Working title:

An Evolutionary Approach to Online Mass Customization of Products

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This research focuses on means of browsing through multidimensional solution spaces in search for solutions to ill-defined problems. It aims at devising algorithms capable of eliminating the problem of mass confusion or the paradox of choice in mass customization of products over the internet. It is proposed that an evolutionary approach to mass customization may be a solution to these problems. To confirm this hypothesis, evolutionary product configurators are being developed and tested online.

1. Mass Customization and the Potential of Mass Confusion

Mass customization enjoys increasingly wide recognition both in business (Configurators Database 2010) and in academia (Franke and Piller 2003), but configuration presents the potential problem of “mass confusion” or the “paradox of choice”, in which increasing the number of user controlled parameters to allow for flexibility simultaneously makes for a more difficult user experience (Teresko 1994, Piller et al. 2003). Schwartz argued that a threshold exists in the relation of the number of available choice and users satisfaction, beyond which increasing amount of choice begins to contribute to decreasing satisfaction (Schwartz 2004a, 2004b). This relation is shaped similarly to a “Wundt curve” (Figure 1), an inverted U-shape curve, which was first adopted from Wundt by Berlyne to describe human and animal arousal response to stimuli (Berlyne 1971).

It was proposed that what seals an occurrence of mass confusion is the unavailability of meaningful choice in conjunction with a too large number of options, rather than just a too large scope of choice (Piasecki and Hanna 2010). Thus the task of MC practitioners becomes to provide the users with meaningful choice. A recent review of B2C configurators showed that the choice users are presented with concerns separate product attributes, since majority of configurators require an explicit definition of each attribute level (Piasecki and Hanna 2009).

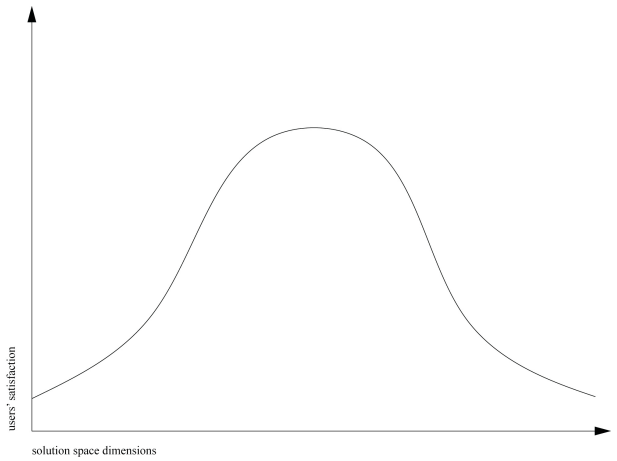

Figure 1. The supposed Wundt curve like relation between the scope of choice and users satisfaction.

2. An Evolutionary Approach to Solving Mass Confusion Problem

In an evolutionary approach to mass customization users are asked to recognize rather than define meaningful solutions. An implementation of artificial selection in genetic algorithms (GAs) enables the users to browse through a solution space by expressing preferences and does not require any explicit definition of the attribute levels. Nor there is a need to express any fitness criteria. Instead the users are able to breed their products by manually selecting instances, which become parents of the next generations.

The term artificial selection is a reference to a process of manual selection of individuals, which breeders perform to preserve and nourish most desired characteristics in the whole stock. It served as Darwin's inspiration for development of natural selection theory (Steadman 1979). It was also discussed in the context of fine arts by Todd and Latham (1999) and it was referred to as "interactive genetic algorithm" in the context of fashion design and emotion-based image retrieval (Cho 2002). This research is a first proposition of it's implementation in online B2C mass customization of products.

3. Implementation of the Evolutionary Approach to Mass Customization

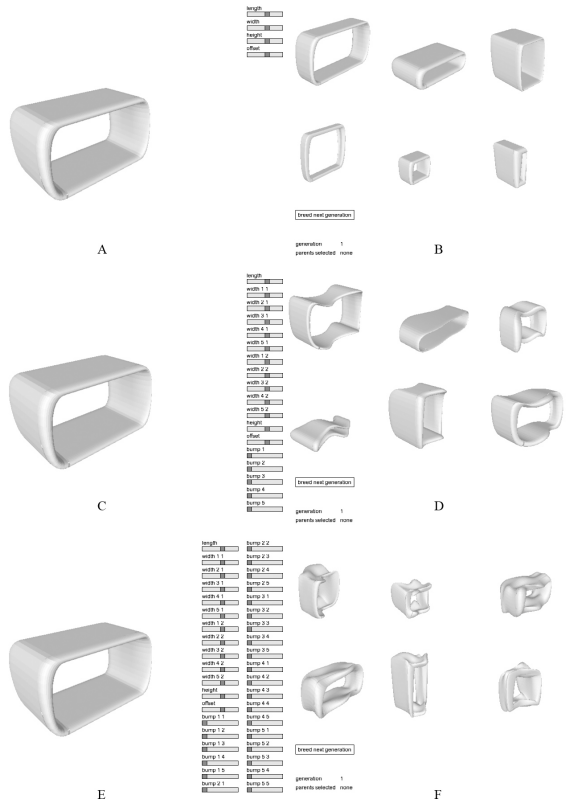

Figure 2. Six B2C configurators subject to experiment: 4 attribute parametric configurator - top left, GA - top right; 18 attribute parametric - middle left; GA - middle right; 38 attribute parametric - bottom right; GA - bottom left.

An empirical comparison of two distinctive sets of B2C product configurators was conducted to evaluate if artificial selection is a promising approach to solving the mass confusion problem (Piasecki and Hanna 2010). The first set contained three configurators using artificial selection in GAs, which enabled the users to browse through a solution space by selecting the solutions which they found meaningful. These tools where referred to as "genetic algorithms" or "GA" configurators. The other set featured 3 menu-based

configurators, which required an explicit definition of attributes levels and thus where further referred to as “parametric” or ”P” configurators. This set mimicked the strategies implemented in majority of commercial B2C configurators. A subject to customization was a parametric definition of a NURBS surface. It was meant to represent a piece of furniture, but it’s function was not specified. The six configurators where grouped into pairs from different sets but with the same number of solution space dimensions, that is the same number of attributes controlling the geometry (Figure 2).

It was found that a threshold existed in the number of solution space dimensions beyond which the popularity of parametric configurators was decreasing, but genetic algorithm configurators were not subject to this rule. The popularity of GA configurators appeared to grow continuously, while the number of customizable attributes was increasing (Figure 3). This finding suggested that the evolutionary approach to mass customization may solve the mass confusion problem in case of solution spaces with large number of dimensions. A principal components analysis of the patterns of interactions with each of the configurators revealed that highly correlated bundles of attributes are clearly visible in the choices made by particular users, but these are not common for all users. Because the manner of browsing through a solution space affects the values of the correlations, these therefore cannot serve as a basis of reduction of the solution space dimensionality. Additionally, a pre mature convergence of the population was identified as one of the potential drawbacks of the evolutionary approach.

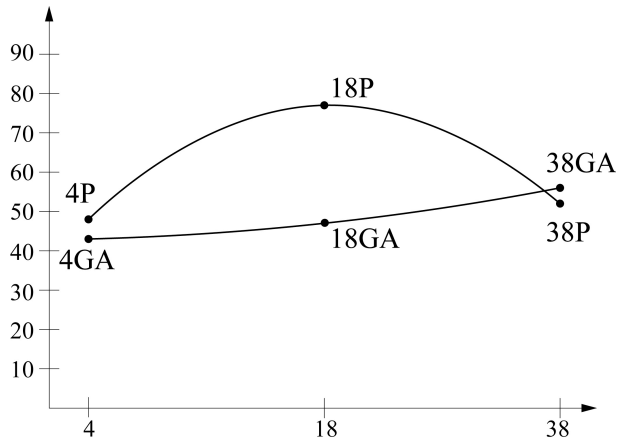

Figure 3. Number of sessions with and thus popularity of each of the six configurators.

Further experimentation will concern a conjunction of recommender systems, algorithms which automatically make suggestions based on users’ previous activities (Maes 1994, Schmidt-Thieme 2005, Felfernig et al. 2007), with the evolutionary approach to mass customization.

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