A modular future
How to make customization a success
Management summary

Henry Ford famously said of his pioneering Model T car, “You can have any color as long as it’s black”. Despite its uniformity, the product became a blockbuster.

But Ford hadn’t reckoned with the so-called long tail, a modern business theory proposing that “endless choice creates unlimited demand”. With digitalization making the personalization of products increasingly popular, it begs a question: Is business shifting towards mass customization and the long tail?

Mass customization has been a growing trend in many industries in recent years. Both multinationals and startups are luring customers by offering increasingly individualized products. They exploit technologies such as 3D printing, artificial intelligence and robot automation to individually tweak or customize off-the-shelf products while still enjoying the benefits of mass production.

This development requires businesses to rethink their strategy, and ask themselves two key questions: Is your industry and business a good fit for customization? And how can you successfully integrate customization without creating endless complexity?

The answer to the first depends on your business and the needs of your customer. We have seen a range of different consumer oriented and B2B oriented industries move into customization and create value.

The solution to the second question depends on a long-standing but increasingly important principle: modularization. In the right setting, businesses are using the latest iteration of the concept, what we call Modularization 4.0, to differentiate where it matters for the customer and make complexity manageable.

This principle goes much further than simply implementing new technologies such as 3D printing in design and production. It requires a holistic approach to all key functions in the product creation and delivery process, including sales, marketing, innovation and operations, in order to put the customer at the heart of a client journey that features a digitalized end-to-end sales to production process.

This study considers all of these questions and ideas, culminating in recommendations on the key issues of facilitating customization, embracing its complexity and making it work. In short, it outlines how businesses can move from Ford’s principle of “one design” to the long tail principle of “design for one”.

Roland Berger
Focus
A modular future
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1. To customize or not to customize
How to tell if your business is a good fit

Should a business embrace customization? The simple answer is it depends. The car industry is a shining example of one that already has. Take Mercedes, for example. It is extending its range from just over 20 models in 2010 to more than 40 in 2020, with multiple configurations available for each, including fully electric versions. The strategy has seemingly worked: After years in the doldrums, the brand became the number one producer of cars in the premium segment in 2017.

Its rival BMW has also cottoned on to the benefits of customization. It is well known for its myriad configuration options and is now taking an even more radical approach with the Mini Yours Customized model. Using 3D printing techniques, the BMW subsidiary enables customers to produce their own design for parts of the car’s dashboard and cabin. Although still in an early phase, the technology offers many more possibilities for customization in the industry.

Similar product proliferation – and shorter product lifecycles – are happening across other industries, from food to consumer electronics and fashion to DIY.

But product proliferation does not work in every situation. In music and film, for example, blockbusters are typically still the main revenue generator. The same applies to the pharmaceutical industry. But even here, things are changing. In film, business models are being shaken up by YouTube, Netflix and vloggers, while the trend of personalized medicine is doing the same in pharma.

But it’s not all plain sailing. While customers like choice, they often still opt for default options in configuration menus because they are overwhelmed or too busy to research further. So there’s a danger consumers can be offered too much customization. This means the way choice is offered is very important.

Which route you choose depends a great deal on your customers. If you want to go long tail, you first have to make sure that you truly understand your target customers. In food & beverages and consumer products, the choice may be obvious – in industrial segments it can be less so. How do you know? Take a look at developments in your industry:

- **Customization** Is there increasing need for configuration, personalization and other types of customization?
- **Direct customer interface** Does your customer expect to be able to order and configure the product online?
- **Fast supply chain** Are product lifecycles getting shorter?
- **Short time to market** Are service levels increasing and is the time to order shortening (“instant gratification”)?
- **Lower costs** Is there increasing pressure on what the product costs?

If the answer is “yes” to any of these question, then long tail may be a good fit. But while modularization techniques have typically been able to handle the increasing complexity and costs that come with product variety, today’s customers and interlinked supply chains present new challenges to such proven approaches.

In today’s version of modularization, many more business functions are involved, the customer perspective plays an ever larger role and the operational setup must be ready. Welcome to Modularization 4.0.
A: More for less
Product proliferation has more than doubled in the past 15 years, while lifecycles have fallen by about 25%.

Increase of product variety across all industries[^1]

Complexity has increased dramatically. Product variety more than doubled between 1997 and 2012, while the number of raw materials and components increased to a lesser extent.

The smaller rate of increase in raw materials and components is due to the standardization and modularization efforts of leading industries such as automotive and FMCG.

Source: Roland Berger

[^1]: Automotive, chemicals, machinery, FMCG, pharmaceuticals
2. Modularization 4.0
The logical progression of customization

Modularization 4.0 builds on long-standing, proven principles of traditional modularization, such as platform sharing among carmakers. But it combines these with new technological tools and opportunities thanks to digitalization and Industry 4.0, or the automation of machines.

Digitalization dramatically improves direct customer interaction, the use of online platforms and enables the use of data to offer tailor-made products. On the operational side, Industry 4.0 elements like robotization, 3D printing and integrated supply chains offer new or improved instruments to develop holistic systems.

Yes, today’s long tail will lead to more complexity. But Modularization 4.0 makes this manageable and more effective. For many businesses, it’s time to embrace the transformation.

THE EVOLUTION OF MODULARIZATION – FROM "ONE DESIGN" TO "DESIGN FOR ONE"
We are on the brink of a new era, one where products can be fully customized to the specificities of the person or business buying them, the so-called "design for one". But to understand the future, it’s useful to first consider how we got here. → B, C

I. Mass production: One design
Mass production started with one design. The Model T Ford, first produced in 1908, is an iconic example of the efficient production of affordable goods. But as customer preferences became more important, companies started to look for ways to develop variants.

II. Carryover approach and platform thinking
Companies started to reuse components and designs across variants and ranges fairly early on, especially in the automotive industry. These were the early days of modularization, the so-called carryover and platform approaches, marked by cost and time efficiency in production, but also a noticeable lack of customer input and involvement from functions such as marketing.

III. The age of configuration
Gradually, the customer perspective started to take the lead, and companies began to look for ways to enrich options. This led to the introduction of modules: complex systems or subsystems offering multiple options but dedicated to one function, enabling easy and rapid configuration based on a customer’s preferences. This type of modularization is still seen today in many industries, including consumer electronics, health tech, footwear, food ingredients, and of course automotive.

IV. Modularization 4.0: Design for one
In this burgeoning new level of modularization, at least one module can be completely customized to the preferences of the customer. This so-called adaptable module is empowered by digital tools that support the customer interface (for example online configurators) and by Industry 4.0 technologies like 3D printing and robotization. But Modularization 4.0 does not erase advantages of scale. In the new world of mass customization, you take individual customer requirements and start production without any engineering effort, keeping scale advantages while reducing time to order.
**B: Grown up**

Modularization has evolved from mass production to mass customization

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Modular elements</th>
<th>Functions involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV. Design for one (Modularization 4.0)</td>
<td>The customer can customize and order in one go</td>
<td>- Adaptable module (3D printing, robot)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Direct customer interface</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Integrated supply chain</td>
</tr>
<tr>
<td>III. Configuration</td>
<td>The customer can configure the product</td>
<td>- Marketing &amp; sales</td>
</tr>
<tr>
<td>II. Carryover</td>
<td>The customer can choose from a range of variants</td>
<td>- R&amp;D</td>
</tr>
<tr>
<td>I. One design</td>
<td>Each customer buys the same product</td>
<td>- Production</td>
</tr>
</tbody>
</table>

**Perceived added value**

**Basic functionality**

**Mass production**

**(Mass) customization**

Source: Roland Berger
C: The future is here
Several industries are ready to move to adaptable modules and product customization

<table>
<thead>
<tr>
<th>Industry</th>
<th>Mass production</th>
<th>Mass choice</th>
<th>Configuration</th>
<th>Adaptable module</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fashion</td>
<td>Standard jeans</td>
<td>Mi Adidas</td>
<td>Spreadshirt Picture This</td>
<td></td>
</tr>
<tr>
<td></td>
<td>“One design”</td>
<td>“Carryover”</td>
<td>“Design for one”</td>
<td></td>
</tr>
<tr>
<td></td>
<td>– Produced to stock (in batches)</td>
<td>– Configurable online (colors, materials)</td>
<td>– Personalized designs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>– Several variants (fabric, shape)</td>
<td>– Make to order in 3-6 weeks</td>
<td>– Sell designs in your own shop</td>
<td></td>
</tr>
<tr>
<td>Food</td>
<td>Standard chocolate bars</td>
<td>Design a Tea</td>
<td>mymuesli</td>
<td></td>
</tr>
<tr>
<td></td>
<td>“One design”</td>
<td>“Configuration”</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>– Produced to stock</td>
<td>– Customize packaging</td>
<td>– Customize packaging</td>
<td></td>
</tr>
<tr>
<td></td>
<td>– Available in many flavors</td>
<td>– Select flavors</td>
<td>– Select flavors</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Produced to order</td>
<td>– Sell your recipe</td>
<td></td>
</tr>
<tr>
<td>Automotive</td>
<td>Model T Ford</td>
<td>Tesla</td>
<td>Mini Yours Customized</td>
<td></td>
</tr>
<tr>
<td></td>
<td>“One design”</td>
<td>“Carryover”</td>
<td>“Design for one”</td>
<td></td>
</tr>
<tr>
<td></td>
<td>– Produced to stock on a fixed production line</td>
<td>– Configurable online (color, interior, exterior)</td>
<td>– Personalize elements (e.g. dashboard panels)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>– Identical cars</td>
<td>– Online ordering</td>
<td>– Produced by 3D printing</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Remote services for your car</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumer electronics</td>
<td>Standard hearing aid</td>
<td>TAG Connected Modular</td>
<td>3D printed shaver</td>
<td></td>
</tr>
<tr>
<td></td>
<td>“One design”</td>
<td>“Carryover”</td>
<td>“Design for one”</td>
<td></td>
</tr>
<tr>
<td></td>
<td>– Choice limited to customer fit</td>
<td>– Configure your own watch</td>
<td>– Personalize shape</td>
<td></td>
</tr>
<tr>
<td></td>
<td>– Produced to stock</td>
<td>– Choose body metal, material for straps and a variety of lugs</td>
<td>– (Commercial) pilot</td>
<td></td>
</tr>
<tr>
<td></td>
<td>– Technical redesign each time to reduce size</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Furniture</td>
<td>Standard chair</td>
<td>IKEA PAX wardrobe</td>
<td>Your own IKEA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>“One of the first mass produced chairs: Thonet”</td>
<td>“Carryover”</td>
<td>“Design for one”</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Configure yourself (plug &amp; play)</td>
<td>– Buy adaptable modules for ikea furniture (Mykea, Superfront, Plykea, etc.)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Assembled to order (by customer)</td>
<td>– Submit preferences and get tailor-made furniture (Ikeahackers)</td>
<td></td>
</tr>
</tbody>
</table>

Source: Roland Berger
Industry giants are facing significant challenges from startups in the customization race. It is new players that are blazing the trail in extensive configuration solutions. Take Spreadshirt or Picture This, for example, which allow you to design your own clothes, or Tesla’s platform to configure, buy and update your car online. Consumer goods are also being made customizable, with startups such as mymuesli and Design a Tea leading the way.

Many of these new firms combine a self-design aspect with its immediate resale. Studies have shown that customers are willing to pay a premium for self-designed products, and also for goods designed by others.

But the startups are not having it all their own way. Established players are finding ways to keep pace in the customization race, or even move ahead.

Adidas and Nike, for example, can leverage their brand power while still offering customization options. And in consumer electronics, we are seeing interesting partnerships with pioneering startups. Philips, for example, has experimented with startups Twikit (web-based configuration) and Shapeways (3D printing) to produce custom razors.

Meanwhile, startups are also feeding off established players. For example, firms like Mykea, Superfront and Plykea use IKEA’s modular systems as a platform for their own self-designed, handmade or customized furniture. Prices are often much higher than the equivalent IKEA component, underlining the value they hold for the customer.
D: **Flat packed**
IKEA has a tried-and-tested configuration concept, but is it ready for customization?

**Today, IKEA focuses on broad configuration options**
- IKEA has a long history of modular products
- One of the first companies to sell self-assembly furniture
- Fresh designs, value for money and endless configuration options helped it develop a highly successful business model
- Its modularization approach is characterized by the ability to configure products:
  - Standardization of components
  - Availability of several platforms (like PAX wardrobes)
  - Offering different modules

**Modularization 4.0: Are startups cashing in on IKEA?**
- IKEA is working on customer interaction: expanding its online offerings to Amazon and investing in augmented reality
- It is also exploring new technologies such as 3D printing to personalize products and increase customization
- Additionally, startups are building on the modularized IKEA setup to develop customization niche markets, e.g. Mykea (stickers) and Superfront (doors etc.)
- Are these startups capable of capturing true value?

**Configuration of basic units from IKEA?**

**Value from module captured by startups?**

Source: Roland Berger
3. Quantify and prioritize
A five-step guide to Modularization 4.0

We have identified five factors that are key to Modularization 4.0 succeeding across the supply chain: customer needs, managing complexity, product configuration, modular strategy and operating model. Below we explore each in more detail.

#1 IDENTIFY CUSTOMER NEEDS AND PREPARE CHOICE NAVIGATION
The core challenge of product innovation is identifying what customers really want, what drives the product’s value and how that value can be enhanced by customization. To make a success of Modularization 4.0, companies must be able to analyze user-generated data and customer configurations (both completed purchases and uncompleted orders) using artificial intelligence as well as traditional data analysis tools. Insights from these can then be used to identify which aspects of a product are most commonly modified. This also paves the way for setting up customer interaction.

The combination of customizable options and customer interaction when ordering a product is what we call choice navigation, and its importance should not be underestimated. It starts with a clear and easy-to-navigate ordering pathway. Here are a few tips:
1. Create a “fast lane” for customers who want a more standard configuration
2. Make it visually clear that a customer is in the configuration stage of ordering
3. Visualize progress as the customer goes through the options (e.g. use an image of a product as currently customized, and/or displaying price with current choices)
4. Keep it simple and engaging
5. Offer inspiration by highlighting other customers’ designs (perhaps with additional rewards for customers whose designs are chosen)

#2 UNDERSTAND THE ADDITIONAL COMPLEXITY AND PINPOINT ITS OPTIMAL LEVEL
Complexity is not necessarily a bad thing. The key is to have the right type: complexity that differentiates, provides competitive advantage and fulfills customer needs. Other types can lead to unnecessary costs. Seeing the issue in this light makes it possible to determine what complexity to keep and what to simplify.

To make a success of Modularization 4.0, companies must be able to analyze user-generated data and customer configurations using artificial intelligence as well as traditional data analysis tools.
**E: Simplifying complexity**

The success of Modularization 4.0 across the supply chain is dependent on five key factors:

1. **Customer Needs**
2. **Managing Complexity**
3. **Product Configuration**
4. **Modular Strategy**
5. **Operating Model**

Source: Roland Berger

*) Stock keeping unit
#3 ALIGN THE CUSTOMER PERSPECTIVE WITH THE OPERATIONAL PERSPECTIVE FOR PRODUCT CONFIGURATION

Before going any further with modularization, a company must square the customer perspective with the operational perspective. A good question to ask is: What are the most logical targets for customization?

To answer this, take your results from steps 1 and 2 and, in conjunction with marketing, R&D and operations, match potentially customizable options with different product components. In short, compare what customers might want against what is technically possible. This will yield a set of building blocks (sub-systems) with well-defined interfaces.

Next, prepare a flexible plug & play structure. Do this by categorizing product functions into separate stand-alone sub-systems, whereby each function can be readily changed by switching only the corresponding sub-system. Make sure to bundle key functions in larger blocks, and separate functions with high strategic value.

#4 DEVELOP A CLEAR MODULARIZATION STRATEGY

Different strategies apply to different modules depending on their competitive value and the motive for the modularization. There are four main strategies: reuse over generations (carryover), reuse over series and platforms, plug & play modules and the newly introduced adaptable module. Finding the right one is key.

Development of a modularization strategy is a multi-disciplinary effort: R&D for the modular product design and lead time management, input from sourcing and operations.

Case study: Hearing aid manufacturer

In a recent project for a hearing aid manufacturer, our objective was to reduce lead time and enhance the effectiveness of innovation. Our approach was to create a balance between the market demand for long tail, accelerated development time and manufacturing complexity costs by prioritizing functions. We used structured tools to support this process.

The result was a 31% reduction in modules and their variants and a 12% increase in development capacity. The introduction of standardized interfaces improved go-to-market agility, accelerating lead times by six months and allowing for the earlier launch of products.

We were also able to improve project predictability by focusing on the reuse of proven modules, which cut testing time in the project integration phase by about 25%. First-time module development then cost only an additional 15% in development effort.

What did we learn? That the implementation of modularization relies on mature systems engineering and building competencies. At the same time, it drives multidisciplinary alignment between R&D, marketing and sales and operations.
**Plug & play**

Product parts that are potential targets for modularization can be identified by matching likely customer desires with technical feasibility.

**Principles**

- Building blocks should be chosen such that they are **aligned with the key functions** that the customer expects from the hearing aid.
- Building blocks form sub-systems of the total hearing aid system in which **design complexity is confined** and separated from total hearing aid.
- Key functions follow from the **customer needs** defined in different value spaces.

Source: Roland Berger
Industry 4.0 will connect the customer interface with your operating model through digitalization, automation and customization.

#5 DEFINE A ROBUST END-TO-END OPERATING MODEL

Modularization 4.0 will undoubtedly change the operating model. It will have to deliver more quickly, be cost competitive and offer customization in an agile and rapidly adaptable way.

A key challenge here is adapting a standardized, large-scale production process to customized orders. At first glance, it seems the order “decoupling point” must shift, with the entire process from a make-to-stock to make-to-order focus. But there is another way. The trick is to balance prefabrication with the flexible nature of customization. This will mean sales & operations and production planning will build from new starting points and the design of the supply chain will change dramatically. And as delivery lead time gains importance, the operational footprint will need to move closer to the customer.

Industry 4.0 makes this possible. It will connect the customer interface with your operating model through digitalization, automation and customization, while also applying the rules of modularization and combining mass production with “adaptable” modules. The latter fully self-configured products can be created using 3D printing and multipurpose, reprogrammable and collaborative robots.
G: Custom made
Different modularization strategies fit different products

PRODUCT SERIES I

Module reuse across generations (carryover)

PRODUCT SERIES II

Module reuse across series and platforms

Product features/functions (1–3)

Plug & play modules for fast innovation

Product base/platform

Adaptable modules for customization

GENERATION 1

GENERATION 2

Source: Roland Berger
A new mindset for a new order

Whether it's a personalized T-shirt or a 3D-printed gadget, customization is a trend most businesses cannot afford to overlook. Modularization 4.0 offers a ready solution, but one more complicated than simply integrating a new technology into a supply chain. Instead it is a mindset, embracing effective complexity and the opportunities that come with it.

To make Modularization 4.0 a success requires thinking and acting in a new way. As outlined in our five key factors above, this means focusing on more than just R&D and production, where modularization efforts typically become trapped. Rather, Modularization 4.0 involves the entire process and brings it together: R&D with marketing, production with sales – in fact the whole supply chain, from end to end.

Making it work requires a new order – and strong leadership that dares to change the system.
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