VARIANT AND COMPLEXITY MANAGEMENT

UNDERSTANDING AND MASTERING
THE BIG PICTURE

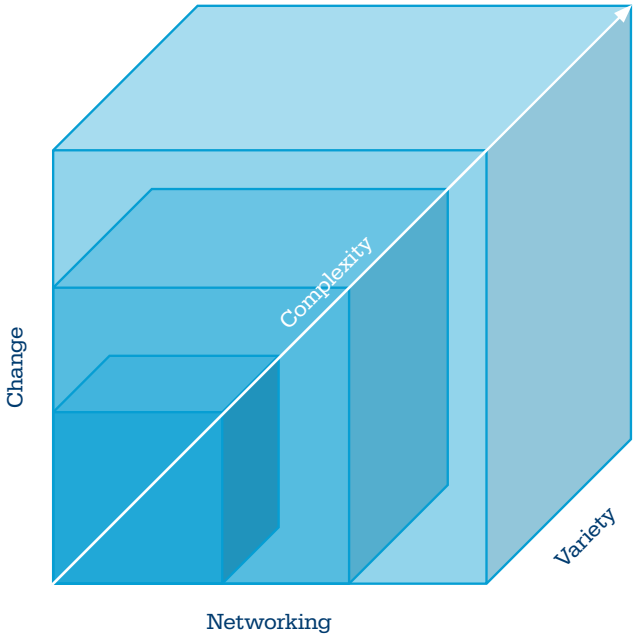
STAUFEN.

CONTENT

1. COMPLEXITY – WHAT IS DRIVING AND WHAT IS BEING DRIVEN

Digitalization and globalization are intensifying competition and putting medium-sized and manufacturing companies in particular under great pressure. In addition, new competitors are entering the market and causing difficulties for even established players. Many companies are trying to attract existing customers and new customers through an ever-expanding product range. Furthermore, possibilities for individualization and customization create an almost "infinite variety" of offers. But also the internal drive of development engineers to create ever better, more efficient technical solutions leads to new variants on the component side. As a result, complexity is increasing throughout the company, which is reflected in ever complex processes along the entire value chain. The supposed advantages on the market side – in particular increased sales – are increasingly being eroded by rising production costs.

Three factors are the main drivers of complexity: variety, networking and change.



Variety – Longer price lists are evidence of growing diversity on the sales side. At the same time, the number of component, assembly or module variants increases. When including different materials, manufacturing processes or levels of vertical integration in production and assembly with almost the same function, the expenditure for a large number of companies and departments in the company involved grows disproportionately.

Networking – When components are used, for example, in platforms across different products or by several brands within a corporate group, there is another factor that increases complexity: networking.

Change – Change is driven by internal and external influences. Internally, for example, new processes, shorter product life cycles or model updates determine the degree of change, while externally controlled factors such as fluctuations in market demand, social awareness (CO_2!) or raw material prices are drivers for change.

While each of the three factors can be controlled on its own, combining them creates "complexity," i.e. an overall situation that increasingly prevents an overview from being established and decisions made based on cause-and-effect relationships. The company risks becoming out of control! Controlling and containing complexity thus becomes one of the central challenges for many companies. Missing or half-hearted variant and complexity management leads to "offer fragmentation," a lack of resources in product development and excessive costs in production, thereby burdening the company result. Since this is a slow process, the consequences only become apparent when the annual balance sheets are prepared. A profitable balance between customer requirements and product manufacturing can only be guaranteed with an interdisciplinary understanding of the product range, product design and economic contexts. With the help of structured variant and complexity management, companies are thus transforming from being driven by the market to driving the market.

2. THE STAUFEN APPROACH

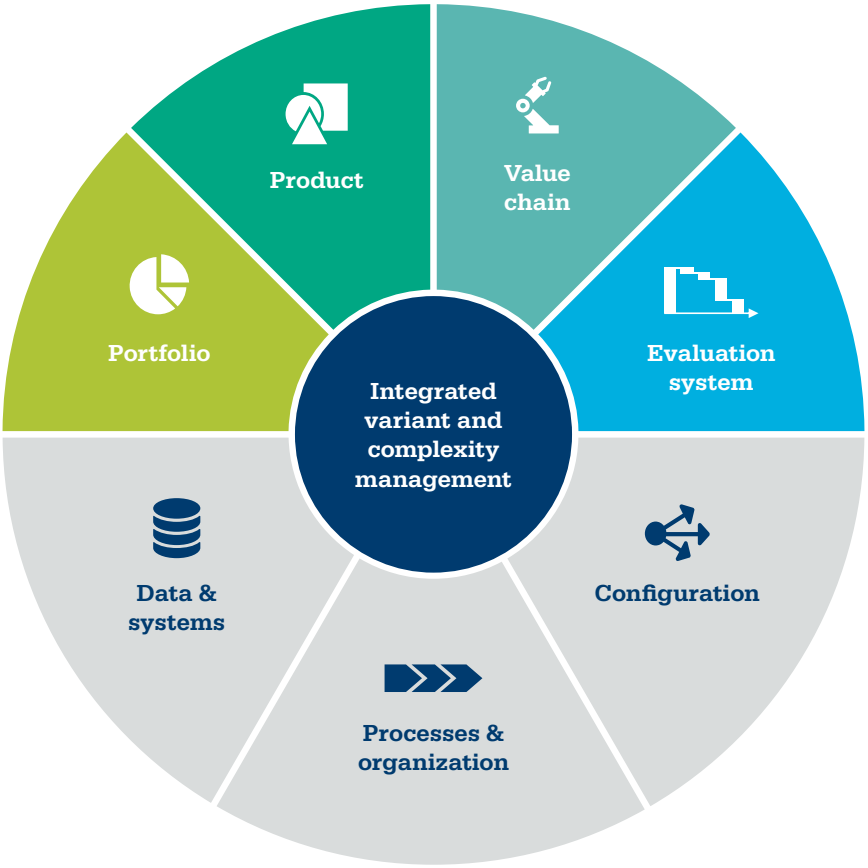
Integrated and holistic variant and complexity management

Companies are faced with the challenge of finding a profitable balance between customer requirements and efficient product design. This problem cannot be solved using small isolated applications. An interdisciplinary understanding combined with integrated variant and complexity management is needed. An ideal state can only be achieved through a holistic concept that covers the entire value-creation process and other company processes.

The starting point for optimizing the product portfolio should be the question: "What do our customers really want / need? Instead of offering everything that is possible "on spec," the requirements of the market must be identified. This is because customers do not buy part numbers, but rather features that meet their needs. If products do not meet expectations, even low prices will not lead to success. When designing the product portfolio, the focus should therefore be on satisfying customer needs, as well as searching for possibilities to produce and offer corresponding articles with a favorable price-performance structure.

After precise determination of the features and the necessary characteristics (properties) that must be fulfilled from the customer's point of view, development's task is to implement the necessary sales variants with as few different components as possible at low cost. Platforms, modules or construction kits help reduce complexity while still guaranteeing the necessary variety in the market. At the same time, however, the requirements of all participants in the entire value chain must be taken into account, which lead to cost-effective processes. The focus is on creating differences only where the customer perceives and appreciates them! Behind the scenes, the focus can then be placed on standard solutions that prevent frequent changes and variety in components and assembly processes.

The Staufen approach of an integrated and holistic variant and complexity management comprises the following components:



Portfolio – Offering properties that the customer can perceive and segmenting the portfolio based on properties offered and their sales rates

Product – Development of multi-variant products while meeting external (market perspective) and internal requirements (design suitable for procurement, production and assembly)

Value chain – Development of multi-variant products while meeting external (market perspective) and internal requirements (design suitable for procurement, production and assembly) using platform, modular and assembly approaches

Evaluation system – Result-oriented evaluation of alternative variant concepts while considering complexity and variant costs

Configuration – Automatic derivation of required order-specific documents (parts lists, drawings, work plans, costs, offer documents, etc.) directly from the properties selected by the customer. Application of higher-level configuration rules instead of individual knowledge!

Processes & organization – Adapted process landscapes (e.g., module development process) and organizational units (e.g., module committees, module responsibilities), which support the holistic variant management system

Data & systems – Consistent system landscapes and data models that link customer requirements (properties) with the necessary components

3. VARIANT & COMPLEXITY MANAGEMENT IN PRACTICE

Successful variant and complexity management creates transparency, simplifies processes in nearly all functional areas and thereby improves the company result. The following three examples illustrate how this is done:

3.1 OPTIMIZING THE PORTFOLIO

The reduction of technical variants often has an impact on the product range. However, as soon as there are signs of a reduction in the sales program, people often argue that there will be a loss in sales volume which cannot be offset by comparable savings in operations.

But how can you pull off a successful balancing act of offering an attractive variety on the market with the lowest possible production costs?

An example: An automobile manufacturer offers different steering wheel variants in their product range (figures in the example are hypothetical). The variants are created by the characteristic "material" with the specifications of "plastic" and "leather" and the characteristic "design" with the specifications "baseline" and "sportsline" and in the colors "black," "gray" and "brown." The resulting theoretical variants of 2 x 2 x 3 = 12 are limited to currently six sales variants by specifications (rules) from the marketing department such as "plastic steering wheels only as baseline in black."

For the next generation of vehicles, marketing is now demanding that wooden steering wheels be introduced with an estimated sales rate of 20 percent.

In the first step, the combinations are displayed from the data of the previous generation in the form of a variant tree. At the same time, the sales rates of the variants are determined and entered backwards (from color to material) in the variant tree. This results in the installation rates of the "design" and "material" characteristics at the nodes. Threshold values (red, yellow, green) make it easy to visualize fast and slow sellers.

Alternative future scenarios can now be simulated based on sales ratios determined for the characteristics and specification values.

Sample variant tree

Car manufacturer with different steering wheel variants in their product range (figures in the example are hypothetical)

Scenario 1 (+ wood (best case = 20 % sales rate))

- "Wood" as a luxury variant behaves like "leather" in terms of "design" and "color."
- The estimated sales rate of 20 % "wood" is halved by the volume of "leather."

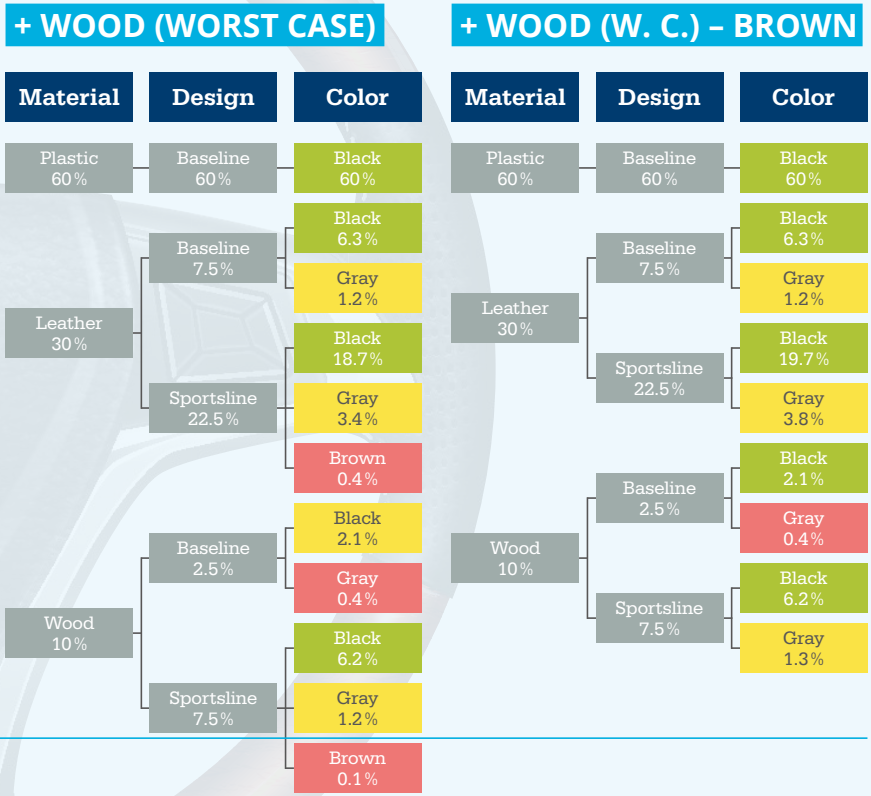
Scenario 2 (+ wood (worst case = 10 % sales rate))

- Distribution "leather" = 30 %, "wood" = 10 %

Scenario 3 (+ wood (worst case) and removal of the color "brown")

- No loss of customers
- Volume moves from "brown" to "gray"

This results in eleven variants each in scenarios 1 and 2 and nine in scenario 3.



The characteristics, specifications and the overall scenario are now assigned key figures. Current costs are cumulated within the duration to allow a comparison of the total costs to be made. At the same time, cumulative revenues from the option business are calculated, in order for profit contributions to then be compared to the base value. Here, the so-called sequencing limit of ten variants is important, from which the steering wheels are to be delivered in sequence due to limited space on the line.

Key figures over duration	Foundation	+ Wood (best case)	+ Wood (worst case)	+ Wood (w. c.) – brown
Turnover from option business	**144,147,000**	**147,090,000**	**145,617,000**	**147,087,000**
Development	2,600,000	3,000,000	3,000,000	3,000,000
Investments	2,900,000	3,300,000	3,300,000	3,300,000
Logistics	1,000,000	2,000,000	2,000,000	1,000,000
Assembly	2,000,000	2,000,000	2,000,000	2,000,000
Material	79,799,000	81,799,000	80,799,000	81,767,000
Total costs	**88,299,000**	**92,099,000**	**91,099,000**	**91,067,000**
Profit contribution	**55,848,000**	**54,991,000**	**54,518,000**	**56,020,000**
Change compared to base		**-857,000**	**-1,330,000**	**172,000**

Scenario 3 can be used to combine the ideas of marketing and prevent increased logistics costs.

3.2 MODULAR PRODUCT DESIGN

How can complexity be prevented even before it arises? A real example from the machine tool industry shows how significant optimizations in the value stream can be achieved by reducing the use of components. To reduce the main driver of complexity – variety of components – a modular system was developed.

The reason for this was increasing competitive pressure in a shrinking market segment, while internally the number of new components (1 / 3 of active parts less than a year old) increased exponentially. Despite standard series in printed product catalogs, nearly no machines were sold without undergoing a considerable adaptation and design process. As a result, R&D became an increasing bottleneck and a significant cost factor, and the areas involved in production suffered from ever-increasing variety. Thus, economies of scale in purchasing were practically impossible due to a typical lot size of 1. Suppliers often struggled with uncertainties in constructive details, at the expense of delivery dates and quality. A new NC program was created for each component in production and the assembly department had to "rethink" each machine. As a result, machines became too expensive overall at the expense of competitiveness.

The answer was a modular system with machine-independent modules. Instead of specially designing individual parts, pre-developed components are now combined using clearly defined interfaces. The machine-neutral product structure ensures that it can be applied to several product groups – without having to be adapted! The modules can be configured to meet the requirements of the sales department with maximum use of common parts. Custom combinations are therefore assembled from basic modules containing families of standard parts.

Put simply, the system resembles a Lego kit. Instead of constantly developing new modules, predefined modules are used, which can be easily exchanged with others. Standardization has made it possible to drastically reduce complexity. One example are drive systems for axles with ball screws. The system consists of six basic modules, which have been greatly reduced with regard to the number of required variants.

Through optimization it became clear that the previous multitude of different parts was not at all necessary to meet the different customer requirements. Most of the individual solutions were the result of individual technical considerations from different designers. An incorrect understanding of cost awareness led to perfectly matched component dimensions, resulting in considerable calculation work. Nevertheless, some risks were still shielded by high safety factors, while costs continued to be ignored by suppliers and internal departments. Thanks to standardized calculation models, it was now possible to create a low number of standard variants, some of which were even smaller, and by integrating the other areas, standards for production and assembly were also implemented.

Base module	Article numbers (old: last 5 years)	Change in costs
 Ball screw	Old 39 -87 % New 5	-28 %
 Bearing blocks	Old 45 -97 % New 1	-57 %
 Shaft bearings	Old 23 -96 % New 1	-41 %
 Brakes	Old 7 -57 % New 3	+8 %
 Motors	Old 24 -75 % New 6	+11 %
 Belt drive	Old 42 -81 % New 8	-33 %
As a results of the detailed analysis and holistic evaluation, a cost reduction of 15 % could be achieved		Total: -15 %

The modular system also enables new sales approaches because the modules allow for more combinations in the machinery. In the past, only large machines with high output and small machines with low output were manufactured. Now, the sales department can combine the smallest possible components to suit the application. Using configurable modules therefore does not limit the portfolio, but rather it increases the number of variants for sales.

3.3 FINANCIAL EVALUATION

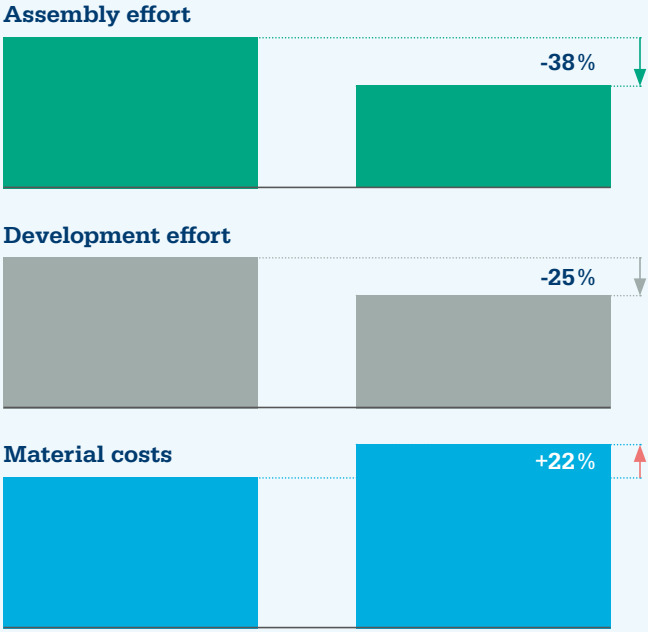
At a mechanical engineering company, a database-supported modular system was implemented. Nevertheless, the selected standard components could at best be regarded a "best-fitting" starting point for necessary design adaptations. Due to different customer requirements, the sales department was unable to imagine that the range of customer requirements could be covered with the same components.

Proof to the contrary was provided based on a specific assembly group, which showed numerous variants with different equipment using compressed air, hydraulic and electrical components:

First of all, assembly requirements were defined in interdepartmental workshops. The sales, design, purchasing, planning, logistics and production departments had the opportunity to identify problems and requirements they were aware of and suggest solutions.

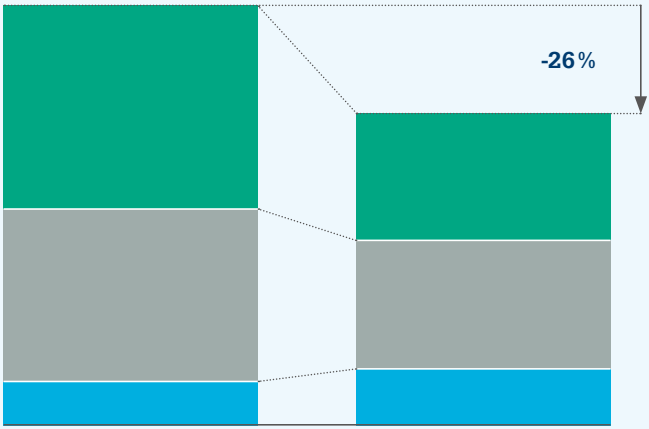
A concept was then developed that was essentially based on subdividing assembly into common sub-functions. Within these sub-areas the variance could be kept within narrow limits and subsequently configurable assemblies could be designed. A flexible carrier element was then developed, on which the configured assembly groups could be mounted at standardized workstations.

PERCENTAGE CHANGE



Stop! Reduced contribution margin!

ABSOLUTE CHANGE TOTAL



€ 25,100

€ -6,500

€ 18,600

When used in 20 machines € 130,000 / a higher result!

These carrier elements initially led to an increase in material costs of more than 20 %. With the resulting deterioration of the contribution margin, the solution was not mathematically "economical" – like so many good standardization ideas in the past.

Upon closer analysis, however, the realization was made that assembly costs were never determined in principle. Development costs were included in the overheads and considered costs which would be incurred anyway. Against this background, common work steps for typical order processing were gathered in workshops with the planning, assembly and construction departments.

These steps were then assigned an estimated amount of work in hours, multiplied by hourly rates and summed for each area.

Finally, with regard to the new concept, which was based on the ideas of the same group of people in the first workshop, the question was posed: "Does this step still exist in the new concept, and if so, how long does it take?"

The astounding realization was that the absolute change in the total cost of materials, development and assembly resulted in a 26 % improvement in earnings. Savings were thus three times higher than the original material costs of the assembly group!

As a consequence, a decision was made to implement the new modular concept for the assembly group. In principle, the contribution margin determined was retained; however, for future modular decisions, the profit contribution would also be determined.

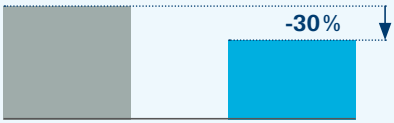
4. CONCLUSION

Consistent application of modern variant and complexity management does not aim to limit the number of variants or individualization options. Rather, the objective is to establish a cross-divisional approach for determining the relevant requirements from the customer's point of view and for cost-effective manufacture of products. The advantages are noticeable in all stages of the value stream. Experiences from Staufen AG in over ten years of implementing many projects prove that all essential key figures can be considerably improved through holistic variant and complexity management.

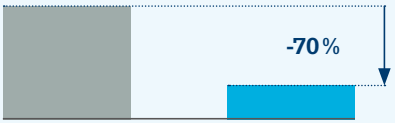
Integrated variant and complexity management creates the basis to sustainably improve a company's competitiveness and profitability.

MAXIMUM VALUES FROM PREVIOUS PROJECTS

Material



Manufacturing



Assembly

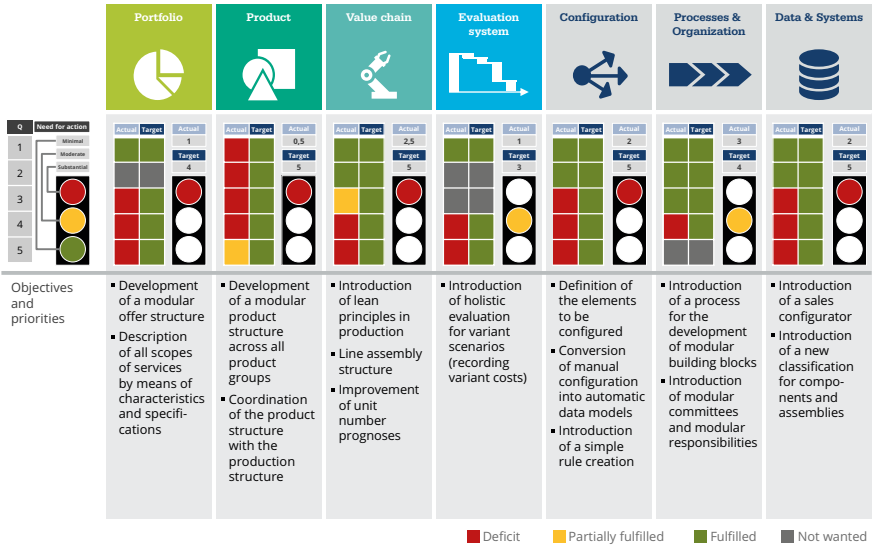
Lead time

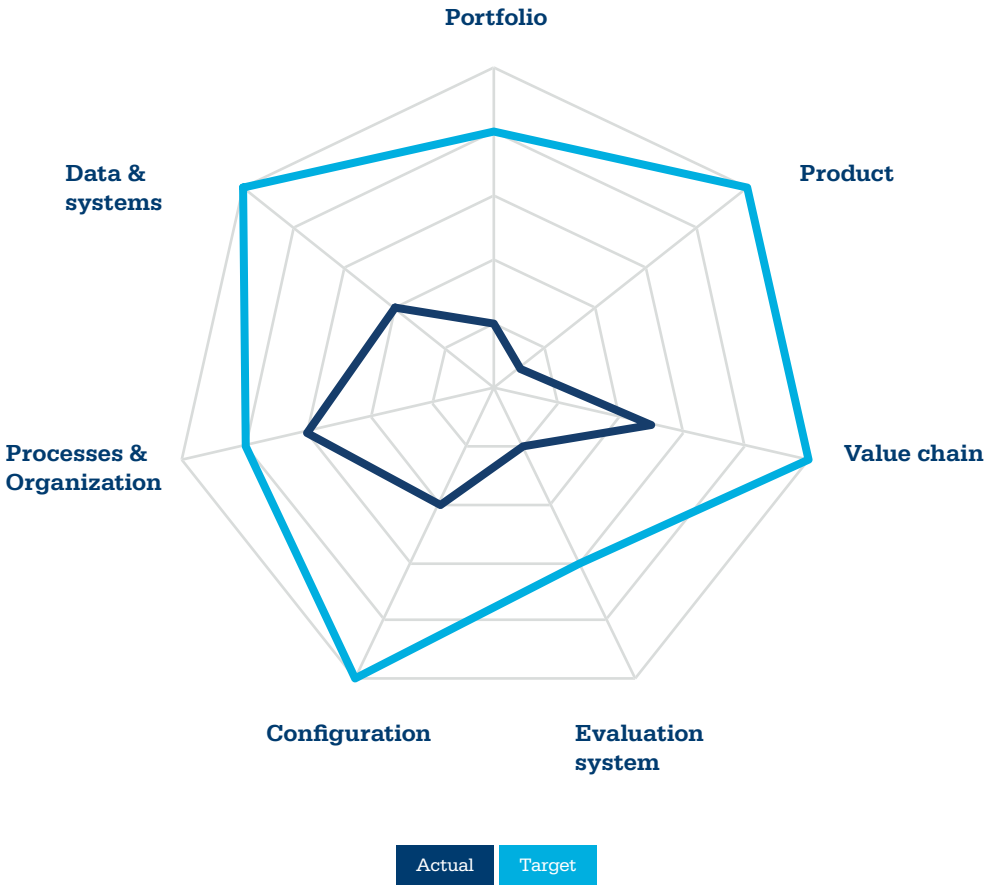
5. GETTING STARTED

The starting signal for integrated variant and complexity management

In a workshop with all areas involved in the process, the partial aspects of the Staufen approach are discussed. Together, the actual situation is reflected on and a target image is developed. Results and main areas of action are summarized in the Quick Check Cockpit and serve as a basis for specific follow-up steps.

RESULT OF VARIANT AND COMPLEXITY MANAGEMENT – QUICK CHECK




Portfolio
Product
Value chain
Evaluation system
Configuration
Processes & Organization
Data & systems
Actual
Target

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