Next Generation Hardware Development:
Requirements and Configuration Options for the Organization
of Procurement Activities in the Context of Agile New Product Development

Günther Schuh, Stephan Schröder, Felix Lau, Tim Wetterney
Fraunhofer Institute for Production Technology IPT, Aachen, Germany

Abstract--Companies are adapting their traditional development processes, aiming for project-specific designs that are referred to as "Agile Product Development" – flexible, adaptive and accelerated processes. Implementing these principles supports developers to react to challenges such as shortened innovation cycles. For successful implementation and use of these new principles, support functions such as procurement have to be adapted to the demands of flexible, agile and accelerated processes. Complexity of tasks and impact on corporate success of procurement increased significantly in the last decades resulting in specialized stand-alone procurement departments. Being optimized for traditional development methods such as stage-gate, these departments will be challenged by agile developers demanding for highly flexible, hardly predictable procurement activities. Therefore, the authors present a scientifically derived catalog of requirements for procurement in agile product and technology development projects, e.g. shortened lead times and vague technical specification of products to be procured. Based on this catalog, options for the configuration of procurement in agile development projects, such as the organizational merging of development and procurement, are discussed. Adapting the procurement according to the requirements derived in this paper will help companies to successfully conduct procurement activities in regard to the needs of agile new product development.

I. INTRODUCTION

Companies are exposed to an increasing pressure to innovate in the last years, due to global competition and decreasing product life cycle times [17, 37]. Therefore companies are adapting their traditional development processes like e.g. the widely spread stage-gate-process to more flexible, adaptive and accelerated processes. By implementing these processes referred to as "Agile New Product Development" (ANPD), developers should be supported to react to the increasing challenges like shortened life-cycle-times in a better way.

On the other hand, in most companies the vertical range of manufacture decreased significantly in the last years leading to increasing complexity of supplied components and increasing challenges for procurement departments. Suppliers' contribution to the innovation performance increased in the same way. Thus, the importance and contribution of procurement for the success of NPD projects and for the innovativeness of the company intensified considerably.

In practice, this means that not only the efficient and punctual supply of parts, but also more strategic procurement activities become very important. A close cooperation and early integration of suppliers in the development process become crucial requirements for successful development projects and product innovations. But many procurement departments are still mostly occupied with operative procurement tasks, despite to the scientific discussions about the importance of strategic procurement activities in the last years and companies efforts to implement strategic procurement. Further many companies also still haven't implemented project procurement departments specialized on the procurement activities in the context of traditional development projects [29]. But even if specialized project procurement departments are implemented, their organization does not fit to the requirements of ANPD projects and thus an optimal support of these projects by procurement is not warranted.

From the theoretical perspective there is also a lack of research with regard to the organization and the methods of procurement within ANPD projects. As the agile movement has its origin in the software industry available research is focused on procurement within software development projects but not considering hardware development. Therefore, in this paper we derive the changing requirements on procurement by analyzing the characteristics of ANPD projects. Based on these requirements, we develop a first proposal for a set of configuration options of procurement activities within the context of ANPD projects. By doing so, we intend to generate a sensitization of manufacturing companies for the importance of this topic and give them a first guidance, while setting up ANPD projects and project procurement.

Section 2 of this paper describes the origin of agile development methods and discusses the differences between software and hardware development. Furthermore an overview on the current status of project procurement is given. Section 3 comprises the literature review of previous research, concerning the requirements on procurement activities within the context of agile development projects. In chapter 4 the characteristics of agile new product development projects are discussed. Based on these characteristics, requirements on procurement activities are derived. In a last step possible configuration options therefore are presented. The conclusion in chapter 5 completes the paper.

II. NEW PRODUCT DEVELOPMENT AND PROJECT PROCUREMENT

A. New Product Development

The successful development and launch of new technologies and products is an essential task for companies. But good ideas do not automatically result in workable, appealing products [1]. Moving new products from an idea to launch is a complex process and a significant number of products or projects fail on its way to market [25]. However, in many cases not the failure itself, but the late awareness is problematic, as valuable resources are wasted instead of using them for new promising ideas. Various different approaches for the management of new product development (NPD) projects exist in literature as well as in practice. As shown in a study from 2011, the use of a defined NPD-process is essential for the success of product developing companies[12]. One of the first NPD approaches was the BAH model, developed by BOOZ ET AL in 1982 [5]. The BAH model divides the NPD process in seven steps: *New Product Strategy, Idea Generation, Screening and Evaluation, Business Analysis, Design and Development, Testing* and *Commercialization*. Based on extensive surveys, in depth interviews and case studies, it underlies still most other NPD Systems that have been put forward [4]. The stage-gate process developed by COOPER [8] is today one of the most prevalent models, whether in its original form or in a specialized modification. The stage-gate model divides the NPD process in several phases. Every phase is followed by a gate, in which the results and the success of the previous phase is evaluated and a decision about the following proceeding in the project is made. In many cases one single and fixed process is not sufficient for a company anymore and successful practices are using different or variable processes, trying to react to the variable level of risk and complexity of different development projects[9]. A further approach for NPD is the Toyota Product Development System (TPDS) as it is described by MORGAN and LIKER, which is developed and used by the Toyota Motor Corporation [22]. Similar to the Toyota Production System (TPS) [24] the TPDS tries to realize lean processes by minimizing waste during the development process. Decisions in the development process are based on know-how and technical expertise and not on hierarchies, process structures or fixed procedures [19].

Due to decreasing cycles of innovation and increasing product complexity, existing NPD models are reaching their limits. They use sequential processes with few defined points of decision and are based on detailed predictive planning. Thus, they are assumed to be not adaptive and flexible enough as well as too controlling and bureaucratic for future challenges in NPD [2, 10, 21]. Hence, NPD processes and models are rethought or modified and new approaches developed. A promising approach to fulfill the demand for more flexibility, adaptivity and acceleration is the use of agile methods.

1. Agile Software Development

The principle of ANPD can be traced back to a 1986 Harvard Business Review Article by TAKEUCHI AND NONAKA [34], in which a new approach to all-at-once product development, that several successful companies were using, was presented [26]. The agile approach is a holistic and flexible method that is based on empowered, self-organizing teams as well as on daily face-to-face communication and validated learning by trying-out. The agile method was further developed in software engineering in the 1990's and in 2001, seventeen software developers proclaimed a set of underlying principles called the "agile manifesto". It is today among the most cited works on the topic of agile software development and consists of four values: (1) individuals and interactions over processes and tools, (2) working software over comprehensive documentation, (3) customer collaboration over contract negotiation and (4) responding to change over following a plan. These values should express that certain elements or approaches within NPD are preferable over others; however, it is important to notice that the less preferred elements are not refused generally.

The software industry is the origin of the agile development approach. Several different methods and processes have been developed there and are today widely used standard. Some examples for development approaches using the agile principles are Scrum[30, 31], Dynamic Systems Development Method (DSDM)[33], Crystal[16] or Extreme Programming[3]. The different process models can be differentiated by their level of abstraction. Especially Scrum and DSDM are, due to their high level of abstraction, not limited to the use in software development projects, but also suitable for any other development projects. For a successful implementation or use project teams with a high level of process experience are required [20].

2. Agile Hardware Development

The use of agile methods for hardware development has only developed in the most recent years and scientific literature is still scarce in contrast to software development. Despite this, manufacturing firms increasingly incorporate agile values into their traditional NPD processes, as they try to shorten lead time, reduce development costs and increase customer satisfaction. As will be elaborated subsequently, both research and practice show that adapting agile methods like scrum for hardware development, presents a challenging endeavor. The difficulties arise from a few immanent differences between software development (that is intangible) and hardware development (that is restraint by the physical nature of products). THOMPSON identifies the main differences between software and hardware development as shown in Table 1 [35]. He structures them in three major dimensions. First dimension is *Adaption, Development and Alteration*. The major differences between software and hardware development in this category refer to the adaptivity

TAB. 1: DIFFERENCES BETWEEN SOFTWARE AND HARDWARE DEVELOPMENT [35]

Dimension	Examples
Adaption, Development and Alteration	Software is more malleable (easier to change) than hardware
	Costs of change is much higher for hardware than for software
	Software products evolve through multiple releases by a process of accretion and refactoring, Hardware products consist largely of physical components that cannot be "refactored" after manufacturing, and cannot "accrete" new capabilities that require hardware changes
	Software development allows for more latitude in deciding what to develop than is the case for hardware. Upgraded versions of hardware products typically have less scope for major qualitative changes, and focus more on quantitative improvements of existing capabilities
	Hardware designs are constrained by the need to incorporate standard parts The design for a hardware product is driven in large part by architectural decisions. As the cost of change is high, more of the architectural work must be done up front compared to software products
Validation and evaluation period	Testing software commonly requires developing thousands of test cases; Hardware testing involves far fewer tests, but more specialized and expensive equipment
	Software testing is commonly done by, or defined by, specialized Quality Assurance engineers, while hardware testing is commonly done by the engineers who are creating the product
	Hardware must be designed and tested to work over a range of time (aging) and environmental conditions, which is not the case for software
Time-to-market, flexibility and delivery time	Specialized hardware components can have much longer lead times for acquisition than is true for software
	The cost of development for software products is relatively flat over time; the cost of hardware development rises rapidly towards the end of the development cycle for hardware products
	It is possible to make major changes in direction for a planned software-product upgrade in mid-development, without massive disruption and waste; make such changes in hardware development come at a much higher cost
	Hardware development incorporates synchronized projects; software development, the detailed design is the product, and production deployment consists of moving the product into a context where it can be used

of products. Software is easier to change and change costs are much lower than for hardware. Second dimension is *Validation and evaluation period*. While for software testing commonly thousands of test cases have to be developed, hardware testing requires much more expensive equipment. Another important difference is the necessity of testing the aging behavior of hardware products, while this is nonrelevant for software. The last mentioned dimension by THOMPSON is *Time-to-market, flexibility and delivery time*. Especially longer lead times for the procurement of specialized hardware components in contrast to the acquisition of software are important in this dimension. Furthermore in hardware projects it must be considered that the costs of massive changes in product specification during the project are much higher than for software. Plurality of resulting differences between hardware and software development emphasizes the need for the development of concrete methods and concepts for the use of agile methods within hardware development projects.

Due to the lack of concrete ANPD methods and less modification effort the adaption of existing stage-gate processes is a common approach for manufacturing firms to make their product development processes more agile. Thus, they become less plan-driven and rigid but instead more prone to adaption, iterations and probing. SOMMER ET AL.

outlined a "manufacturing scrum framework" that combines stage-gate NPD with scrum [32]. In this framework, the planning level of strategic project management (i.e. portfolio management and steering committees) is approached with stage-gate methods, whereas the project execution is done using scrum. While their study shows that a hybrid combination of agile and stage-gate processes can lead to significant performance increases in hardware NPD in a wide range of industries, this is only one of several possible approaches to change from traditional to ANPD methods. Similarly, COOPER proposes an adapted stage-gate process that incorporates elements of the agile manifesto [10]. In addition, his framework includes a contingency-based risk model, where projects with a low risk assessment undergo an agile fast-track stage-gate process with few gates whereas high-risk major projects undergo a more linear development process that resembles the traditional stage-gate approach [10].

B. Project Procurement

The importance of efficient and effective procurement for the success of producing companies increased significantly in the last years due to the decreasing vertical range of manufacture and increasing product complexity [28]. This implicated also an ample scientific discussion about the

optimal procurement strategy, the definition of the optimal procurement process as well as the organizational structure of procurement departments. In terms of NPD one of the key findings is the importance of a very early and intensive integration of the procurement department within the development process. On the one hand because the majority of the costs of a product are already defined in this early phase of a development project and the knowledge and experience of purchasers can help to decrease these costs significantly [28]. On the other hand, procurement departments are companies' interface to its suppliers and thus the know-how and information from procurement market research can be better integrated and used for the NPD process. Another important consequence of the decreasing vertical range or manufacture of producing companies is that the share and complexity of parts developed and produced completely by suppliers increased significantly in the last years

Thus the influence of suppliers on the innovation capabilities of companies increased in a similar way. To profit from suppliers' innovation potential an early integration of them in the development process and long-term development partnerships are the basis [27]. Furthermore the early integration of supplier in the NPD includes an significant potential for time and development cost reduction [29].

Procurement activities in (development) projects differ from those in serial production and thus the requirements and demands for purchasers differ as well. Activities and strategies to meet this special demand are summarized under the term *project procurement*. The way and intensity project procurement is implemented differs significantly between companies dependent on company size and structure of the normal procurement departments. A possible organizational structure to implement project procurement is the matrix organization shown in Fig. 1[36]. Specialized project purchasers are responsible for the procurement activities in one or more projects and are the key contact in the procurement department for other project members [28]. Commodity purchasers are responsible for the procurement activities of one or more commodities. Their objective is the bundling of order volumes for their respective commodity. In case of a matrix organization project purchasers coordinate the procurement activities of the project with different commodity purchasers and discuss the optimal solution with them. Thus an optimal support of the development project should be guaranteed without neglecting the overall goals of companies' procurement strategy [36].

III. LITERATURE REVIEW

GLOGER AND MARGETICH describe the challenges organizations have to struggle with when implementing the agile management philosophy Scrum for project management. In context of procurement activities they discuss the major challenges due to contrarian objectives of procurement and development team. Further they emphasize the problems due to less documentation and less detailed technical planning in Scrum projects. As a solution they propose especially a closer integration of purchasers into the development team [15]. As a guidebook for the implementation of the Scrum methodology in companies neither procurement is in focus of this work nor are other agile development methods considered.

JAMIESON ET AL discuss in their paper the need for an agile procurement in the context of an agile software development process. Thereby they focus especially on the contracting model for the sourcing of service providers for the development and programing of software. They develop an agile procurement method for the sourcing of software development services by harmonizing procurement and agile methodologies and validate their developed method by testing in a use case [18]. Focus of the paper is on software development. hardware development projects and the procurement of hardware components are not considered.
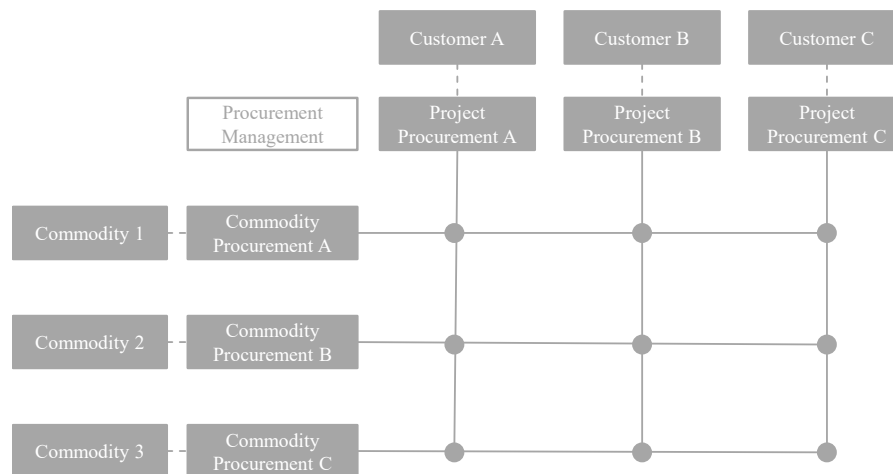

Fig. 1: Matrix organization of project and commodity procurement based on [36]

DIECKMANN AND FRÖHLICH discuss the need for more agility in procurement departments, due to the increasing requirements on purchasers. Thereby they focus especially on the requirement for more agility in the workforce of companies. Based on the use case of an insurance company and the conceptual model of agility they derive the development model of an agile workforce [11]. Producing companies and especially development project are not in the focus of this work.

CHRISTOPHER discusses the importance for supply chains to be reactive to today's volatile and unpredictable markets. Therefore, the author suggests the model of an agile supply chain, which consists in his perspective of the four aspects *market sensitivity, virtuality, process integration* and *networked based*. But the needs for agility presented in this work are more market based [6]. The focus in this paper is the organization of the total supply chain and not the cooperation between development and procurement.

As shown in the previous section, four exemplary research papers and books have been analyzed, demonstrating the lack of current research in the field of procurement within ANPD projects. Except the work of GLOGER AND MARGETICH, current research approaches lack a comprehensive consideration of the changing requirements on procurement due to the implementation of ANPD methods in companies. The purpose of this paper is to address this need for research and to analyze requirements of agile development methods on procurement and to propose first configuration options for the resulting challenges.

IV. PROCUREMENT ACTIVITIES IN THE CONTEXT OF AGILE NEW PRODUCT DEVELOPMENT

A. Characteristics of agile new product development projects

An essential requirement for the successful implementation of agile methods or approaches in NPD is to understand, that agility and related methods are not fixed processes but more an attitude and philosophy, representing the framework for the decisions and the acting of the team and the management [32] [15]. As development projects do not exist in a kind of vacuum, but are normally part of an existing company or organization [15] the implementation of agile methods in a company does not only affect the team member and the management of the development project, but also most other departments in line organization, which are interacting with the development team. Critical for the success of an ANPD project are furthermore a high density of communication and a high concentration and focusing of team members. Thus project members should be 100 percent dedicated to the project and based at the same bureau or location, which results in a high resource intensity of agile development methods [10]. Thereby all required qualifications and skills which are necessary for designing, building and testing of the product or technology have to be available in the cross-functional project team [13, 26].

As mentioned, the implementation of agile methods within NPD will change the way of developing and working in development projects fundamentally compared to old and familiar approaches like the stage-gate process. For a successful implementation of these methods and thus for successful development projects, meeting their time and cost targets, with highly innovative products, supporting processes have to be adapted to these changes. Procurement is responsible for the supply with required material and components in time and budget as well as it is the companies interface to suppliers [28]. Due to decreasing vertical range of manufacture procurement is one of the processes which are critical for the success of NPD projects.

Characteristics of ANPD and the resulting requirements on procurement activities are very versatile. To structure the different characteristic of ANPD projects and its requirements on procurement, they are classified in three different categories: *process*, *project team* and *product/technology* as it is shown in Fig. 2. The different aspects are not 100 % selective and partly influencing also one of the other two categories but are classified in that category they are influencing most.

1. Process

ANPD processes are agile, adaptive and flexible and especially accelerated [10]. Besides the shortened development times, one of the most important changes within ANPD projects is the development in iterative cycles, combined with a split of the development object in small, manageable increments [26]. Thus the project is divided in several very small development tasks, which can be realized within a short period of time. A further basic idea of the ANPD method is the early and iterative testing of the product or parts of it [10]. In terms of hardware this is mainly done by the use of physical and functional prototypes. The objective of these frequent testing is on the one hand a review of the current project progress and on the other hand a verification of the initial market assumptions [10]. Thus, besides testing the technical feasibility also the testing by potential customers and users is in focus.

2. Project Team

In contrast to todays commonly high share of indirect communication via e.g. email, in ANPD projects direct face-to-face communication is the preferred and leading form of communication [7]. Therefore all project members are centralized at one location and are ideally working in one room [13]. Thus a high communication density can be achieved. For the fostering of a climate of innovation in many cases the teams of agile development projects are furthermore strongly separated from the line organization by founding a spin-off or start-up or choosing a new innovative location outside of existing company locations [10].

	Process	Project team	Product/ Technology
Characteristics of ANPD projects	▪ High speed / shortened development times ▪ Iterative development cycles ▪ Split of product in small manageable increments for development ▪ Less detailed planning and less detailed specifications of product before the project ▪ Less documentation ▪ Early and frequent testing with functional (physical) prototypes ▪ Strong customer integration / pull innovation	▪ Strong centralization of project members (working in one room) ▪ Direct communication (face to face) is the leading communication form ▪ High communication density ▪ Cross-functional development teams ▪ Development projects / teams are more separated from line organization and daily business (incubators, spin-offs, new location)	▪ Frequent and more radical change in product requirements and specification possible ▪ More radical then incremental innovations ▪ Addressing new and unknown markets

Fig. 2: Characteristics of agile new product development projects

3. Product / Technology

Generic changes of the developed products or technologies due to the implementation of ANPD methods are less clear and much more depending on the individual case, but some tendencies can be derived. As a consequence of the iterative development cycles and the frequent test also frequent and more radical changes in the product specifications are possible. Furthermore, the overall objective of the implementation ANPD is to increase innovativeness and to enable more radical than incremental innovations [10]. Thereby also new and unknown markets should be addressed

B. Requirements on procurement in the context of agile new product development

Based on the presented characteristics of ANPD projects above, in this chapter the resulting requirements on procurement activities are derived. Similar to the characteristics, the requirements are structured into the categories *process*, *project team* and *product/technology* as it is shown in Fig. 3.

1. Process

As the implementation of ANPD is especially a change in the process of development projects, significant requirements on procurement activities are identified in this category. The shortened overall development times and the development in iterative cycles, combined with the mentioned incrementation of the development object, implies that lead and delivery times for required material and components have to decrease in the same way. Otherwise the procurement could become the bottleneck of the project, leading to a delay in the buildup of prototypes. Less detailed planning and specification of the product before and within the project courses increasing requirements on the technical capabilities of the purchasers, increasing risks for the procurement of wrong parts and thus not at least increasing responsibility of procurement for the success of the whole project [15]. Furthermore, the more frequent functional testing entails an increasing demand for sample parts for the buildup of prototypes at an early stage of

the project. In case of development orders this includes also the provision of functional component-prototypes by suppliers. Especially the last aspect is challenging procurement departments as many suppliers are not able or willing to provide such prototypes due to diverse reasons like warranty or safeguarding.

2. Project Team

As shown above, the project team, its composition and the way project members are working together will change significantly. For the procurement this implies several important requirements. Existing models or approaches for the support of development projects by corporate procurement are problematic, as working culture differs significantly and geographical distance could be a hurdle. Furthermore, the existing processes are not optimized for the use in ANPD projects and they are, especially in large companies, often to protracted and bureaucratic. Another major requirement on procurement in terms of the project team is the increasing demand for coordination between developers and purchasers. This includes also an increasing demand on purchasers for a deeper technical understanding of the development object and the current development status.

3. Product / Technology

Due to iterative development cycles and early testing of functional prototypes, frequent and more radical changes in product requirements and specifications may occur. Thus common procurement instruments like buying ahead [15] and the execution of framework contracts with suppliers, determining fixed purchase quantities, become less usable in the context of ANPD projects. The addressing of new and unknown markets may cause a high share of new suppliers as well as unknown components and materials which have to be procured. Depending on the innovativeness of the product it may also cause a high share of totally new and less tested technologies and components within the procurement volume. Both aspects are resulting in an appropriate high demand for procurement market research.

Process	Project team	Product/ Technology
• Shortened lead times / delivery times required • Increased responsibility of and requirements on procurement • Increased complexity / difficulty of procurements tasks • Increasing risk for procurement of wrong parts • Increasing demand on sample parts at an early stage of the project	• Support by corporate procurement departments difficult / not helpful • Existing processes not optimized or suitable for next generation hardware projects • Increasing demand for coordination between procurement and development • Increasing demand for involvement of procurement in technical development	• Buying ahead becoming problematic due to frequent change in required components • Framework contracts about fixed purchase quantities less helpful instrument • High share of new supplier and new components • Use of new and less tested technologies and components due to higher innovativeness

Fig. 3: Requirements on procurement activities due to implementation of ANPD methods

C. Configuration options for procurement in agile new product development projects

As shown and discussed above, the implementation of new methods within the NPD courses several challenges and new and changing requirements for procurement. As the research field of agile hardware development is still new and procurement activities have not been considered in detail within this context, the following presented configuration options are far from completeness and should not represent a sufficient solution to all mentioned problems and difficulties. But they are a first proposal for the reconfiguration of procurement activities within development projects and a starting point for further research in this field. Majority of the presented configuration options have been tested within the context of an ANPD project with the objective to develop a full electrical lightweight car for urban use.

According to the implications on procurement presented above, the different configuration options are also structured into the categories *process*, *organization* and *product/technology* as shown in Fig. 4. Most of the presented configuration options are referring to the category *process*. This does not imply that the category *process* necessarily has

the highest demand for changes, but is just resulting from the experiences made during the considered use case.

1. Process

Changes in the development process caused by the integration of next generation hardware development methods have especially a strong influence on the way how companies cooperate with their suppliers. For example, early discussions and plannings based on detailed target specification are not possible anymore. Thus an even more intensive integration of the supplier in the development process is necessary, including frequent meetings on-site [14]. Furthermore, new forms of cooperation between companies and their supplier are required, including e.g. new contract-models, which are less quantity driven and more oriented to a common development partnership. Further new and additional criteria for the selection and evaluation of suppliers are required as new qualities are becoming more important in the context of ANPD projects. Especially the agility of the supplier, its mind-set or culture and the experience with similar agile development projects should be considered. In the same way a local sourcing should be preferred instead of global sourcing, as the direct and

Process	Project team	Product/ Technology

• Preferred local sourcing instead of global sourcing
• New criteria in supplier evaluation (e.g. agility, mind-set, etc.)
• Early and intensive integration of suppliers in the development process
• New forms of cooperation with suppliers (e.g. new contract-models, less quantity driven)
• Disruptive-Network-Approach
  – Cooperation on eye-level / equal development partners
  – Collective derivation of specification
• Use of IT-tools and e-procurement solutions
	• Merging of procurement and product development within project
	  – Intensive integration of procurement in daily development process
	• New system of objectives / evaluation system for purchasers
		• Preferred use of at the market available technologies and components due to budget and especially time restrictions

Fig. 4: Possible configuration options for the adaptation of procurement to the needs of next generation hardware development

intensive exchange between both parties is extremely important for a good cooperation and a fast and flexible supply of components. A successful approach in this context is the so-called disruptive network approach, which has been tested within a further ANPD project of electric cars [23]. The idea of the disruptive network approach is the common development of a product with several companies, which are acting on eye-level, in contrast to the hierarchical supplier structure as you can find it for example in the automotive industry. Thus the approach should enable the maximal integration and use of the knowhow and expertise of the different partners [23]. Besides the equal acting of all partners the approach demands also a very early integration of suppliers in the development process. So, fundamental errors in the conceptual phase of the project can be prevented and product specification can be derived commonly, using the expertise of the supplier. To decrease the effort for operative procurement tasks within a project and to maximize the process speed, the intensive use of IT tools and e-procurement solutions is suggested. Especially in case of new founded spin-offs and incubators, the new set-up of the IT systems enable an easy and fast integration of these systems.

2. Project Team

As shown above, the implementation of ANPD methods has also strong implications on the project team. Following the Scrum principle, one suggested solution for the presented requirements is a very intensive integration of the purchasers into the development team and a dedication to one single development project [15]. The merging of procurement and development team guarantees deep technical insights for the purchasers, an early and intensive integration of the procurement expertise and a high communication density. In addition to this, a new system of objectives for the evaluation of the purchasers within development projects is suggested. Existing systems are mainly cost or savings oriented, but within agile ANPD projects and their development sprints time and innovativeness will become much more important target figures. Furthermore classical procurement methods like buying ahead and the bundling of procurement volumes are less suitable within ANPD projects due to the frequent and short-term change in procurement demands [15]. Flexibility and agility of procurement have to be paid by higher prices. To prevent delay within the project these higher costs should not stand in contrast to the individual objectives of the purchaser. But, of course, costs and savings should not be neglected totally within a new objective system [15].

3. Product / Technology

Depending on the product, a possible solution for the reduction of costs by simultaneously short lead times is a preferred use of serial components and technologies which are already available at market and reducing the share of components or technologies, which have to be developed individually, on a minimum. This includes two advantages.

On the one hand individual development costs are economized and on the other hand the price per peace is lower due to higher absolute lot sizes of serial components. In case of licensed components, first a contract with the license owner has to be arranged, which could eliminate the advantages of this solution.

V. CONCLUSION AND FUTURE RESEARCH

Intended as a discussion paper, the overall aim of this article was to analyze the implications of ANPD methods on procurement and to sensitize for the importance of an adaption of procurement activities to these changes. Therefore, we presented in this paper the changes between traditional and new approaches of NPD and discussed, based on this, the implications on procurement activities. Based on the author's experience from participation in ANPD projects in a last step a set of possible configuration options for the adaption of procurement to the challenges and new requirements has been presented.

As the analysis of the available literature showed, academic work on the topic of ANPD and equally on procurement within ANPD is still scarce. Thus, in a first step this paper sensitizes for the general problematics of procurement within ANPD projects. Current approaches for the organization of procurement in development projects appear as not suitable to the changing requirements. Used methods and strategies regarding the cooperation with suppliers and regarding their integration into the development process seems to be suboptimal as well. The results of this paper emphasize the importance of adapting procurement activities for the successful execution of ANPD projects and for increases in innovativeness by successful supplier integration.

As a next step for scholarly work on the issue, a framework should be developed to describe procurement activities within ANPD projects. Based on the here presented new requirements and the proposed configuration options, this framework should address the organization of procurement within the project, the roles and responsibilities, the processes, an objective system and cultural aspects. A further aspect which should be investigated in details in future research is the optimal integration of suppliers in ANPD projects, considering the optimal time as well as process-related and organizational aspects.

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