperopic optimal strategy requires a specification of the multi-period risk measure $r$, the general return function and the non-stationary process $(Y^t)_{t \geq 0}$. It remains a big but promising challenge for further research to proceed in this direction. [BDW11, p. 3007].

The topic of risk management is addressed in different risk management frameworks that are connected with legal requirements in different regulation domains. For the financial services industry the Basel Committee on Banking Supervision (BCBS) standardized the measurement of financial and operational risks. The measured risk must be covered by equity capital to ensure the stability of the banking industry. The risk measurements have to be embedded in sound risk management systems. The overall adequacy is ensured by the supervisory review process that is performed by the local regulatory authorities: 720. The supervisory review process of the Framework is intended not only to ensure that banks have adequate capital to support all the risks in their business, but also to encourage banks to develop and use better risk management techniques in monitoring and managing their risks. [Basel2–06, § 720]. The BCBS framework is very specific on the measurement of risks but related to the risk management procedures detailed information is missing. The specification of procedural aspects is left to the national authorities on banking supervision what seems doubtful in the light of the financial crises in the banking industry.

The risk management framework specified by the international standardization organization (ISO) is much more elaborated by having a clear process orientation and by giving principles for the design, implementation and improvement of the risk management framework. Organizations of all types and sizes face internal and external factors and influences that make it uncertain whether and when they will achieve their objectives. The effect this uncertainty has on an organization’s objectives is “risk”. All activities of an organization involve risk. Organizations manage risk by identifying it, analysing it and then evaluating whether the risk should be modified by risk treatment in order to satisfy their risk criteria. Throughout this process, they communicate and consult with stakeholders and monitor and review the risk and the controls that are modifying the risk in order to ensure that no further risk treatment is required. This International Standard describes this systematic and logical process in detail.
While all organizations manage risk to some degree, this International Standard establishes a number of principles that need to be satisfied to make risk management effective. This International Standard recommends that organizations develop, implement and continuously improve a framework whose purpose is to integrate the process for managing risk into the organization's overall governance, strategy and planning, management, reporting processes, policies, values and culture. [RMS09, p. v].

Embedded within the ISO-risk management framework is the ISO-risk management process. The ISO-risk management is defined in Figure 4 and it has to be implemented according to (4.4) in the ISO-risk management framework shown in Figure 3.
The risk management framework developed by the Committee of Sponsoring Organizations (COSO) of the Treadway Commission casts the risk management explicitly into the enterprise context. Enterprise risk management is a process, effected by an entity’s board of directors, management and other personnel, applied in strategy setting and across the enterprise, designed to identify potential events that may affect the entity, and manage risk to be within its risk appetite, to provide reasonable assurance regarding the achievement of entity objectives. [COSO2–04a, p. 4]. The COSO-enterprise risk management framework provides an enterprise wide language for risk management that

- is process oriented,
- relates to strategic, operations, reporting and compliance objectives and
- is relevant for all organizational units of the enterprise (subsidiaries, business units, divisions and entity-level).

To visualize the three aspects of the COSO-enterprise risk management framework the cube form shown in Figure 5 is used.
The COSO-enterprise risk management framework is characterized by intuitively clear definition of risks and chances that are based on events. An event is an incident or occurrence from internal or external sources that affects achievement of objectives. Events can have negative impact, positive impact, or both. Events with negative impact represent risks. Accordingly, risk is defined as follows: Risk is the possibility that an event will occur and adversely affect the achievement of objectives.

Events with adverse impact prevent value creation or erode existing value. Examples include plant machinery breakdowns, fire, and credit losses. Events with an adverse impact can derive from seemingly positive conditions, such as where customer demand for product exceeds production capacity, causing failure to meet buyer demand, eroded customer loyalty, and decline in future orders. [COSO2–04, p. 16].

The event based definition of risks and changes is quite intuitive and therefore helpful for establishing a common risk management language throughout the enterprise. From the theoretical side the event based definition is the key – as is shown later on – that opens the risk management framework to stochastic modeling.
3 Cybernetic Management Framework: Translating MGT into Action

The three risk management frameworks just presented i.e.
- BCBS-risk management framework,
- ISO-risk management framework and
- COSO-enterprise risk management framework

are conceptually quite different. Management systemic considerations are clearly underlying the ISO- and the COSO-framework whereas they are missing in the BCBS-framework. The ISO-framework explicitly rests on the cybernetic feedback principle in form of PDCA-cycles. Management system standards provide a model to follow in setting up and operating a management system. This model incorporates the features on which experts in the field have reached a consensus as being the international state of the art. The Plan – Do – Check – Act (PDCA) cycle is the operating principle of ISO’s management system standards.

- Plan – establish objectives and make plans (analyze your organization’s situation, establish your overall objectives and set your interim targets, and develop plans to achieve them).
- Do – implement your plans (do what you planned to).
- Check – measure your results (measure/monitor how far your actual achievements meet your planned objectives).
- Act – correct and improve your plans and how you put them into practice (correct and learn from your mistakes to improve your plans in order to achieve better results next time). [ISO-MSS11].

Figure 6: ISO-PDCA-Cycle [ISO-MSS11]

Figure 6 shows the PDCA-cycle that is used as the operating principle in all ISO’s management system standards. The cybernetic feedback mechanism is indicated in the figure by the arrow whose tip points towards its end.
Shewhart [Shew80] applied the PDCA-cycle to statistical quality management already in the 30s of the last century. He therefore used cybernetic concepts before they were termed cybernetic. Ten years after Wiener [Wiener49] created the term Cybernetics its concepts were applied by Beer [Beer59] to the management context. Malik [Malik08] is the most prominent current representative in the field of Management Cybernetics that is based on the ideas of Beer.

In this article the cybernetic planning and control framework introduced by Anthony [Anth65] is taken to put the PDCA-cycle into a managerial planning and control framework. Using the planning and control framework the business management system is composed out of a planning system and a control system that are established to manage the operating activities in the operating system. In Figure 7 this definition of the business management system is visualized by a Venn-diagram. The overlapping circles indicate that there are different associations between the three sub-systems of the business management system.

![Figure 7: Cybernetic Business Management System – Sub-Systems](image)

The integration of the planning and control framework, the PDCA-cycle and its related information flows is realized by using MGT-Activity-diagrams. In the MGT-Activity-diagram the object and process orientation is implemented by simultaneously modeling the managerial PDCA-activities as processes and the related information flows as objects. In the spirit of Cybernetics as the science of control and communication in the animal and the machine the MGT-
Activity-diagram is the object and process oriented modeling technique for *planning, control and communication in management*.

Figure 8 contains a simple variant of a MGT-Activity-diagram that relates to rather mechanical systems where only single loop learning occurs. In this diagram the business activity is modeled as a black box to abstract from the details of the business process itself. The process details are not modeled by using MGT-Activity-diagrams but using REA-Activity-diagrams instead (see Figure 1) where the economic Event related Resource flows between Agents are specified. Furthermore the business process is modeled as an ongoing process which can be seen in Figure 8 by the arrow that goes from the end of the business process via the diamond again into the process. This *going concern view* is characteristic for the *business management level*. It contrasts to the *execution view* which prevails at the *business process management level* where single executions of business processes are designed, monitored and improved over time.

**Figure 8: 1st-order Cybernetic MGT Framework – Single Loop Learning**
In the MGT-Activity-diagram stereotypes which are marked by <<guillemets>> are used to show the semantic meaning of the operational and managerial activities in the management process. In Figure 8 the managerial activities are stereotyped as Plan-activity (1), Check-activity (3) and Act-activity (4). The operational business process is characterized as Do-activity. Next to the activities which are modeled as rounded rectangles also the information flows are modeled and stereotyped. To distinguish the information flows from the activities the information flows are modeled as objects in form of rectangles. The stereotypes used indicate their meaning, i.e. Standard of performance (1a), Do-rules (1b), Check-rules (1c), Act-rules (1d), Measure-rules (1e), Performance-realization (2a), State Variable-realization (2b), Deviation (3a) and Control Input (4b). The numbers and letters indicate the connections which exist between the different activities and information flows. E.g. in the Measure-activity (2) the realization of the business process performance (2a) and the realization of the state variable (2b) are measured.

The performance information is compared in the Check-activity (3) with the standard of performance (1a) which is set as objective. This comparison constitutes a closed loop control system. The realization of the state variable is not connected to a Check-activity. Instead it goes directly into the Act-activity (4) where it is evaluated according to the Act-rules (1b) to give the Control Input (4b) which changes the behavior of the business process. The usage of the control variable constitutes an open loop control system. The open loop system is the control theoretic analogue to the classical decision theory where the control inputs are called decision variables. The difference between decision theory and control theory corresponds e.g. to the different modeling frameworks that are used in the portfolio selection theory of Markowitz [Mark52] and the option pricing theory of Black and Scholes [BlSc73].

The 1st-order cybernetic management framework presented in Figure 8 allows – as already mentioned – according to its single loop characteristic the derivation of only simple variants of cybernetic management processes. The adequacy of 1st-order cybernetic management processes depends on the peculiarities of the system that is to be managed. Boulding [Bould56] defined 9 levels of systems complexity as follows:

1. Static Systems (Frameworks): Taxonomy of classifications and associations
2. Dynamic Systems (Clockworks): Something is moving over time
3. Control Systems (Thermostats): Information is an essential part of the system
4. Living Systems (Cells): Open system with self-production and self-maintenance
5. Decentralized Systems (Plants): Society with differentiated and dependent parts
6. Thinking Systems (Animals): Brain as information organizer (mental structure)
8. Social Systems (Social Organizations): Set of communicating roles

In this complexity hierarchy the 1st-order cybernetic management framework seems to be adequate for level 3 complex systems. In these systems information plays an essential role and the information is used to align the system to specified objectives or control rules.

To make the cybernetic management framework suitable for more complex systems the transition to 2nd-order cybernetics has to be taken. The transition to the 2nd-order framework includes a qualitative change which corresponds to the transition onto level 7 to 9 complex systems. In these systems the self-reflection principle is included. This means that the system is aware of its system structure and it has the potential and the power to change the system structure at will. In the 2nd-order cybernetic management framework presented in Figure 9 this qualitative transition gets incorporated by the additional loop which provides the double loop learning mechanism. The second loop refers back to the planning system. This means that the system can learn also about its single loop learning effectiveness. Compared to the single loop learning system there is an additional adaptive Act-activity (5) and an additional information flow in form of adaptive instructions (5a, 5b) back to the Plan-activity. This double loop feedback is used to adjust the overall system structure.
The 2nd-order cybernetic management framework in Figure 9 is a flexible construction that allows different specifications. The cube presented in Figure 10 contains eight different control process variants that can be derived by distinguishing in three dimensions, i.e. open vs. closed loop, single vs. double loop and proactive vs. reactive loops. The simplest variant is the right upper front field which is characterized as a combination of a closed, single and reactive loop so that it is called reactive closed single loop control process. This process is reactive as it uses realization related information in its single closed loop learning mechanism. The process gets proactive if the measured information is transformed into future related information. This happens if e.g. forecasts about future results are derived out of observable information which is compared in the Check-activity with the standard of performance.
The 2nd-order cybernetic management framework possesses already substantial flexibility so that the cybernetic management processes derived thereof can be applied in many different management domains. Despite the flexibility there is still one more peculiarity to be considered to establish a generic cybernetic management framework. This peculiarity relates to the problem that the agents involved in the system have next to their self reflectivity and their system reflectivity also self interests. This means that agents do not always conform in their behavior to what is expected from them. Arrow [Arrow64] brings this clearly to the point: In this address, I wish to set forth some considerations on one aspect of the working of an organization – how it can best keep its members in step with each other to maximize the organization's objective function. This may be referred to as the problem of organizational "control". It divides itself naturally into two parts: the choice of "operating rules" instructing the members of the organization how to act, and the choice of enforcement rules to persuade or compel them to act in accordance with the operating rules. Various other terms for these two problems have appeared in the literature; a widespread usage is to refer to the operating rules as control-in-the-large and the enforcement rules as control-in-the-small. It should be noted that enforcement, here as elsewhere, includes both the detection and the punishment of deviations from the operating rules. [Arrow64, p. 398].

Figure 11 shows the generic cybernetic management framework where also the supervisory enforcement rules are included which are implemented to supervise the agents in order to keep their actual behavior in line with the
proposed rules. The Supervision-activity is modeled in the MGT-Activity-diagram as an exception handler. The exception handler catches disturbances from the observed processes. This is indicated by the lightning bolt symbol and the small rectangle to which it shows. In the Supervision-activity itself the information is processed and the corresponding exception handler action is selected and feed back to the region where the out-going arrow refers to. Thus the exception handler possesses an embedded cybernetic structure which is not explicitly shown in its symbol.

Figure 11: Generic Cybernetic MGT Framework – Double Loop Learning and Supervision
In the generic cybernetic management framework there are 8 managerial activities:
1. Plan-activity
2. Measure-activity
3. Check-activity
4. Corrective Act-activity
5. Adapting Act-activity
6. Process related Supervision-activity
7. Control related Supervision-activity
8. System related Supervision-activity

Compared to the 2nd-order cybernetic management framework three additional Supervisory-activities are included which take care of the control-in-the-small aspect. The supervisory activities are established to ensure the actual execution of the operational Do-rules and the managerial Control-rules. At the overall level they are implemented to ensure the rule compliant behavior of the complete management system architecture.

In the presentations of the cybernetic management framework so far the focus was exclusively on the cybernetic aspects of the framework. In Figure 12 the cybernetic pillar is shown in the middle of three pillars upon which the cybernetic management framework is based. Furthermore there is a foundation in form of the UML based MGT-Activity-diagrams. By using these diagrams it is ensured that cybernetic management systems are translated into managerial actions.

![Figure 12: Foundations of Enterprise Management Systems](image-url)
Next to the cybernetic pillars there are two more pillars in the cybernetic management framework. The economic pillar carries the economic context of the framework. Its integration into the MGT-Activity-diagram is over the specified Measure-rules where the performance measure and the state variable are defined. The economic context is prevailing when economic performance measures or state variables are used in an application. The third pillar of the cybernetic management framework is the stochastic pillar. The stochastic pillar carries the uncertainty that is intrinsically connected to all social systems which are level 8 complex systems in the systems complexity hierarchy of Boulding.

4 Cybernetic MGT Framework: Applied to Risk MGT Processes

The application of the generic cybernetic management framework to the risk management context requires the context specific specification of the managerial activities and the related informational objects. Figure 13 contains the cybernetic risk management process modeled as MGT-Activity-diagram. The process is constructed as double loop control system with three supervisory activities related to the business process, to the control system and to the overall system. The stereotypes remain the same as in the generic framework to enable a consistent semantic interpretation of the diagram. In the Plan-activity the Objective is set in form of the risk limit and the Measure-, Check- and Act-rules are specified to establish a double loop management system. The supervision specifications are defined in the three Supervision-activities.
The cybernetic risk management process in Figure 13 is still generic as it relates to all kind of risk at the operational, financial and strategic level. The separation of the cybernetic management methodology from the risk type demonstrates the applied abstract reasoning which the MGT-Activity-diagram allows.

The informational output of the Measure-activity is the actual risk $Risk_{j,k}(s_{t,i})$. The actual risk is compared in the Check-activity with the $RiskLimit_{j,k}$. If the resulting deviation is within acceptable ranges the management process is stopped what is indicated by the crossed circle. If there is an excessive risk the deviation is forwarded to the two Act-activities where it is evaluated according to two Act-rules, i.e. in form of the risk reduction rule for the single loop mechanism and the adaptation rule for the double loop mechanism. The corrective control
input contains the information needed to bring the risk of the business process down. Related to operational risks this could be the execution of maintenance services to the equipment used in the business process. Related to financial risks this could be the instruction so sell the most risky financial instruments.

A closer look at the risk definition shows that the risk has two sub-indices attached and that it is a function of a variable. The variable used in the risk measure definition is the state variable $s_{t,i}$. It indicates that the measured actual risk is depending on the prevailing state $i$ that occurs at the time $t$ when the risk is measured. This dependence structure already highlights the dynamic nature of the MGT-Activity-diagram. The cybernetic management modeled therein is an iterating process that starts periodically when the timer – symbolized by the wait cursor – initializes the Measure-activity. Furthermore in a future oriented look the dynamics are stochastic. That means that from the current time point on there are different possible developments the state variable can take. In Figure 14 different developments are shown for illustrative purposes in a simple set up where the state variable follows a binomial process. In such a process at each point there are two possible movements that are indicated by the two arrows starting from each point. Over time different states can be reached by the state variables which are specified by the two sub-indices of the state variable.

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**Figure 14:** Modeling the Uncertainty – Event Tree Approach
In stochastics the binomial tree shown in Figure 14 corresponds to the event space upon which the stochastic process is defined. Stochastic processes are measurable functions that map the event space into the real numbers. The measurability of the functions means that the different elements in the event space have probabilities associated. These probabilities allow the calculation of state conditional expectations and state conditional risk measures. In this sense the measured actual risk \( \text{Risk}_{j,k}(s_{t,i}) \) is conditional in the \( i \)-th state at time \( t \).

The stochastic view underlies the COSO-enterprise risk management framework what makes it qualitatively distinct from the BCBS- and the ISO-risk management frameworks. In the COSO-framework the stochastic view is presented in prose form without using formulas. Uncertainty of potential events is evaluated from two perspectives:

- likelihood and
- impact.

Likelihood represents the possibility that a given event will occur, while impact represents its effect. Likelihood and impact are commonly used terms, although some entities use terms such as probability, and severity, seriousness, or consequence. Sometimes the words take on more specific connotations, with “likelihood” indicating the possibility that a given event will occur in qualitative terms such as high, medium, and low, or other judgmental scales, and with “probability” indicating a quantitative measure such as a percentage, frequency of occurrence, or other numerical metric. [COSO2–04, p. 50].

In equation (1) the risk definition out of the COSO-framework is formulated in mathematical terms where the impact is defined by the loss given event (LGE) and the likelihood by the probability of event (PE). The two sub-indices used in the definition of the risk relate to the \( j \)-th business which can be associated with different risks that are indexed by the \( k \)-letter.

\[
\text{Risk}_{j,k}(s_{t,i}) = \begin{cases} 
LGE_{j,k}(s_{t,i}) \\
PE_{j,k}(s_{t,i}) 
\end{cases}
\]  

(1)

In the BCBS-risk management framework [Basel2–06] there are many different risk measures defined. Most of them can be captured by the generic risk model presented in equation (2). The \( s_{t,i} \)-conditional risk arises out of the negative impact the \( k \)-th risk factor \( RF_k \) can have in this state. In the simplest case it
is assumed that the risk factor is normally distributed what can be seen in the last row of the equation. Out of the risk factor’s distribution the coefficient of variation (CV) is calculated by dividing the standard deviation $\sigma_k$ through the mean $\mu_k$. The CV gives the relative deviation around the mean. By multiplying it with the quantile (z-value) associated with the loss probability $\alpha$ ($p$-value) the cut-off rate ($\text{COR}_k$) is derived. This rate specifies the percentage deviation of the risk factor from its mean which is associated with the loss probability $\alpha$. The cut-off rate is transformed into the loss given event by multiplying it with the exposure that is at risk times the multiplier that leverages the risk factor impact.

$$LGE_{j,k}(s_{t,i}) = \text{Exposure}_{j,k}(s_{t,i}) \cdot \text{Multiplier}_{j,k}(s_{t,i}) \cdot \text{COR}_k(s_{t,i})$$

$$PE_{j,k}(s_{t,i}) = \alpha$$

with

$$\text{COR}_k(s_{t,i}) = \begin{cases} \frac{\sigma_k(s_{t,i})}{\mu_k(s_{t,i})} \cdot N^{-1}(\alpha) = CV_k(s_{t,i}) \cdot z_k(s_{t,i}) & \text{CV Model} \\ \sigma_k(s_{t,i}) \cdot N^{-1}(\alpha) = \sigma_k(s_{t,i}) \cdot z_k(s_{t,i}) & \text{Vola Model (if } \mu_k \text{ is zero)} \end{cases}$$

where

$$\text{RF}_k(s_{t,i}) \sim N(\mu_k(s_{t,i}),\sigma^2_k(s_{t,i})) \text{ and } Z_k(s_{t,i}) \sim N(0,1)$$

The risk model in equation (2) is generic as it can be applied to different risk measures. E.g. the traditional Value-at-Risk (VaR) measure assumes a mean for the risk factor of zero so that the volatility model has to be used for the calculation of cut-off rate. As the volatility relates to the price of the risky financial instrument the multiplier is equal to one. The exposure is the current value of the instrument which is equal to the future value due to the zero mean of the risk factor.

In Figure 15 the risk model out of equation (2) is used to calculate the Earnings-at-Risk (EaR) measure. In contrast to the VaR the EaR relates not to value related losses but to earnings related losses. Accordingly the loss given event is calculated by the negative impact that the cut-off rate related to sales deterioration has on the operational earnings (OE). The multiplier used in this risk measure is the operational leverage. The operational leverage is defined as the quotient between the overall contribution margin and the operating earnings. Accordingly the operational leverage increases when the fixed costs are increasing. The operational leverage is equal to one when there are no fixed costs.
The frame around Figure 15 symbolizes that the Measure-rules are an informational object. In Figure 13 it can be seen that the Measure-rules are one of the informational outputs of the Plan-activity and that they are used as informational input in the Measure-activity.

In the Measure-activity the actual risk is measured according to the Measure-rules. The actual risk is used in the Check-activity to calculate the risk limit deviation ($RLD$) as percentage of the risk limit. The rules for calculating the percentage risk limit deviation ($RLD\%$) comes out of the Check-rules object.

$$RLD_{j,k}^{\%}(s_{t,i}) = \frac{RLD_{j,k}(s_{t,i}) - RiskLimit_{j,k}}{RiskLimit_{j,k}}$$  \hspace{1cm} (3)$$

The calculated percentage risk limit deviation is evaluated in the corrective as well as adaptive Act-activity according to the Act-rules. In Figure 16 the Control-function $[u(RLD_{j,k}^{\%}(s_{t,i}))]$ for the corrective actions is sketched. Depending on the size of the percentage deviations different corrective activities are proposed. The selection of the adequate activities depends on the relative deviation that is realized in the $s_{t,i}$-state.
If realized deviations cause doubt about the validity, i.e. the effectiveness of the single loop risk management system, then the double loop learning mechanism gets invoked and the adaptive Act-activities that are defined in the adapting Act-rules are executed. Examples of adapting activities are the re-calibrations or the re-constructions of the risk models used as risk measures. It is important to recognize that in social systems not only the agents but also the risk models have life cycles. This requires a permanent cybernetic model life cycle management which is an important aspect in the double loop learning mechanism.

In Figure 13 there are three Supervision-activities that serve different purposes. The control related monitoring activity implements an enforcement rule in the sense of Arrow. It exists to ensure that the implemented double loop risk management process is performed as intended by the different agents engaged in the cybernetic risk management system. This activity is exactly what in the COSO-Cube (Figure 5) is called control activity.

The Supervision-activity monitoring the overall risk management system is usually performed periodically and it is concerned with the validity of the entire risk management system. For this purpose the usefulness of the cybernetic management framework can be seen as it gives clear and systematic directions for detecting the deficiencies of the implemented risk management system. In the search for deficiencies all activities and related information flows specified in Figure 13 are possible candidates.
5 Risk Management Integration into Business MGT Processes

Enterprise risk management is different from the perspective of some observers who view it as something added on to an entity’s activities. That is not to say effective enterprise risk management does not require incremental effort, as it may. In considering credit and currency risks, for example, incremental effort may be required to develop needed models and make necessary analyses and calculations. However, these enterprise risk management mechanisms are intertwined with an entity’s operating activities and exist for fundamental business reasons. Enterprise risk management is most effective when these mechanisms are built into the entity’s infrastructure and are part of the essence of the enterprise. By building in enterprise risk management, an entity can directly affect its ability to implement its strategy and achieve its mission. [COSO2–04, p. 17].

The central idea of the COSO-enterprise risk management framework is to intertwine business management and risk management. At the first glance it is not easy to imagine how this could be done. Risk management is a rather young research discipline. It heavily rests on mathematics and is therefore quite different from the qualitative business management research. The integration starts by considering the objectives pursued in the business management process and combining the objectives with the risk definition given in the COSO-enterprise risk management framework. Accordingly, risk is defined as follows: Risk is the possibility that an event will occur and adversely affect the achievement of objectives. [COSO2–04, p. 16]. In this sense risk management is engaged in managing the probability as well as the impact of the occurrence of events with negative effects on the objectives. Risk management therefore increases the probability that the objectives set in the Plan-activity get actually realized. Thus risk management has the same purpose as performance management which is established to ensure the realization of the objectives set in the Plan-activity. The combination of business and risk management is therefore synonymous to business performance management.

The essential concepts of business performance management are the information revelation principle and the plan progress check concept. In order to ensure the realization of the objectives set over the planning horizon there must be possibilities to detect deviations of the objectives in an early stage and to take correcting actions already before the final result is realized. To this end the planning horizon is broken down into sub-periods. After each sub-period
the sub-periodic results are measured and estimations for the remaining sub-periods are made. In the Check-activity it is judged if the objectives set for the planning horizon can be reached conditional on the prevailing sub-periodic results and the estimations based upon them. If there are substantial deviations corrective actions are taken in the Act-activity according to the Act-rules to bring the anticipated performance in line with the planning horizon related objectives.

**Figure 17:** Cybernetic Sales MGT Process – Supervised Closed Double Loop MGT

In Figure 17 the cybernetic sales management process is modeled in form of the MGT-Activity-diagram for the supervised closed double loop management process variant. The Objective set in the Plan-activity is the volume of...
the planned sales over the planning horizon \( Sales^{Plan}_{j} \). In each sub-period the realized returns are measured and conditional upon this information the conditional forecasts for the sales over the planning horizon are calculated.

\[
E[\tilde{Sales}_{j} | s_{t,i}] = \sum_{Q=t} \sum_{s_{t,i}} Sales_{j,Q} + \sum_{Q=t} E[\tilde{Sales}_{j,Q} | s_{t,i}] 
\]

(4)

The conditional forecast \( E[Sales_{j} | s_{t,i}] \) is defined according to the stochastic pillar of the cybernetic management framework as a conditional expectation. In equation (4) the conditionality of the forecast is indicated by the vertical line and the following state \( s_{t,i} \), which represents the realized sales information. The conditional forecast consists out of the accumulated actual sales over the realized sub-periods up to the \( s_{t,i} \)-state (accumulated actual) and the expected future sales for the remaining sub-periods conditional on the realized \( s_{t,i} \)-state (need to complete). The meaning of the two different time indices, i.e. \( t \) and \( Q \) relates – as is shown in Figure 18 – to the different time points and the different time periods between the time points.

\[
\begin{array}{cccc}
\text{Q1} & \text{Q2} & \text{Q3} & \text{Q4} \\
\text{t0} & \text{t1} & \text{t2} & \text{t3} \\
\end{array}
\]

Figure 18: Relationship between Time Indices – Time Points vs. Time Periods

In the Check-activity the plan/forecast deviation (PFD) is calculated out of the difference between the planned sales volume over the planning horizon and the conditional sales forecast which relates to the same time horizon.

\[
PFD(s_{t,i}) = Sales^{Plan}_{j} - E[\tilde{Sales}_{j} | s_{t,i}] 
\]

(5)

The conditional forecast is a feedforward information as it includes also future sub-periods that still have to be realized until the end of the planning horizon. Consequently the corrective actions selected in the Act-activity are proactive.
Proactive activities allow to take correcting actions to future related deviations and thereby enhancing the probability that the objectives over the planning horizon are realized at the end. The proactive actions are distinct from the reactive activities which result out of comparing plan values with realized actual values.

The cybernetic sales management process in Figure 17 is modeled as a *supervised proactive closed double loop management process*. In this case the *feedforward information* is also used in the double loop learning mechanism which feeds the information related to the excessive plan/forecast deviation back to the Plan-activity. This allows the adjustment of the Objectives, the Do-rules, the Control-rules, the Measure-rules and the Plan-rules before the planning horizon is over. This possibility if used correctly can further enhance the probability of realizing the objectives set over the planning horizon. The final risk management facility consists out of the Supervision-activity that prevents or reduces the probability or the impact of potential negative effects caused by the human agents who do not comply to the rules due to pursuing their self-interests.

The cybernetic management framework designed for the operational sales management process can also be used for financial business performance management purposes. In this case financial performance measures are used in the *supervised proactive closed double loop management process*. In equation (6) e.g. a generic definition of a *risk adjusted performance measure* is taken. This *residual income* ($RI_j$) which relates to the $j$-th business is calculated by subtracting the financing costs and the risk costs from the operating profits.

$$RI = OperatingProfits - FinancingCosts - RiskCosts$$ \hspace{1cm} (6)

To establish a proactive closed loop mechanism the revelation principle and the plan progress check concept have to be integrated again. These requirements are fulfilled by introducing sub-periods, by defining a feedforward informational forecast and by making sub-periodical plan/forecast checks which allow proactive Act-activities. The feedforward informational forecast is defined in equation (7) as the $s_{t,i}$-state conditional expectation for the residual income over the planning horizon consisting out of the accumulated residual incomes up to the $s_{t,i}$-state (accumulated actual) and the $s_{t,i}$-conditional expected value of the future sub-periodic residual incomes (need to complete).
The stochastic pillar of the cybernetic management framework can be used in the Check-activity not only to define plan/forecast deviation measures as shown for the sales management process in equation (5). The stochastic framework allows also the definition of risk adjusted plan/forecast deviation measures where the plan/forecast deviations are normalized by the uncertainty which is connected to the conditional forecast.

\[
E[\tilde{RI}_j \mid s_{t,i}] = \sum_{Q<\ell} RI_{j,Q} + \sum_{Q>\ell} E[\tilde{RI}_{j,Q} \mid s_{t,i}] 
\]

(7)

In equation (8) the risk adjusted plan/forecast deviation measure is derived by dividing the difference of the planned residual income over the planning horizon \(RI_{j,\text{Plan}}\) and the conditional residual income forecast \(E[RI_{j,\mid s_{t,i}}]\) by the \(s_{t,i}\)-state conditional uncertainty measure. In equation (9) the uncertainty measure is defined as the standard deviation (SD). In this specification the \(s_{t,i}\)-conditional uncertainty measure relates to the future sub-periods until the end of the planning horizon. Under the assumption of stochastic independence of the sub-periods the conditional uncertainty is defined as the square root out of the product of the sub-periodic variances.

\[
PFD_{RA}(s_{t,i}) = \frac{RI_{j,\text{Plan}} - E[\tilde{RI}_j \mid s_{t,i}]}{\text{Uncertainty}_{j}(s_{t,i})} 
\]

(8)

\[
\text{Uncertainty}_{j}(s_{t,i}) = \sqrt{\sum_{Q>\ell} SD[\tilde{RI}_{j,Q} \mid s_{t,i}]^2} 
\]

(9)

By using the risk adjusted plan/forecast deviation measure in the Check-rules the financial business performance management takes the uncertainty in the conditional forecast explicitly into account. This has the advantage that statistical significant plan/forecast deviations can be detected and correspondingly treated in the Act-rules. This advantage is not limited to the financial performance management but it can be applied to the operational performance management as well. The other way round it is to say that the supervised proactive closed double loop management process modeled in Figure 17 for the operational performance management is also suitable for the financial performance management. The risk management facilities imbedded in such processes in
form of the double loop adjustment possibilities and the supervisory controls are eminent in any such cybernetic management process.

6 Risk Management Integration into Strategic MGT Processes

At the enterprise level a broad and strategic view is prevailing. The broad scope consists out of considering the different business units over their life cycles and in a portfolio context. Consequently the enterprise management system extends the business management systems – as is shown in Figure 19 – by incorporating the planning, control and operating systems of all business units in the enterprise.

![Figure 19: Enterprise Management System – Sub-Systems (Portfolio View)](image)

The enterprise is a portfolio consisting out of business units which are modeled as investment centers. The portfolio theory originated by Markowitz [Mark52] is not adequate any more as the portfolio elements in form of the investment centers are not market tradable assets and a myopic one-period model framing is not sufficient due to the life cycle consideration at the enterprise level.

In the enterprise portfolio framework the enterprise value can be calculated as the sum of the present values of the periodic profits of the different business units.
units over their individual life cycles. The calculation of the enterprise risk is much more demanding as special characteristics have to be taken into account that are missing in the framework of Markowitz. The enterprise risk is based on a cross sectional and longitudinal aggregation of the risks related to the different business units in the different periods. Equation (10) contains this aggregation which requires four summation terms to take all interactions between the different risk components into account. Due to the different time periods involved an additional time weighting $w_{j,b,y,y'}$ has to be included to take the time value related to future periods into account.

\begin{equation}
EnterpriseRisk(s_{t,i}) = \sqrt{\sum_j \sum_y \sum_{j'} \sum_{y'} BR_{j,y}(s_{t,i}) \cdot \rho_{j,j',y,y'}(s_{t,i}) \cdot BR_{j',y'}(s_{t,i}) \cdot w_{j,j',y,y'}(s_{t,i})}
\end{equation}

(10)

The calculation of the enterprise risk corresponds to the second stage of a hierarchical risk aggregation. In the first stage the risks of the business units are aggregated cross sectional as demonstrated in equation (11). There the individual risks $LGE_{j,k,j}$ of the $k$ different risk factors within the $j$-th business unit are aggregated via the covariance approach for a one year horizon.

\begin{equation}
BR_{j,y}(s_{t,i}) = \sqrt{\sum_k \sum_{k'} LGE_{j,k,y}(s_{t,i}) \cdot \rho_{k,k',y}(s_{t,i}) \cdot LGE_{j,k',y}(s_{t,i})}
\end{equation}

(11)

The hierarchical structure from the individual risks of the business units to the enterprise risk can be seen by substituting the definition of the business risks in equation (11) into the definition of the enterprise risk given in equation (10). The calculation of the enterprise risk and the allocation of the different diversification effects is an open question in the financial enterprise management literature. Up to now only quite simple allocation principle are discussed in the literature. In Buch et al. [BDW11] a stochastic framework is proposed for modeling the enterprise risk but when it comes to the enterprise risk allocation a myopic approach in a stationary environment is specified.

In the financial enterprise management domain risks are explicitly modeled. This contrasts to the strategic enterprise management domain where risk considerations are integrated in the strategic management processes, i.e. in the strategy development, in the strategy execution and in the strategy control activities.
Strategy is the creation of a unique and valuable position, involving a set of different activities [Port96, p. 3]. Porter sees activities as the basic units of competitive advantage and he stresses the importance of not confusing strategy and operational effectiveness. Operational effectiveness is a necessary but not a sufficient condition for competitive advantages. Operational effectiveness and strategy are both essential to superior performance, which, after all, is the primary goal of any enterprise. But they work in very different ways. A company can outperform rivals only if it can establish a difference that it can preserve. It must deliver greater value to customers or create comparable value at a lower cost, or do both. The arithmetic of superior profitability then follows: delivering greater value allows a company to charge higher average unit prices; greater efficiency results in lower average unit costs. Ultimately, all differences between companies in cost or price derive from the hundreds of activities required to create, produce, sell, and deliver their products or services, such as calling on customers, assembling final products, and training employees. … Overall advantage or disadvantage results from all a company’s activities, not only a few. [Port96, p. 4–5].

In the context of the cybernetic management framework the operational effectiveness corresponds to the operational Do-rules that work effectively relative to objectives set in the Plan-activity. In Figure 20 the strategic planning process and its informational outputs in form of Do-, Measure-, Control- and Plan-rules as well as Objectives are shown. Operational effectiveness is reached if for the different (value chain) activities the correct rules are chosen in order to achieve the standards of performance set in the Plan-activity.

![Figure 20: Strategic MGT Planning – Strategic Planning and Control](image-url)
Kaplan and Norton [KaNo96] developed the *balanced scorecard framework* to highlight that not only financial performance measures should be used. The financial perspective is expanded by three additional non-financial perspectives, i.e. the customer, the internal business process and the learning and growth perspective. By analyzing different enterprises [KaNo96, S. 44] … we identify generic measures that show up in most organization's scorecards such as the following:

- **Financial Perspective:** Return on Investment and economic value-added
- **Customer Perspective:** Satisfaction, retention, market and account share
- **Internal Perspective:** Quality, response time, cost, and new product introduction
- **Learning and Growth:** Employee satisfaction and information system availability.

In the strategic Plan-activity the financial and non-financial performance measures as well as the corresponding standards of performance are set. In order to achieve these standards also adequate operational Do-rules are specified. In addition to that also proactive performance management activities are specified which serve as risk management facility as was shown in the last chapter. Risk management can also explicitly be integrated into the balanced scorecard by specifying the risk events that are related to the different performance objectives in the scorecard. In Figure 21 this extension is indicated by the three additional columns next to the objective column in each perspective. By using the *risk integrated balanced scorecard* in the Plan-activity the risk awareness and the related management activities are anchored in the *strategy execution framework* as well.

*Figure 21: Balanced Scorecard Strategy Execution – Risk Integration*
Kaplan and Norton see the balanced scorecard not as a static tool for translating strategy into action. They stress explicitly the importance of double loop learning where over time information that relates to the adequacy of the implemented strategies is generated and adaptively processed. The theory behind the top-down command-and-control model is that the captain of the ship (the CEO) determines the direction and speed of the ship (the business unit). The sailors (the managers and front-line employees) carry out the orders and implement the plan determined by the captain. Operational and management control systems are established to ensure that the managers and employees act in accordance with the strategic plan established by senior executives. …

The strategies for information age organizations, however, cannot be this linear or this stable. Today's information age organizations operate in more turbulent environments, and senior managers need to receive feedback about more complicated strategies. The planned strategy, though initiated with the best of intention and with the best available information and knowledge, may no longer be appropriate or valid for contemporary conditions. The metaphor is closer to that of a sailing in a highly competitive race, under changing weather and sea conditions, to a destination. In a sailboat race, a chain of command still exists. But the captain is constantly monitoring the environment, being highly sensitive and often responding tactically and strategically to shifts in competitor's behavior, team and boat capabilities, wind conditions, and water current. …

Organizations need the capacity for double-loop learning. Double-loop learning occurs when managers question their underlying assumptions and reflect on whether the theory under which they were operating remains consistent with current evidence, observations, and experience. Of course, managers need feedback about whether their planned strategy is being executed according to plan – the single-loop learning process. But even more important, they need to feedback about whether the planned strategy remains a viable and successful strategy – the double-loop learning process. Managers need information so that they can question whether the fundamental assumptions made when they launched the strategy are valid. [KaNo96, p. 16–17].

The double loop learning mechanism related to the strategy control framework has one peculiarity that distinguishes it qualitatively from the double loop learning mechanism applied in the performance management process. The peculiarity relates to the special content of the information that is used in the learning mechanism at the strategic level. The information is not related to the performance of the operational processes but it is concerned with the business
environment. The relevant business environmental information is measured by state dependent indicators for the actual competitiveness in the different markets the enterprise is engaged in with its business units. This proactive strategic information is evaluated mainly in the adaptive Act-activities of the double loop mechanism to derive the control inputs for adjusting the strategically set objectives and operational as well as managerial rules.

**Figure 22:** Cybernetic Strategic MGT Process – Supervised Open Double Loop MGT

In Figure 22 such a cybernetic strategic management process is modeled in form of the MGT-Activity-diagram. In this diagram the State Variable informational object is filled with two strategic indicators, i.e. the attractiveness of the market $MA(s_{t,i})$ in which the business units are operating and the competitive advan-
tages $CA(s_{t,i})$ that the business units possess. Both measures are state dependent what is indicated in the parenthesis of the abbreviations of both indicators. Due to the state dependency the concrete values of both indicators change stochastically over time according to the realization of the variables that are used to define the two indicators. The information generated successively by the two indicators is of proactive nature and it is used in the double loop mechanism to adapt the current strategic positioning of the business units if they are in the light of the new information not adequate any more.

**Figure 23:** Strategic Portfolio Model – Attractiveness/Competitive Advantage-Matrix

In Figure 23 the market attractiveness indicator is specified according to *Porter’s Five Forces model* [Port79, p. 3] where five forces are specified that govern the competition in an industry, i.e. the positions among current competitors, threads of new entrants, bargaining power of customers, bargaining power of suppliers and threat of substitute products or services. In the competitive advantage indicator the competition in the market measured with the five forces is analyzed with the SWOT model where strengths, weaknesses, opportunities and threats are specified by contrasting the internal capabilities in the business units with the external forces of competition.

In this attractiveness/competitive advantage-matrix the strategic positioning of all business units are analyzed. The strategy development process starts by the current positions of the business units from where their strategic developments are determined. *Whatever their collective strength, the corporate strate-
gist’s goal is to find a position in the industry where his or her company can best defend itself against these forces or can influence them in its favor [Port79, p. 3]. Connected to the determined positioning is the targeted strategy that is translated into action by using the (risk-based) balanced scorecard. The same procedure is typically repeated every year when the strategic indicators are evaluated in the light of the newly revealed information.

7 Conclusion and Outlook

In this article the problem of integrating risk management into the enterprise management was addressed. To solve this problem the cybernetic management framework which is an interdisciplinary framework combining cybernetics, economics and stochastics was applied to three different contexts. In the risk management context a closed double loop management process was presented to model a risk limiting system as a separate management system. To integrate the risk management and the business management the cybernetic management framework was designed as a proactive closed double loop management process. This management process variant corresponds to the business performance management where the achievement of the objectives is ensured by the proactive control system which uses feedforward information. For the strategic enterprise management the cybernetic management framework was finally designed as a proactive open double loop management process. In the open loop mechanism strategic indicators are used as state variables that guide the strategic positioning of the business units over time. In the cybernetic strategic management process risk considerations were integrated in the two strategic indicators, namely market attractiveness and competitive advantage. These indicators provide important information on eroding strategic developments that are counter acted by a strategically re-positioning of the business units. In the strategy execution process risk considerations are integrated by using the risk-based balanced scorecard in translating strategy into actions.

The cybernetic management framework provides a conceptually simple and good understandable methodology that can be used by the different responsible to derive adequate management processes in many different management domains. But the framework is not restricted to the problem of designing new management systems. The cybernetic management framework is
also suitable for testing the effectiveness of existing risk management systems as is required by different legal requirements (e.g. IFRS and audits directive). Due to the strict process orientation in the MGT-Activity-diagram that is used in the framework for the process modeling a solid benchmark for the managerial activities and the related informational flows within each specific risk management system is provided. This benchmark can be used to detect shortcomings in existing management systems, e.g. by testing the completeness of the managerial activities and related information flows, by testing if all managerial activities are assigned to responsible entities and by testing if the managerial activities are really used in the daily activities (use tests).

The cybernetic management framework is characterized by a strict process and object orientation. Both orientations are combined in the MGT-Activity-diagram. The cybernetic management framework is thus a tool for translating management into action. Furthermore this modeling framework is also beneficial for designing enterprise-wide management information systems. By the explicit specification of the operational as well as the managerial activities and the information needed in the different activities concrete process models and data models can be constructed out of the MGT-Activity-diagram. The stochastic foundation in form of filtered probability spaces and stochastic processes allows the explicit inclusion of uncertainty and information revelation in the process and data models. The resulting enterprise-wide management information system thus follows clearly the IS design principle “IT follows business and enterprise management”. Using the object oriented programming standard the information system can directly be implemented in a modern information technology. At the Institute of Management Sciences (Vienna University of Technology) the cybernetic management framework is used to design and implement a modern version of an Enterprise Resource Planning (ERP) system. The prototypical implementation of the enterprise-wide management system – called ERP-CONTROL [IMS11] – contains business processes and management processes and therefore integrates ERP functionalities and business performance management (BPM) functionalities. The integration of ERP and BPM functionalities is also a quite expensive and difficult venture for ERP and business intelligence providers. In the year 2008 the market leading providers of ERP systems expanded their businesses by buying business intelligence providers. The market leader SAP bought e.g. Business Objects for USD 4.9 bn. and increased thereby its balance sheet assets by 1/3.
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