MODULA
Web Configurator for Automatic dispensing system

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Picture of the team

Description
The project addresses the development of a product configurator for Inkmaker s.r.l., an Italian SME, producing dispensing systems for inks and paints, acting on the B2B market. In an age of continuous technological breakthroughs, companies always need to ensure that the available technologies are employed in the best possible way. Moreover, the market in which the company is acting is characterized by some criticalities. In fact, customers simultaneously ask for: low price, short lead time, high product customization. To cope with these requirements, a two-steps approach is necessary: first, an improvement of the design and the assembly processes must be adopted, that will lead to the

modularization and standardization of the mechanical components of the machines, i.e. the final products. Second, the modularization will be used for realizing a product configurator. From this rough description, it is possible to grasp the intrinsic multi-disciplinary nature of the project. On the one hand, it is essential to understand the technical features of the products, so that the proposed modularization is effectively performed and supported by a solid and efficient IT solution; on the other hand, the economical results of this new paradigm must be taken into account, leading to an analysis of the impacts of the solution, ensuring that the configurator fits correctly inside the company's sales process.
This complex task has been performed with a scientific approach: identification of the main stakeholders and definition of their requirements; analysis of the state of the art; feasibility analysis; technical implementation.
Starting from these initial steps, three teams have been identified. A technical team worked on modularization of the machinery components, resulting in the definition of modules. Another technical searched for the optimal way to implement the product configurator.. In order to ensure that the definition of modules into final machines could be performed automatically, an optimization model has been introduced. Lastly, a business steam – mostly oriented on business and company economics – analyzed the business context, studied the impacts of the configurator and interviewed some customers of the company. The received feedback was then reported to the technical members, so that it was possible to improve the final implementation. Thus, these activities resulted in the final development of a functioning prototype of the product configurator.

Tasks and skills

Stefano Amato: *as a technical consultant, he analyzed the product features, designed the mechanical modules and worked on the parametric implementation of the modules.*

Alfredo Fantetti: *as a technical consultant, he analyzed the product features, designed the mechanical modules and worked on the parametric implementation of the modules.*

Sara Mottola: *as a business consultant, she worked on the requirements analysis, defined the process mapping and analyzed the internal impacts.*

Giovanni Prencipe [Team Controller]: *as the team coordinator and business consultant, he worked on the requirements analysis, studied the external impacts, edited the final report and managed the budget.*

Andrea Radaelli: *as a technical consultant, he investigated the state of the art of product configurators, designed the system architecture, and implemented the software.*

Arianna Rosa Brusin: *as a business consultant, she worked on the requirements analysis, defined the process mapping and analyzed the internal impacts.*

Alex Saja: *as a mathematical consultant, he worked on the state of the art, developed an optimization model and implemented it in an executable program.*

Keywords
Product configurator; Customization; Co-design; Modules standardization

Abstract

Nowadays, the increased competition on the global markets pushes companies to face the trade-off between volume and variety. Customers simultaneously ask for huge quantities and very specific product requirements. New strategies are required to keep high the competitiveness.

This challenging context has lead Inkmaker to establish some ambitious objectives and envision the project MODULA. Inkmaker s.r.l is an Italian SME realizing dispensing systems for inks and paints. Through MODULA, Inkmaker wants to achieve the following strategic objectives: realization of the machines co-design; modules standardization; reduction of lead time. They all converge in a design and manufacturing standardization. The adopted solution is an online product configurator.

To develop the solution, a scientific approach has been applied: identification of the main stakeholders and definition of their requirements; analysis of the state of the art; feasibility analysis; technical implementation;. Future steps are represented by the integration of the solution with the company ERP and the extension to all the portfolio.

Understanding the problem

Inkmaker's value proposition includes efficient and customized products, high reliability, great assistance service, and a cost based pricing scheme that has a relatively good profit margin.
However, in a context of fierce competition, to keep being profitable, it is necessary to: reduce costs; grant the maximum level of product customization. In fact, customers simultaneously ask for huge volumes and wide product variety. To keep high the competitiveness, the company would like to increase the internal efficiency - through a design and manufacturing standardization - and to improve the customer satisfaction.
To meet these ambitious objectives, the current project has been conceived: the implementation of a product configurator that will allow to realize the machine in co-design, with higher accuracy and design automation. Furthermore, the delivery lead time will be reduced.
The company realizes different type of products, that can be divided into two broad categories: small, relatively similar machines (called Croma) and large, more expensive, configurations. Since the first type of products could be better designed with a modular approach, they have been selected has pilot products for implementing the adopted solution.
After having outlined the context and the main stakeholders, the team identified a list of different requirements:

1. **Company** requirements, developed after a series of meetings with the company's employees, that can be classified into technical and business needs. The former ones refer to the products features, the latter involve the mapping of all the phases of the design and the selling processes. Moreover, the supply chain structure has been analyzed, resulting in the inexistence of a standardized process. This scenario often causes feasibility problems for the project of machines and time delays. The team recognized the needs of having the entire design process, from the first touch of the customer to the generation of the machine (Bill of Materials), of granting the right level of assistance to the customer and finally of granting customizability to the machines, responding to customers' needs.
2. **Customer** requirements, understood by means of a structured questionnaire, highlighting the desire of customers' of an online platform and the need of a short and efficient configuration process.
3. **IT** requirements, gathered from stakeholders interviews and analysis of the state of the art, which reflected the need of an online, easy-to-use and entirely automated solution.

Exploring the opportunities

To comprehend the effects of the adoption of a product configurator, a four step methodology has been adopted, with the original contribution of adapting popular literature models to small ETO companies.

1. Analysis of the as-is business model, based upon consideration of the classical business model canvas.
2. Analysis of the internal organization, that aligned the push for a configurator, with a modification of the manufacturing strategy.
3. Analysis of the supply chain, with a schematization of the supplier side, as the introduction of a configurator would involve.
4. Definition of the to-be state, where the desired scenario has been described.

This methodology has been applied within the paper “Deployment of product configurators: analysis of impacts inside and outside the user company”, presented at the 14th Conference on PLM, in Seville.

Discussion of the two papers at the 14th Conference on PLM, in Seville - Giovanni Prencipe and Alfredo Fantetti

The main internal changes - with respect to the user company - refer to the following processes: sales, design and manufacturing. Currently, the selling and the design process are conducted through the traditional human-based communication channel. Several interactions with customers are necessary, during the design process, due to misunderstanding of customers' requirements. This leads to high lead times. The introduction of a product configurator would automate both the selling and the design process, drastically reducing the lead time and increasing the accuracy: customers input the requirements and automatically obtain the machine BOM and the layout representation. Significant impacts involve also the manufacturing process. In fact, a standard modules inventory will be kept. After having received the order, Inkmaker simply has to assemble them, with a reduction of the manufacturing lead time. A total delivery lead time reduction of 58% will be achieved.

The external impacts involve: the supply chain, the market and the society. The impacts on the supply chain refer to a better integration and coordination with customers and suppliers. In fact, on the one side, customers directly configure the desired machines; on the other side, a better coordination with suppliers is necessary to manage the modules inventory. The presence of this stock will change the structure of the supply chain: it represents a downstream shift of the customer order decoupling point transforming the ETO configuration in an ATO one. Moreover, the implementation of the configurator would grant a higher competitiveness for Inkmaker who will be the first mover with respect to this new technology. Finally, the adoption of this solution can be seen as the first step to achieve the implementation of a Factory 4.0.

Product configurator: impacts evaluation

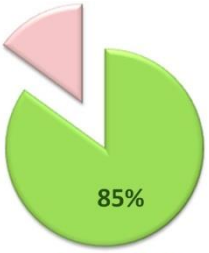
Generating a solution

Similarly, a structured plan has been employed in tackling the technical development of the configurator, resulting in a three-step procedure.

1. Technical standardization. This step consists in interviewing product experts and consulting company documentation to retrieve information about the knowledge and reasoning process underlying product development, leading to the definition of standard machine modules.
2. Knowledge representation. This step consists in the design of digital representations of the modules altogether with their bill of materials and engineering drawings, and of an optimization algorithm, able to compute the optimal allocation of the modules in the machines according to the customers' inputs.
3. Configurator implementation. The last step consists in implementing a software able to take in input the customer requirements, analyze them, and provide all the product information and specification necessary to validate the design and start the manufacturing phase.

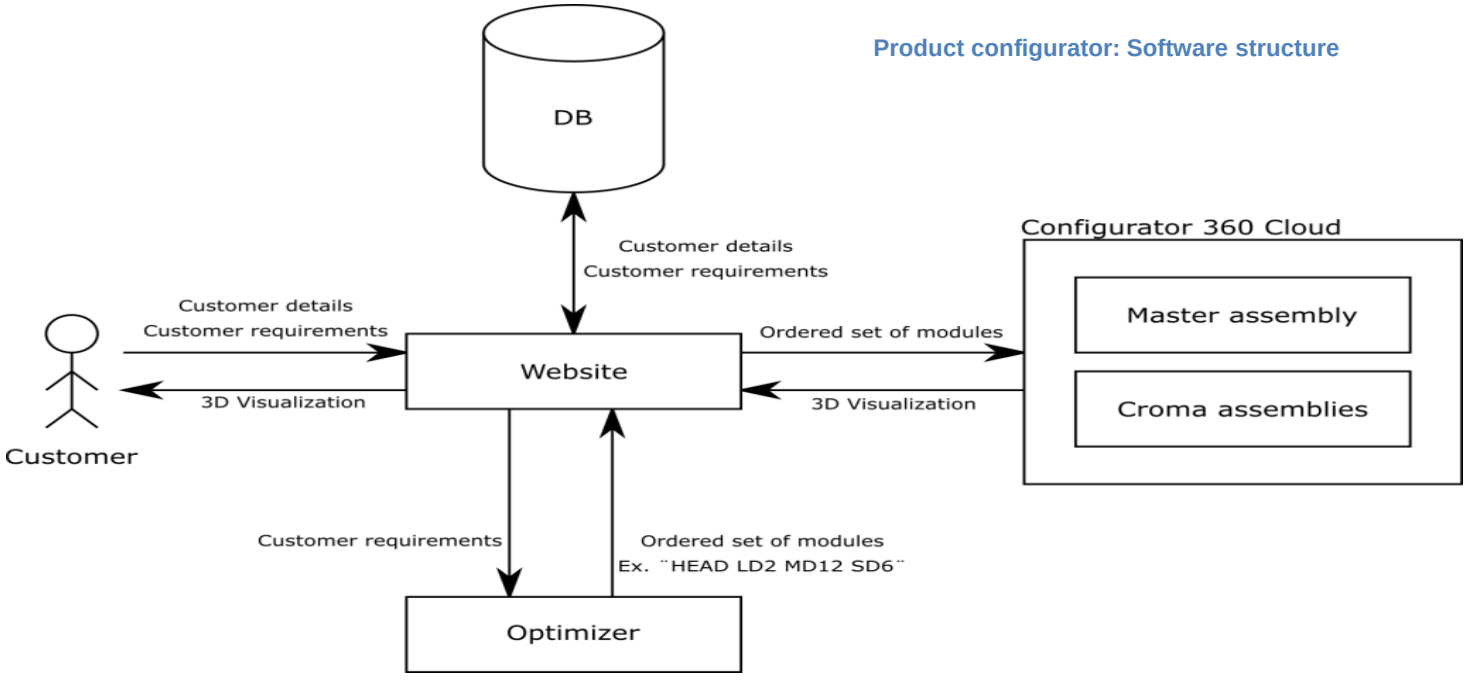
This methodology has been described within the paper "Automatic configuration of modularized products", presented at the 14th Conference on PLM, in Seville.

The team started by analyzing past projects and realized that, among the different constraint types, topology played a major role. Each module consisted in a structural part, in electrical and hydraulic connections, and in a different number of slots for containers, that are of two different types (large or small). On the one hand, a low total number of modules was desired (to reduce variations), nevertheless it was necessary to define a sufficient set of modules. These opposing tendencies led to the definition of 15 modules, later applied on the past projects, with an 83 % of success. Not all projects could be solved with this approach, due to specific case limitations. These projects should be realized through the traditional design process.



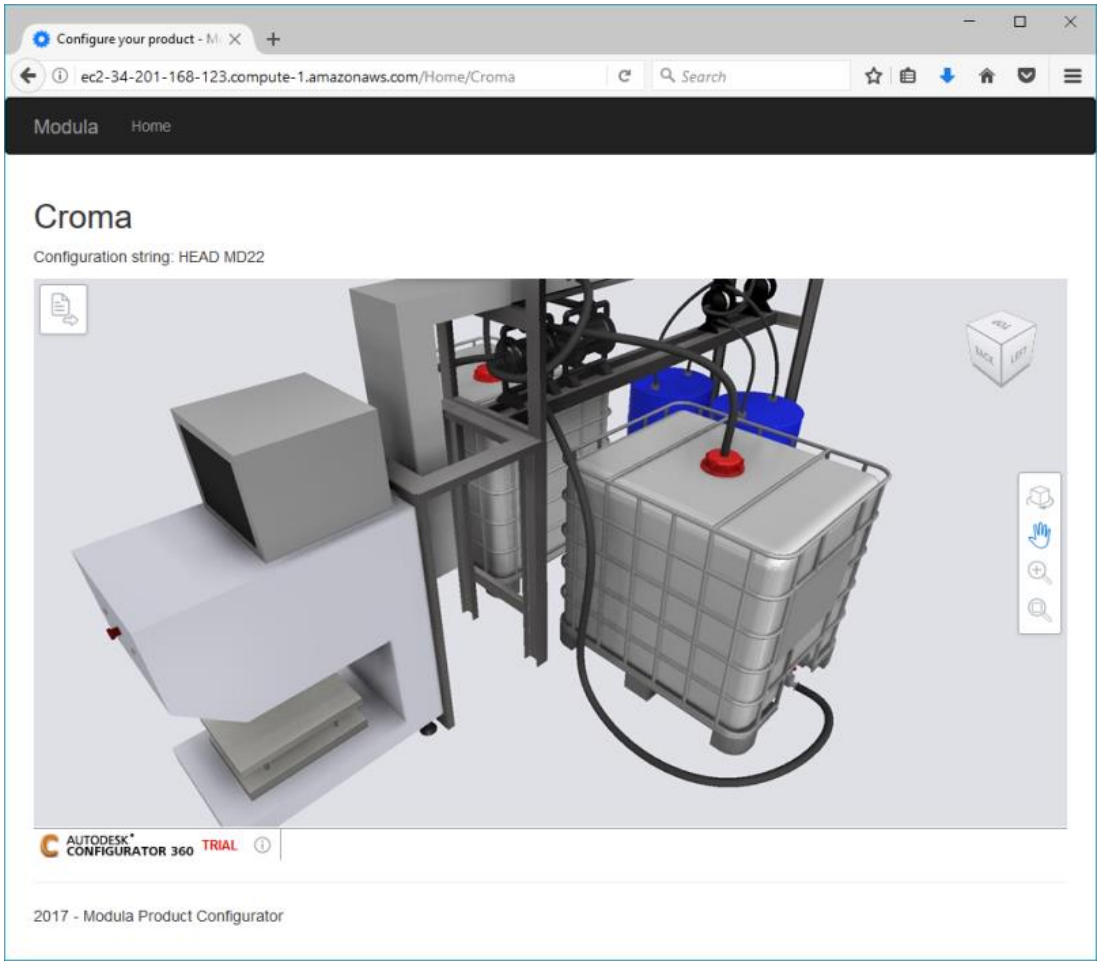
Success rate of test on past project

The modules identified have been digitally designed using a professional CAD software for mechanical design: Autodesk Inventor. The designs contain all information needed to build a module: the bill of materials, their dimensions, and how they are assembled together. Finally, it was possible to develop a prototype product configurator.



Product configurator: Software structure

The prototype is composed of four software components: Autodesk Configurator 360, the Optimizer, a database, and a website. Configurator 360 is a cloud service exposing the functionalities of managing the CAD files of the modules, generating the assemblies, the 3D visualizations, and the engineering drawings. The Optimizer is a custom program for solving the mathematical optimization problem of translating the customer requirements into the optimal set of modules minimizing the spatial needed. The database stores the information about the customer, their requirements, and their orders, collected during the configuration process. The website provides an interface accessible to any device with a web browser which can be used to configure a custom ink dispenser.



Prototype: screenshot of a machine configuration

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