The 50th CIRP Conference on Manufacturing Systems

Consumer Driven New Product Development in Future Re-Distributed Models of Sustainable Production and Consumption

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Abstract

The customer as co-creator of products is a grand challenge the entire consumer products manufacturing industry is facing. The design, manufacture and delivery of mass personalised consumer products must not only meet customer preferences but must be produced economically and sustainably too. Re-Distributed Manufacturing (RDM) has the potential to disrupt the way products are designed, produced and consumed products across their entire lifecycle and will allow the creation of disruptive business models and entirely new supply chain structures. New structures of design and manufacturing can enable large reductions in resource consumption by limiting waste in a supply chain (e.g. reducing transport distances) and through addressing the flows of resources at critical times in the lifecycle of products. It can also enable reduction of R&D waste by enabling a more targeted delivery of custom products to meet specific user needs and demands in different contexts and across extended timespans of the product lifecycle. Few manufacturers have started experimenting with open innovation to address the two manufacturing challenges of: (i) the ability to identify rapidly the needs and preferences of different market segments; (ii) the ability to respond quickly and flexibly to those. This paper demonstrates a model-based methodology and information technology to engage consumers at large scales to drive new product and manufacturing process development to address these challenges. An orange beverage has been selected to show that by linking a game-like consumer facing web application and a novel computer driven flow manufacturing system, target sensory attributes obtained by consumer groups can be rapidly translated into a new formulation recipe and its manufacturing process of a beverage that meets those needs and prototyped for that consumer group to evaluate. One can then envisage future scenarios where formulated consumer products are rapidly co-created and produced serving the needs of localised markets.

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Peer-review under responsibility of the scientific committee of The 50th CIRP Conference on Manufacturing Systems

Keywords: Re-Distributed Manufacturing; Mass Customization; Product Development.

1. Introduction

Nowadays the process of designing and developing new products to meet consumer expectations is becoming a complex task. In this regard, intrinsic and extrinsic quality determinants involve in the success of New Product Development (NPD) such as globalisation, mass-individuation, the physical characteristics of product itself and environmental variables. Also, advanced technologies that deliver a variety of products should be properly adopted to become competitive tools for manufacturing companies in global markets [1] [2]. These factors (i.e. changing in consumers' lifestyle and values) as well as short product lifecycles have shifted the NPD process from a step-by-step approach to a continuous one focused on consumer values (i.e. close-loop approach) [3]. That, in turn,

requires a close collaboration between the end-users and manufacturers of formulated consumer goods to succeed consumer-driven new products or reformulated ones [1] [2] [4].

A new pattern of the sustainable manufacturing system coupled with localised production can enhance the demanding change [5] [6] [7] [8]. The ability to provide advances in process and information technologies supporting rapid responds that allow for the best consumer requirements for an individual customer to be rapidly determined will be a key part of the growth [6]. Re-Distributed Manufacturing (RDM) can reinforce this enabling the delivery of tailored, first-time-right product to consumers.

The RDM can be described as "*the ability to personalise product manufacturing at multiple scales and locations, be it at the point of consumption, sale, or within production sites that*

exploit local resources, exemplified by enhanced user participation across product design, fabrication and supply, and typically enabled by digitalisation and new production technologies" [5]. From this point, we can identify different consumer segments with the market intelligence (e.g. crowdsourcing tool for the preference market). Then, the RDM system using intensified processes with small footprint and low energy requirements can be employed to locate closer to these markets and rapidly respond to these by quickly modifying or optimising the product according to consumer needs.

The purpose of this paper is to demonstrate a model-based methodology and information technology to engage consumers at large scales to drive new product and manufacturing process development to address these challenges. An orange beverage has been selected to show that by linking a game-like consumer facing web application and a novel computer driven flow manufacturing system, target sensory attributes obtained by consumer groups can be rapidly translated into a new formulation recipe and its manufacturing process of a beverage that meets those needs and prototyped for that consumer group to evaluate.

2. Materials and Methods

Consumer based formulation of orange-flavored beverage and its novel production process presented to test the ability of the proposed method. Fruit/vegetable flavored beverages are prominent model of emulsions in the soft drinks industry as a concentrated or diluted product. Beverages are known complex alcoholic and nonalcoholic drinks that consist of oil phase flavoring ingredients, sweeteners, coloring agents, stabilizers and their mixing conditions. During the pairing of the ingredients and production of the beverages, there are many product and process parameters that influence the taste and sensory attributes of the final formulated product [9]. As consumers` lifestyle becomes more personalized and demand has surged for a greater variety of beverage options, therefore, the industry has considerably evolved with product formulations becoming particularly targeted to the user needs. Orange-flavored beverage is selected because it is the most widely consumable and profitable drinks in the food and drinks industry. First, consumer preferences were obtained with Preference Marketplace (PM), then formulation space was used to link to deliver the resulting sensory attributes. Formulation space were developed based on number of our previous studies [10] [11] [12], that consist of identifying product and process parameters, optimization of these parameters, developing a novel flow manufacturing platform for optimum product mixing. The following sections provide more details about material and methods used.

Table 1. Description of samples

Product	Brand	Description
Product A	Commercial	orange Juice from Concentrate (50%); Water, Sugar, Vitamin C
Product B	Commercial	water, orange juice from concentrate (8%), citric acid, acidity regulator (sodium citrate), natural flavoring, preservatives (potassium sorbate, dimethyl docorbonate), antioxidant (ascorbic acid), sweeteners (acesulfame k, sucralose), stabilizer (xanthan gum), natural color (carotenes)
Product C	Commercial	water, sugar, orange juice from concentrate (12%), acidity regulator: citric acid; flavorings, antioxsidant ascorbic acid
Product D	Our product based consumers	water, Arabic gum, xanthan gum and orange comminute from concentrate; citric acid, sodium benzoate; natural sweetener: maltodextrin, steviol glycosides; natural food color: beta-carotene

2.1. Samples preparation

Three samples were used from commercially available concentrated orange juices in different variants of concentrated orange level. While one manufactured orange-flavored beverage, with different amount of orange oil, was customised by consumers. The production method was different as the production in commercial products was batch wise, whereas we used a continuous manufacturing with oscillatory flow mixing technology in our samples. However, similar food grade ingredients were used (Table 1).

2.2. Preference marketplace – online consumer Interface

PM was developed using game mechanics for long-term consumer engagement as a low-cost and scalable digital crowdsourcing tool in order to collect information [13]. PM is inspired from Prediction Markets [14] and stock markets [15] in order to link new product features and concepts with contracts and to identify the most promising new product opportunities by trading those contracts. The ultimate goal of PM is to understand individual preferences from stock prices and drive the manufacturing parameters to respond user needs. Markets include figures, graphs and descriptions of product attributes as shown in Fig.1. User interface is a very important motivation factor to encourage being active participant.

First we developed the initial sensory terms for beverage products under four main groups as taste, texture, flavor and appearance. Each sensory group has a bundle of sensory descriptors. We defined individual securities as sensory descriptors that stock prices measure preferences of particular sensory attributes. Four markets were created and all stocks were mutually exclusive as shown in Table 2. Stock prices move between 0 and 100. Price of the attribute represents the percentage of user`s preferences. Amazon vouchers for the top 3 players were provided to motivate participants and improve active collaboration. Markets were designed for one week trading period. Participants were invited to the online based software to create their profile.