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Integrated use of scenario planning and strategic early warning systems to support product engineering processes

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Abstract
In this paper the application of scenario planning and strategic early warning systems is analyzed in the context of product engineering processes (PEP). A review of current literature shows different approaches for the support of certain PEP activities. However, a lack but also a demand for an integrated, overall approach to support PEP is identified. Based on a descriptive case study in four medium sized companies we propose a first prescriptive model for an integrated approach in PEP. The validation of this model is subject to further research and not part of this paper.
Keywords: scenario planning; strategic early warning systems; product engineering process.

Introduction
Due to the economic and financial crises many companies have recognized the growing number of failed prognoses. In particular, companies face two challenges: On the one hand predictions of future developments are less accurate and planning premises less stable over time than they used to be 10 or 20 years ago [1]. Thus, companies need to account for possible changes at a planning stage. On the other hand, if relevant changes in market and business environment occur, they need to be discovered [1]. Hence, there has to be a constant monitoring for change.
There is a growing body of literature in the context of business sciences that deals with strategies to cope with these challenges. In particular, two methods are proposed: Scenario planning (SP), concerning the former; and strategic early warning systems (SEWS), concerning the latter challenge. Companies need to consider these challenges in product engineering processes (PEP), rather than only in overall business strategy [2]. However, the application of these methods in PEP is relatively new and often limited to certain PEP activities. Furthermore, there is little or no interchange between these methods, although there is a strong indication in current literature that a combination of these methods might increase their overall effectiveness.
In this paper we focus on three questions concerning the application of SP and SEWS in PEP: First, which, and second, how activities of PEP can be supported by a combination of these methods. Third, how these methods can be combined and integrated in PEP.
The paper starts by discussing the relevance of foresight information about markets and business environments for PEP. Second, a literature overview over SP and SEWS approaches for different PEP activities is presented. Furthermore, current approaches on how to link SP

and SEWS are discussed. After the definition of the research gap and description of the research strategy, the descriptive case study is presented. Building on the case study data, a first prescriptive model for an integrated approach for supporting PEP activities with SP and SEWS is proposed. The paper closes with remarks on validation of this model and further research.

Background: Market and environment foresight information in PEP

Application in individual activities of product engineering processes

A product engineering process - as defined by ALBERS - is a series of structured recurring *activities* needed to solve the overall problem [3]. In contrast to phases, activities have no pre-specified timing in the product engineering process. These activities describe a structural concept of product engineering and correspond to the product life cycle. Each activity is a problem area in which a certain type of information has to be collected or elaborated. According to this definition a product engineering process consists of ten activities listed in *Table 1* [3]. The following research is based on these activities that have a different demand for foresight information on market and environment. Furthermore, these activities cover the product life cycle and will hereby allow the identification of life cycle specific foresight demand.

Table 1: 10 activities of PEP [3]

1	Project planning and controlling (e.g.): continuous target/actual comparison; planning, controlling	6	Production system engineering: development of the operation system for production
2	Profile detection: detection of a product profile which describes a market gap for the product	7	Production: production of the developed product
3	Idea detection: detection of first ideas for products on basis of a product profile	8	Market launch: sub-activities related to product launch, e.g. distribution network or marketing
4	Modeling of principle solution and embodiment: realization of product ideas	9	Analysis of utilization: pre-thinking and validating the use of a product
5	Validation: central activity of product engineering; continuously executed to validate results	10	Analysis of decommission: analysis of recycling and final disposal

Integration of market and environment foresight information

Based on systems theory, product engineering can be described as the continuous interaction of three system elements: the system of objectives, the operation system and the system of objects [4]. The goal of product engineering is the transformation of a system of objectives into a concrete system of objects by an operation system [3]. System of objectives and system of objects hereby evolve from an initially vague state. Foresight information about customers, markets and company environment is needed in the creation of system of objectives. *Figure 2* shows how this information affects product engineering. A common approach is to use this information to create requirements for the system of objects capturing the future needs of customers, markets and environment (cp. [6, 7]). More recent approaches use foresight information to identify boundary conditions or constraints to

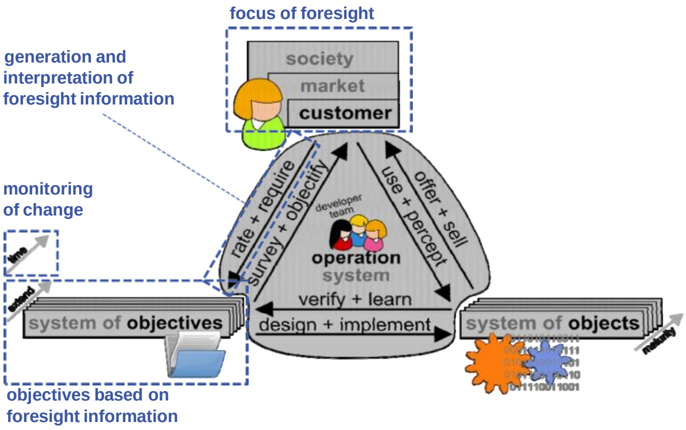

Figure 1: foresight information in the IPEK scheme of product engineering, based on [5]

set a frame for objective generation [8, 9]. However, requirements and boundary conditions might change over time [8, 10]. Thus, the time dynamic of this information needs to be considered and a continuous monitoring is needed.

State of the art in scenario planning and activities of PEP

Basics of scenario planning

Scenario technique was first transferred from military application into a business science context by Wiener and Kahn [11]. Scenarios differ from the analysis of trends in two points of view [12]: First, scenario technique is based on the idea that the future can hardly be foreseen due to high uncertainties in markets as well as technological developments. Thus, scenarios account for different possible developments of the future *(future open thinking)*. Second, companies operate in a complex environment. Hence, scenario technique considers multiple factors and their interdependencies *(networked thinking)*. When scenario technique is integrated in planning processes or activities, it is referred to as scenario planning (SP) [13].
Scenario technique approaches differ in methods used for scenario building and follow specific purposes [14]. Bishop et al. for instance identify 8 categories of techniques for scenario building with additional 23 variations [15]. The main difference, however, is whether the scenario building is done inductively or deductively and whether scenarios include probabilities or not [13]. Apart from differences concerning the scenario building, different types of scenarios can be distinguished [16]: environment scenarios describe a possible future in which a company operates with a set of factors that cannot be influenced by the company. On the contrary, strategy scenarios describe options that can be influenced by a company, such as product or strategy decisions (not in the focus of this paper). Furthermore, scenarios can have different topics, e.g. market, technology or a combination of both (mixed scenarios).

Support of PEP activities - a literature review

Table 2 gives a brief overview over existing approaches of SP for PEP activities. The objective of this overview is to lay out which and how PEP activities are supported by existing SP approaches described in literature.
The current literature on SP focuses on four activities in PEP: *profile detection*, *idea detection*, *modeling principle solution and embodiment* and *production system engineering*. The majority of approaches are designed to be used at an early stage and mostly refer to *profile detection*. But SP can also be used at a later stage for more concrete problems, like deriving objectives for a concrete product or a production system. However, all approaches support a planning problem that faces uncertainties concerning the development of the company environment. Furthermore, all approaches use market scenarios or a combined form of market and technology scenarios. Although activities in PEP are interdependent most approaches focus on one activity.

Table 2: Support of PEP activities by SP approaches

Profile detection	A) Approaches supporting the overall innovation process, e.g. to evaluate a portfolio of future product profiles [17] or to plan and control an innovation strategy [18]. Objective (mainly): validate product profiles / find direction for the overall innovation process. B) Approaches explicitly dealing with a PEP. SP is e.g. used to derive a product profile for a PEP by analyzing future markets [19, 20]. Objective: validate existing / generate new product profiles.
Idea detect.	Approaches are mostly used after a product profile has been detected, e.g. deriving customer requirements with QFD [7]. Objective: identifying concrete objectives related to a product idea [21]. Distinction between approaches supporting *profile detection* and *idea detection* is not always clear: former might also generate first ideas [19] and latter can also be used to validate product profiles to some extend [21].
Modeling of principle solution and embodiment	Only few approaches. Example: planning of the sequence of function deployment using scenarios [22]. Here, SP is used to support the robustness of this activity by sequencing those functions first that are most likely to be needed in all scenarios.

Production system engineering	Only few approaches. Objective: account for possible changes that a production system might face in the future at a planning stage or validate its robustness concerning future developments [23, 24]

State of the art in strategic early warning systems and activities of PEP

Basics of strategic early warning systems

The main function of SEWS is to identify relevant changes in a company's environment, which can be defined as the relevant physical and social factors within and beyond the organization's boundary [25]. The objective of SEWS is to enable companies to react upon chances or risks arising from these changes in time [26]. Three generations or types of early warning systems can be distinguished [27, 28]: The first generation (also called *forecasting*) is based on past data, e.g. from financial reporting or technological developments. This information is forecasted and used to derive early warning metrics. The second generation is based on leading indicators, also called early warning indicators. Early warning indicators are supposed to indicate changes in the environment at an early stage. The challenge for indicator-based early warning systems is to identify the right indicators to monitor. The third generation - also called *strategic* early warning - follows ANSOFF'S weak signal concept [29] to identify discontinuities in the environment [30]. While the first two generations are narrowed down to the monitoring of factors and the logic of *known* change, SEWS also scan for *unknown* change in the environment. An SEWS is not necessary limited to one generation. There are several approaches combining in particular generation two and three, which can be regarded as complementary [31]. Here, we understand SEWS as an overall concept of all three generations of early warning systems.

Support of PEP activities - a literature review

Table 3 gives a brief overview over the roles of existing SEWS approaches in supporting PEP activities. The objective is to lay out which and how PEP activities are supported by SEWS. Three roles can be distinguished: as strategic tool, as source of impulses and as tool for continuous validation on premises. These roles are quite distinct and support a wide range of PEP activities. While the fist two roles focus on scanning of the environment, the third role is mainly based on monitoring. Most approaches of SEWS in a PEP context are still focusing on technological foresight, but more and more integrated approaches arise. Although most approaches support several PEP activities, there is no approach dealing with the whole PEP.

Table 3: Roles of SEWS approches in supporting PEP activities

Profile detection	A) Role as strategic tool to identify new or upcoming business areas. Thus, new market segments or markets can be identified, that could lead to the definition of a product profile [32]. B) Role as source of impulses for profile detection, e.g. by identifying new customer requirements, relevant technological developments or screening activities of competitors. [32]. Most approaches focus on technological information [33], newer mostly use an integrated market and technological view [34]. Mostly third generation SEWS.
Idea detec.	SEWS also support *idea detection* in a similar ways like *profile detection* [32]. The information need differs only in the degree of detail and the clearer focus on a product profile within this activity.
Validation	Third role: Continuous validation (monitoring) of premises (e.g. boundary conditions, constraints) used in objective generation [32]. This validation supports all activities from *profile detection* till *market launch*, especially *production system engineering* [35], *production* [36] and *market launch* [35]. Objective: "warn" about upcoming changes affecting a PEP activity. At an early stage of a PEP this information might be used to update objectives. Later it is used to indicate market performance. Mostly generation 2 (but also 3) SEWS are used.
prod. sys. engineering, production, market l.	Support as described in *validation*. Here, this role is assigned to the activity *validation*, since it is a continuous validation of PEP premises.

State of the art in combining SP and SEWS

HERZHOFF identifies six possibilities of combining SP and SEWS that can be found in companies [37]: Integration of personnel, interchange of results of indicator/key factor identification, SEWS information as input for scenario development, SEWS information to validate scenarios, scenarios as basis for setting up SEWS, analysis of weak signals (from SEWS) with scenario analysis. However, empirical studies show that SP and SEWS are only rudimentarily integrated in practical application [37]. That is, there is no systematic integration of SP and SEWS.

Further potential for integration arises when SP and SEWS combined are used to support the same process, e.g. strategy, innovation or product engineering processes [38, 39]. Recent expert studies show that the integration of these methods in this context is seen as one of the key issues for future research with high relevance for companies [41]. That is, a better integration of SP and SEWS in a process context is not only assumed to increase efficiency, but rather to improve foresight effectiveness for the supported process. In conclusion there is still a great potential for integration of SP and SEWS (mainly in a process context), which has not yet been sufficiently analyzed [16, 38, 40].

Interim conclusion, research gap and research strategy

Foresight information created by SP and SEWS plays an important role in PEP. However, the current support of PEP by SP and SEWS is mainly based on approaches designed to support a certain activity or - in some cases - certain activities of a PEP. There is no overall approach for PEP support. Furthermore, there are little or no combinded approaches of SP and SEWS, especially when it comes to integration in the context of a PEP. At the same time there is a strong indication that an integration of SP and SEWS in a PEP might lead to a significantly more effective support with foresight information.

In this paper we adress this gap in the context of medium sized companies. We follow the research questions which and how activities of PEP can be supported by SP and SEWS and how a combination of these methods can be integrated in PEP.

We use a case study based approach to conduct a descriptive study and indentify possible support and ways of integration. Our goal is to construct a first prescriptive model as basis for a later validation. The validation is not part of this paper and subject to further research.

How to support PEP activities with SP and SEWS - a case study

Research design and case study

Our research design builds on the Design Research Methodology [42]. The research presented corresponds to Descriptive Study type I and partially Prescriptive Study.

Our results base on case studies in four German manufacturing companies. These have been selected for their ascending order in supply chain and therefore differentiated view on markets and business environment. All companies can be described as “medium-sized” with a sales volume between 80 - 600 m€ and between 800 - 6.000 employees. Within this range two companies are on the lower, two on the upper end.

The data gathering was done in several steps. First, interviews with experts have been conducted in each company to understand current foresight activities and to gather basic information (passive researcher role). Second, a scenario study has been carried out in each company. Third, an SEWS has been conceptualized. Steps two and three have been carried out in several workshops at each company (active researcher role). Apart from the primary results (scenarios, SEWS concept) also the process of creation has been analyzed.

Empirical investigation of Challenges and Requirements

The interview study revealed challenges and requirements for the application of SP and

SEWS in PEP. Here, the main results that were used to focus our research are summarized. Three main challenges were identified: (1) Difficulty of observing changes concerning end customers and markets, (2) short reaction time on changes, (3) mismatch of flexibility demand and information about changes. Additionally, the following requirements for application of SP and SEWS have been figured out: (1) the application needs to be "easy to use" and "easy to understand", (2) the focus should mainly be to improve mid-term planning, (3) an information advantage should be generated, (4) the application should not create information dependencies that network partners could use as leverage.

Support of PEP activities - case study results

On the basis of the identified challenges and requirements possible support of PEP activities by SP and SEWS have been identified. The following section summarizes the findings of our case studies. As stated before, these results base on a descriptive analysis and have not yet been tested.

Application of SP in PEP activities

Our case study data suggests that scenarios focusing on market, technologies, customer and environment developments - like described in literature - are well suited to support PEP. These scenarios should focus on the business segment of the PEP and capture its "business logic". This way an SEWS can be used to monitor this business logic. The set of identified key factors should include drivers of market size and of product variants. Also - if appropriate - customers and end customers should be distinguished. Furthermore the most important trends need to be included. The goal of these scenarios is to project possible developments of the business segment into the future. These scenarios can be used to support different PEP activities.

In *profile detection* and *idea detection* these scenarios have two functions. First, product profile and idea can be validated with these scenarios. That is, it is analyzed whether a product profile and idea "fit" into the future described by these scenarios. Second, these scenarios can be used during objective generation: Boundary conditions that are used to generate objectives for the system of objectives can be identified. Furthermore, the development of these boundary conditions can be analyzed.

In *production systems engineering* the production system for the PEP is planned. Since the strategic frame for a PEP is set earlier in profile detection, the goal here is to concretize this information for the planning of a production system. Therefore, information about demand quantities and volatility as well as product variants needs to be considered. This information should be derivable from these scenarios. Thus, scenarios need to include key drivers of market size and product variants.

Similarly *market launch* can be supported. In this activity there are - apart from the product itself - many decisions that influence the product success (e.g. distribution channels, marketing, packaging, shopping experience, …). Like in *production systems engineering* the goal here is to concretize general objectives for this activity. Scenarios in this activity are especially useful, if the company operates close to end customer markets.

Application of SEWS in PEP activities

Our case studies show two ways that SEWS can support PEP activities. First, analysis of weak signals to capture new developments concerning a PEP. These new developments might turn out to be disruptive in a sense that they change the current understanding of the "business logic" (3rd generation early warning system); second, indicators to monitor e.g. boundary conditions, key factors/trends or product performance (2nd generation early warning system). This information is used to identify in which direction the future is developing. Both are used

to update information that activities in PEP are based on. In our case studies we identify the following support of activities:
In *profile detection* and *idea detection* SEWS can be used to scan for new key factors and new relevant information concerning the PEP. Furthermore, an SEWS is adjusted (or set up) for a specific PEP in this activity. Once a product profile has been detected an SEWS can continuously validate its premises. Therefore, the product profile itself is a first source of possible indicators and search field for weak signals. Indicators derived from the product profile should capture the "business logic" behind the profile and contain drivers of market size and product variants. These indicators are especially useful in subsequent activities of a PEP to monitor relevant developments. Also, the most important boundary conditions used in objective generation should be monitored by the SEWS. The SEWS set up in *profile detection* supports the subsequent activities of a PEP in the following ways: In *modeling of principle solution and embodiment* and *production system engineering* information provided by an SEWS is used to update and validate the system of objectives. Thus, it might lead to a change in objectives and thereby - if necessary - also in the system of objects.
In the activity *production* an SEWS provides information about the product performance on markets. The goal is not to forecast quantities but rather to extend existing forecasting with a perspective on mid-term development. This information can be used to prepare production for upcoming developments that are not (yet) identified by forecasting tools.
Market launch benefits similarly from SEWS. In this case the view is broader. The needed information might e.g. contain specific information for customer segments or geographic areas. The support of *production* and *market launch* is - according to our case studies - the most important application of SEWS in PEP.
The SEWS itself is a continuous process in the activity *validation*.

Conclusions for building an integrated approach to support PEP

The results of our case studies suggest that there is indeed a broad demand for better integration of SEWS and SP in PEP. Furthermore, several starting points for integration are identified. Based on these results we propose the following first prescriptive model for integration of SEWS and SP in PEP (see *Figure 2*):

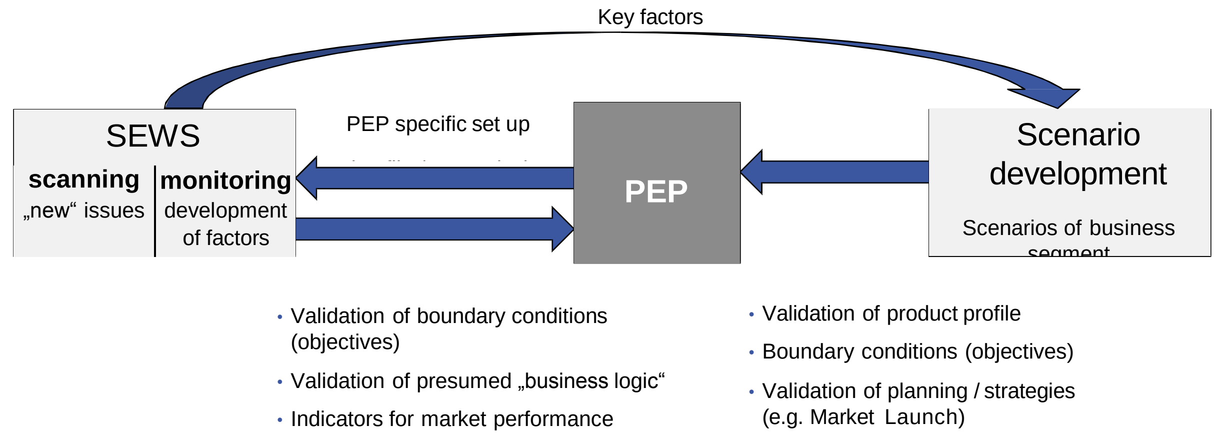

Figure 2: Integrated use of SEWS and SP in PEP

An SEWS should provide the information necessary for SP to set up scenarios for a PEP (key factors). In SP scenarios of the business segment should be developed. These are used to validate the product profile. Product profile and scenarios are the basis for adapting an SEWS to the information need of a certain PEP. The scenarios are further used at a planning stage in PEP activities, e.g. to identify boundary conditions or validate activity strategies. The SEWS provides information to validate objectives and presumed business logic (scanning for weak

signals) but also to indicate market performance (monitoring of indicators), e.g. for PEP activity *production*. To achieve a good integration of SEWS and SP scenarios should contain drivers of market size and product variants.
Overall we conclude that there is still substantial potential in research concerning the integrated application of SP and SEWS in PEP. We find a strong indication that an integrated approach can improve the information and decision support of different activities in a PEP more effectively and efficiently than isolated and specialized SP or SEWS solutions. This conclusion is in line with expert studies suggesting a high relevance of this topic for industrial practice.
Further research will be conducted concerning the detailing and improvement of the proposed first prescriptive model. Its validation will be carried out as next step of the research project VERTUMNUS.

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References

[1] Westkämper E. & Zahn E., *"Wandlungsfähige Produktionsunternehmen"*, Berlin, 2009
[2] Albers, A. & Gausemeier, J. *"Von der fachdisziplinorientierten zur vorausschauenden und systemorientierten Produktentstehung"*. In: Ruprecht, R. (ed), Produktion in Deutschland hat Zukunft, pp 248–256, 2010
[3] Albers, A. & Braun, A., *"A generalised framework to compass and to support complex product engineering processes"*, Int. J. of Product Development 15(1-3): 6-26, 2011
[4] Meboldt, M., *"Mentale und formale Modellbildung in der Produktentstehung",* Karlsruhe, 2008
[5] Albers, A., Geier, M. & Merkel, P., "Validation activities in the X-in-the-loop framework". In: VPV Vehicle Property Validation, Bad Nauheim, Germany, 2011
[6] Ehrlenspiel, K., *"Integrierte Produktentwicklung*", 3rd ed., München, 2007
[7] Eversheim, W. (ed), *"Innovation management for technical products",* 1st., New York
[8] Albers, A. & Muschik, S., *"Development of systems of objectives in early activities of product development processes"*. In: Horváth, I., Mandorli, F. & Rusák, Z. (eds) Proceedings of the TMCE 2010, Ancona, Italy
[9] Muschik, S., *"Development of Systems of Objectives in Early Product Engineering"*, Karlsruhe, 2011
[10] Maletz, M., Blouin, J., Schnedl, H., Brisson, D. & Zamazal, K., *"A Holistic Approach for Integrated Requirements Modeling in the Product Development Process"*. In: Krause, F. (ed), Proceedings of the 17th CIRP Design Conference. New York, pp 197–207, 2007
[11] Kahn, H. & Wiener A.J., *"The year 2000"*. London, 1967
[12] Fink, A. & Siebe, A., *"Handbuch Zukunftsmanagement"*, Frankfurt a.M., 2006
[13] Schoemaker, P.J., "Scenario planning", Sloan Management Review 36(2):25–40, 1995
[14] Durance, P. & Godet, M., *"Scenario building: Uses and abuses"*. Technological Forecasting & Social Change 77:1488–1492, 2010
[15] Bishop, P., Hines, A. & Collins, T. "The current state of scenario development". foresight 9:5–25, 2007
[16] Fink, A., Schlake, O. & Siebe, A., *"Erfolg durch Szenario-Management"*, Frankfurt a.M. 2001

[17] Möhrle, M.G., *"Szenariobasierte Zusammenstellung von Innovationsprogrammen"*, in: Möhrle, M.G. (ed), Der richtige Projekt-Mix, Berlin, pp 73–100, 1999
[18] Albrecht, R., "Szenariogesteuertes Innovationsmanagement", Hamburg, 1999
[19] Albers, A., Siebe, A., Oerding, J., Gegg, T. & Alink, T., *"Aus Marktumfeld-Szenarien systematisch Anforderungen für innovative Produkte generieren"*. In: Gausemeier, J. (ed) Vorausschau und Technologieplanung, Paderborn, 2009
[20] Braun, T.E., *"Methodische Unterstützung der strategischen Produktplanung in einem mittelständisch geprägten Umfeld"*, München, 2005
[21] Lindemann, U., *"Methodische Entwicklung technischer Produkte"*, 3rd edn., Berlin, Heidelberg, 2009
[22] Schuh, G., Lenders, M. & Bender, D., *"Szenariorobuste Produktarchitekturen"*. In: Gausemeier, J. (ed), Vorausschau und Technologieplanung, Paderborn, 2009
[23] Hernández Morales, R. *„Systematik der Wandlungsfähigkeit in der Fabrikplanung"*, Hannover, 2002
[24] Aldinger, L.A., *"Methode zur strategischen Leistungsplanung in wandlungfähigen Produktionsstrukturen des Mittelstandes"*, Stuttgart, 2009
[25] Duncan, R.B. *"Characteristics of organizational environment and perceived environmental uncertainty"*, Administrative science quarterly, 17(3):313–327, 1972
[26] Gomez, P., *"Frühwarnung in der Unternehmung"*, Bern 1983
[27] Mayer, J., Steinecke, N. & Quick, R., *"Improving the Applicability of Environmental Scanning Systems"*, in: Nüttgens, M., Gadatsch, A., Kautz, K., Schirmer, I., Blinn, N. (eds), Governance and Sustainability in IS, vol. 366. Boston, pp 207–223, 2011
[28] Simon, D., "Schwache Signale", Wien, 1986
[29] Ansoff, H.I. *"Managing Strategic Surprise by Response to Weak Signals"*, California Management Review 18(2):21–33, 1975
[30] Krystek U. & Müller-Stewens, G."Frühaufklärung für Unternehmen", Stuttgart, 1993 [31]
Müller, A.W. & Müller-Stewens, G., *"Strategic Foresight*", Stuttgart, 2009
[32] Rohrbeck, R. & Gemünden, H.G., *"Die Rolle der Strategischen Frühaufklärung im Innovationsmanagement"*, in: Himpel, F., Kaluza, B. & Wittmann, J. (eds), Spektrum des Produktions- und Innovationsmanagements, Gabler, pp 149–163, 2008
[33] Mieke, C., "Technologiefrühaufklärung in Netzwerken", Wiesbaden, 2006
[34] Rohrbeck, R. & Gemünden, H.G., *"Technologische und marktseitige Frühaufklärung in der frühen Phase des Innovationsprozesses"*, in: Mieke, C. & Behrens, S. (eds), Entwicklungen in Produktionswissenschaft und Technologieforschung, Berlin, 2009 [35]
Universität Stuttgart, "Wandlungsfähigkeit in der variantenreichen Serienfertigung", Stuttgart, 2008
[36] Spath, D., Gerlach, S., Scholtz, O., Hämmerle, M. & Krause, T., *"Early Alert Cockpits for Changeable Manufacturing Systems"*, In: ElMaraghy, H.A. (ed), Enabling manufacturing competitiveness and economic sustainability, Heidelberg, pp 68–73, 2011
[37] Herzhoff, M., *"Zum Zusammenspiel von Frühaufklärung und Szenariotechnik"*, in: Reimer, M. (ed), Perspektiven des strategischen Controllings, Wiesbaden, 2009 [38]
Fink, A., Siebe, A. & Kuhle, J., *"How scenarios support strategic early warning processes"*, foresight 6(3):173–185, 2004
[39] Jakob, M., Kiehne, D., Schwarz, H., Kaiser, F., Beucker, S., "Delphigestütztes Szenario-Management und -Monitoring", nova-net Werkstattreihe, Stuttgart, 2007
[40] Krystek, U. & Herzhoff, M., *"Szenario-Technik und Frühaufklärung: Anwendungsstand und Integrationspotenzial"*, Controlling & Management 50(5):305–310, 2006
[41] Schwarz, J.O., *"Assessing the future of futures studies in management"*, futures 40:237– 246, 2008
[42] Blessing, L. & Chakrabarti, A., "DRM, a Design Research Methodology", London, 2009