40 Inventive Mass-Customization Strategies

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Abstract

In their attempts to conduct business for effectively, the large majority of organisations adopt innovation strategies built on trade-off and compromise in which one aspect of business performance is improved at the expense of another. A systematic programme of research to identify and distill best practices from all areas of human endeavour has shown that those organisations that sought to challenge and eliminate the compromises and contradictions that their contemporaries assumed were unchallengeable or fundamental, have achieved considerably better business performance (Stalk et al, 2000). Building on a preceding study involving over 1500 person years of research examining the dynamics of system evolution from across all fields of human endeavour, the paper reports research showing that all compromise eliminating solutions so far observed – including those seen throughout the business world – can be derived from 40 basic strategies (Mann et al, 2003). The paper goes on to examine these 40 strategies for breakthrough business innovation in the context of their relevance to the trade-offs and compromises present in the mass-customization and personalization arena. The paper provides a list of the 40 known strategies alongside real world and hypothesised future examples of some of the main strategies in action.

Introduction

Mass-customization is fundamentally about challenging trade-offs. The large majority of so-called mass-customization initiatives appear in fact to simply be cases of moving the cost-versus-adaptability trade-off from one place to another. The findings of systematic innovation research show that successful innovators find ways of challenging trade-offs and compromises that produce genuinely paradigm-shifting win-win solutions.

One of the pillars of the systematic innovation method involves the concept of system ideality. Ideality is largely synonymous with 'value' and is usually defined within systematic innovation as:-

Ideality = Perceived (Benefits/(Cost + Harm))

The distillation of best practice from over 2.5 million cases has clearly shown that successful solutions clearly increase ideality in the eyes of customers relative to the products or services that they come to supersede. There is, in other words, an overall direction of successful innovation towards ever-increasing ideality. While the idea that successful innovations give customers more benefits, less cost and less harm than the things they replace may not sound too surprising, the idea that this evolution direction also has a final destination probably is. In systematic innovation terms, this evolution destination is commonly described as an Ideal Final Result (IFR). The precise definition of this IFR typically varies from one customer to another. This definition in turn frequently contradicts any ideal final result that might be determined by a supplier. Figure 1 attempts to illustrate evolution towards customer IFR and the conflicts that usually arise between customer and supplier.

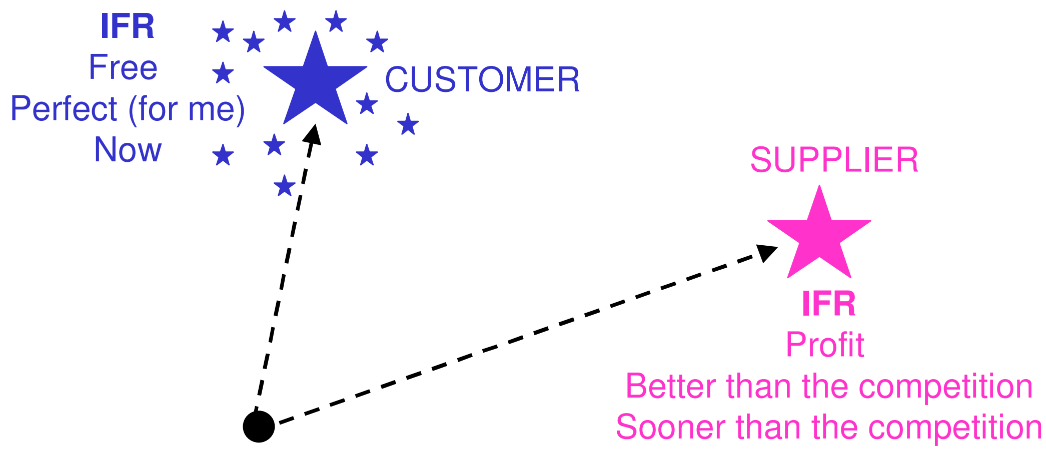

Figure 1: Typical Customer and Supplier Ideal Final Result Definitions

One of the things the figure highlights is the fact that although every individual customer has different definitions of what they might think of as their ‘ideal’ (here indicated as the cluster of stars), there are also a number of features that will be largely consistent. Among these comes the idea of ‘free, perfect and now’ as a customer IFR destination. Clearly such a definition attempts to recognise that ‘perfect’ will mean something different to each customer. Thus at the heart of the ‘free, perfect and now’ evolution destination, when compared to what a supplier might consider to be their ideal – more profit, and better than their competition – is the cost versus customization conflict fundamental to the mass-customization goal.

Although it would be possible to spend a considerable amount of time discussing the merits of the IFR concept and providing examples of systems that have achieved or come close to achieving the ‘free, perfect and now’ state, suffice it to say for the purposes of this paper that the IFR acts as an *attractor* that successful innovations will inevitably travel towards. It is suggested that customer IFR is more appropriate as an attractor than supplier IFR since, in this competitive age, it becomes increasingly likely that if one supplier won’t give customers what they want, another one surely will. What the systematic innovation research also clearly shows is that the mechanisms by which systems travel towards the IFR attractor involve the successive emergence and resolution of conflicts and contradictions. According to Figure 2, evolution occurs through a succession of different s-curves. S-curves represent a fundamental dynamic of evolution. They recognise that evolution is a discontinuous and non-linear process. What the s-curve characteristic suggests is that systems hit fundamental limits which may only be exceeded by changing the system.

The systematic innovation research has also distilled what it is that problem solvers do as they successfully resolve the fundamental limits associated with one system and successfully transition to another. These system transition strategies involve the win-win challenging of trade-offs and compromises. So far, from the 2.5 million cases analysed, just 40 different transition strategies – or 'Inventive Strategies' – have been uncovered.

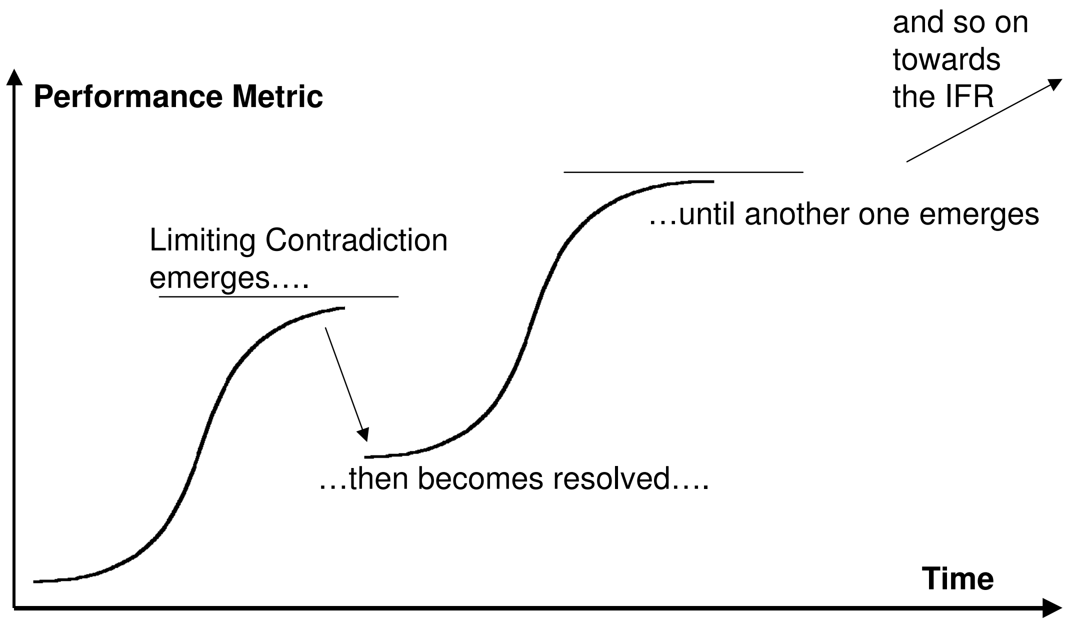

Figure 2: The Fundamental Dynamics of System Evolution

The focus of the paper from here is to examine these 40 Inventive Strategies in the context of their applicability to the mass-customization paradigm. Evidence from other areas of research suggests that some of the 40 Strategies are stronger than others. If we think of each of them as vectors pointing in the direction of the IFR attractor (Figure 3) then the evidence suggests that some vectors are longer than others and that some point directly towards the attractor while others, under certain (as we shall see, predictable) situations, might act in directions inconsistent with the attractor. The principle aim of the paper is to identify which of the 40 Strategies are the strong ones in the mass-customization context, and under which situations.

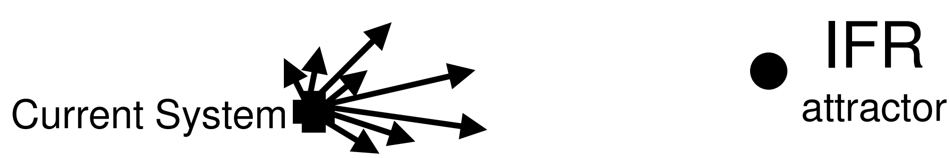

Figure 3: Inventive Principles Act As Signposts To More Ideal Systems

Existing Theories and Work

Whilst the idea of achieving trade-off eliminating, win-win business solutions has long been seen as an attractive goal, there has been little research effort expended in trying to distill the generic elements present in those cases where such an outcome has been achieved. A failure to recognise that at an abstracted level all businesses have to solve very similar problems has traditionally meant that the good solutions from one sector take a long time to transition to others.

The distillation of compromise-eliminating practices across all fields of engineering and science have revealed that all win-win solutions have so far emerged from the 40 inventive strategies mentioned in the introduction. A recent programme of research has demonstrated that businesses and managers are using precisely the same 40 strategies when they have achieved win-win solutions. In the technical arena, the 40 inventive strategies have already begun to prove their worth in accelerating the transfer of good strategies from one discipline to another. In this arena it has been shown that win-win solutions can now be achieved in a much more systematic and disciplined fashion (TRIZ Journal, 1997-2003). In the business model design arena generally and the mass-customization arena specifically, there has thus far been little if any exposure to the 40 known inventive strategies and consequently any win-win solutions have tended to emerge in a piece-meal fashion. The systematic deploy-ability of good solutions from other sectors to those interested in mass-customization form another of the bases of this paper.

Research Approach

The approach adopted in the research has involved the systematic trawling of the management, engineering and scientific literature in search of win-win solutions. Thus far, over 2.5 million such solutions have been recorded since analysis first commenced in 1946. In each case, the research team – which currently totals 25 full-time researchers – examines a solution in order to identify the compromise that has been challenged (for example, where a business has successfully challenged a time versus risk conflict or a quality versus cost conflict) and the inventive strategy or strategies that have been used in achieving the solution. Each solution has then been placed within a matrix of contradictions intended to offer a means of enabling users in other fields to identify a contradictory pair of business requirements and be able to immediately observe – and hence use – the inventive strategies that have been successfully used by others that have already solved a similar contradiction.

Findings

The findings of the research – which is ongoing in order to ensure that new solutions are fed into the contradiction elimination database as they emerge (Mann et al, 2003a) – are that most mass-customizing businesses are in fact merely shifting cost versus product individuation or personalization trade-offs from one place to another. Those few businesses that are successfully challenging the conflicts and contradictions associated with mass-customization, however, are using precisely the same 40 inventive strategies found in other sectors (Mann et al, 2001).

The research has more recently further identified examples of all of the known 40 strategies being used in mass-customization-relevant settings, albeit some are used much more frequently than others, and some to greater effect than others.

One of the important findings of the research has been the characteristic change in system complexity that occurs over the life of a system. This finding in particular needs to influence our application of the Inventive Strategies – since it has been observed (Mann, 2002) that certain Principles are far less applicable in certain stages of the evolution of a system than others. The main distinction that needs to be drawn involves the shifting complexity characteristic illustrated in Figure 4.

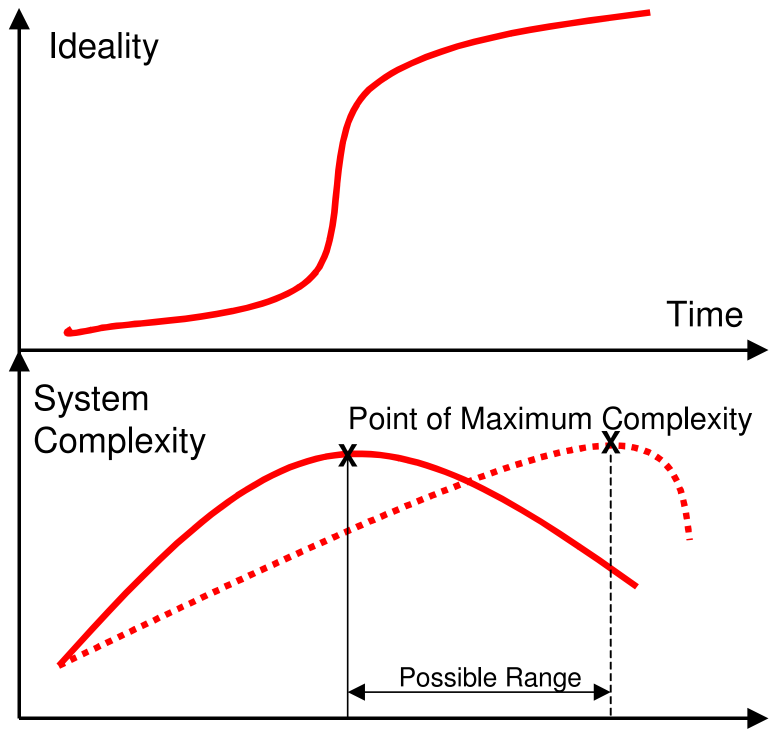

Figure 4: System Complexity Versus Time Correlated To S-Curve Position

The characteristic suggests that during the initial emergence and development of a system that its complexity inherently tends to rise. If we correlate complexity and part count, this part of the characteristic suggests that there are times when part-count will inherently have to increase in order for the system as a whole to evolve. The idea of increasing part-count and increasing complexity can very easily conflict with an intent to achieve a mass-customized solution. Unfortunately, the characteristic does appear – from all of the research conducted under the systematic innovation umbrella – to be fundamental (Mann, 2002). Consequently, any intelligent mass-customization endeavour should take due account of the phenomenon.

As we shall seek to demonstrate in the next section, different Inventive Strategies will be more use during different stages of the evolution of a system.

The main implication of the findings is that a prioritised list of the inventive strategies to systematically identify paradigm-breaking win-win solutions can be generated as a function of evolutionary state. Win-win mass-customization solution concepts for designs at all positions on their evolutionary s-curve should thus be systematically achievable.

40 Inventive (Mass-Customization) Strategies

The 40 Inventive Strategies are listed in the table below. Each entry consists of a description of the Strategy followed by indicative rankings in, respectively, increasing-complexity and decreasing-complexity phases of system evolution. Where a particular Strategy has no 'not applicable' included in the rankings, it should be interpreted that this strategy will not be particularly helpful in generating valid mass-customization solutions. Only Strategies with a demonstrated significant beneficial effect are given rankings. Although the rankings are based on the research evidence they should be interpreted as guidelines rather than absolute rules.

	Inventive Strategy Description and Mass-Customization Context	Ranking (complexity increasing)	Ranking (complexity decreasing)
1	**Segmentation** *A. Divide a system into separate parts or sections.* *B. Make a system easy to put together and take apart.* *C. Increase the amount of segmentation* The Segmentation strategy is a very commonly used one in the initial phases of customizing products. It is however a relatively weak strategy in the longer term since it tends to increase inventory.	15	n/a
2	**Taking out** *A. Where a system provides several functions of which one or more are not required at certain conditions, design the system so that they can be separated or taken out.* The separation of different functions in a system is an important mass-customization technique – particularly in the context of modularization strategies.	n/a	13
3	**Local quality** *A. Where an object or system is uniform or homogenous, make it non-uniform* *B. Change things around the system (e.g. the environment)) from uniform to non-uniform.* *C. Enable each part of a system to function in locally optimised conditions.* *D. Enable each part of a system or object to carry out different (possibly directly opposite) useful functions.* Most effectively used to eliminate existing components from a system and, by changing the shape of other components, transfer capabilities made possible by the eliminated components into the remaining components.	17	7
4	**Asymmetry** *A. Where an object or system is symmetrical or contains lines of symmetry, introduce asymmetries.* *B. Change the shape of an object or system to suit external asymmetries (e.g. ergonomic features)* *C. If an object or system is already asymmetrical, increase the degree of asymmetry.* Usually simple to exploit resource. Asymmetry can be used to enable one system to achieve a multiple number of functions. Similar in some ways to Strategy 3, but here specifically promoting consideration of asymmetrical features. As suggested in B, particularly importance in ergonomic contexts. Also, with the ‘rule of thirds’, an interesting strategy in the context of design aesthetics.	19	14
5	**Merging** A. *Physically join or merge identical or related objects, operations or functions.* *B. Join or merge objects, operations or functions so that they act together in time.* Only effective when cost reduction becomes the primary evolution driver in the mass-customization conflict. Close parallels with Axiomatic Design and DFMA	n/a	18

6	**Universality** *A. Make an object or system able to perform multiple functions, eliminating the need for other systems.* Overlaps slightly with Strategy 5, but intended to give additional focus to the idea of integrating different functions into one place. A Swiss-Army knife is a good example of Strategy 5; having a single tool that performed all of those performed by the different tools on that design would be Strategy 6.	n/a	11
7	**"Nested doll"** *A. Put one object or system inside another* *B. Put several objects or systems inside others.* *C. Allow one object or system to pass through a hole in another.* Effective customization strategy during the early evolution of a system, but adds complexity that the cost structure may not be able to afford in later evolution stages – unless the Strategy can be deployed at the micro or molecular scale.	7	n/a
8	**Anti-weight** *A. Where the weight of an object or system causes problems, combine it with something that provides lift.* *B. Where the weight of an object or system causes problems, use aerodynamic, hydrodynamic, buoyancy and other forces to provide lift.*	20	-
9	**Preliminary anti-action** *A. Where an action contains both harmful and useful effects, precede the action with opposite or anti-actions to reduce or eliminate the harmful effects.* *B. Introduce stresses in an object to oppose known harmful working stresses later on.*	-	-
10	**Preliminary action** *A. Introduce a useful action into an object or system (either fully or partially before it is needed.* *B. Pre-arrange objects or systems such that they can come into action at the most convenient time and place.* Most effectively deployed in either manufacture processes or supply chain management. The Benetton business model is built around this Strategy – they knit garments before dyeing them.	8	19
11	**Beforehand cushioning** *A. Introduce emergency backups to compensate for the potentially low reliability of an object (‘belt and braces’)* Effective only in the initial stages of a mass-customization evolution, and then it usually serves to add benefits at the expense of at least some additional cost.	25	n/a
12	**Equipotentiality** *A. If an object or system is exposed to external forces, redesign the environment so the forces are eliminated or are balanced by the surrounding environment* Specialised, but often effective in terms of matching a mass-customized product or service to local environment.	24	-

13	**'The other way around'** *A. Use an opposite action(s) used to solve the problem (e.g. instead of cooling an object, heat it).* *B. Make movable objects fixed, and fixed objects movable.* *C. Turn the object, system or process 'upside down'.* Several mass-customization interpretations and applications. Generally speaking, the Strategy can only be used one time during the evolution of an s-curve for a system.	6	12
14	**Curvature** *A. Turn straight edges or flat surfaces into curves.* *B. Use rollers, balls, spirals, domes.* *C. Switch between linear and rotary motion* *D. Introduce or make use of centrifugal forces.*	22	-
15	**Dynamics** *A. Allow a system or object to change to achieve optimal operation under different conditions.* *B. Split an object or system into parts capable of moving relative to each other.* *C. If an object or system is rigid or inflexible, make it movable or adaptable.* *D. Increase the amount of free motion* A very effective means of enabling products or services to become adaptable to the different requirements of different customers.	2	8
16	**Partial or excessive actions** *A. If exactly the right amount of an action is hard to achieve, use 'slightly less' or 'slightly more' of the action, to reduce or eliminate the problem.* Relatively weak in the mass-customization context, but often has some application during the reduction of manufacture costs.	-	-
17	**Another dimension** *A. If an object contains or moves in a straight line, consider use of dimensions or movement outside the line.* *B. If an object contains or moves in a plane, consider use of dimensions or movement outside the current plane.* *C. Use a stacking arrangement of objects instead of a single level arrangement.* *D. Re-orient the object or system, lay it on its side.* *E. Use 'another side' of a given object or system.* Successful deployment depends on manufacturing technology availability if compromise is to be avoided.	21	20
18	**Mechanical vibration** *A. Cause an object to oscillate or vibrate.* *B. Increase the vibration frequency (e.g. up to ultrasonic).* *C. Make use of an object or system's resonant frequency.* *D. Use piezoelectric vibrators.* *E. Use combined field oscillations.* Specialised, but has some mass-customization relevance. Resonance can be a particularly useful resource if used with care.	-	-

19	**Periodic action** *A. Replace continuous actions with periodic actions.* *B. If an action is already periodic, change the periodic magnitude or frequency to suit external requirements.* *C. Use gaps between actions to perform different useful actions.*	1	4
20	**Continuity of useful action** *A. Make all parts of an object or system work at full load or optimum efficiency, all the time.* *B. Eliminate all idle or non-productive actions or work.* Relatively weak Strategy overall. Most effectively used in conjunction with other Strategies – particularly 25, Self-Service.	n/a	-
21	**Skipping** *A. Conduct an action at very high speed to eliminate harmful side-effects.* Very specialised Strategy. Often effective but insufficient data to establish relative importance in the mass-customization context.	-	-
22	**"Blessing in disguise"** *A. Transform harmful objects or actions (particularly, from the surrounding environment) so that they deliver a positive effect.* *B. Add a second harmful object or action to neutralize or eliminate the effects of an existing harmful object or action.* *C. Increase a harmful factor to such a level that it is no longer causes harm.* Always useful Strategy. The concept of transforming lemons into lemonade is a central pillar of the systematic innovation method. Highly effective mass-customization solutions often emerge from transforming harmful things into useful ones. Examples – getting competitors to do your work for you, harnessing pressures and temperatures that are normally fought.	9	6
23	**Feedback** *A. Introduce feedback to improve a process or action.* *B. If feedback is already used, make it adaptable to variations in operating requirements or conditions.* With the advent of cheap microprocessors, it is extremely cost effective to make products respond to different customer needs by adding intelligence. Most effectively deployed during early phases of system evolution.	5	n/a
24	**'Intermediary'** *A. Introduce an intermediary between two objects, systems or actions.* *B. Introduce a temporary intermediary that disappears or can be easily removed after it has completed its function.* Particularly during the initial evolution of a system, it is frequently necessary to add intermediary components in order to achieve ancillary functions adequately. In the longer term, such intermediaries tend to become merged (Strategy 5) into other components.	16	n/a

25	**Self-service** *A. Enable an object or system to perform functions or organise itself.* *B. Make use of waste resources, energy, or substances.* Overall, the most powerful of all of the Strategies, Self-Service includes things like ‘self-adjusting’, self-cleaning’, ‘self-aligning’, ‘self-authoring’, etc. Central to the concept of ideal (mass-customized) systems capable of adapting themselves to the changing needs of customers. In the true meaning of the strategy, the self-x capability is achieved without complicating the system (Mann, 2002)	11	1
26	**Copying** *A. Use simple and inexpensive copies in place of expensive, possibly vulnerable objects or systems.* *B. Replace an object, or action with an optical copy.* *C. If optical copies are already being used, make use of infrared or ultraviolet wavelengths.* Increasingly interpreted as a shift to virtual models. Effective as a mass-customization strategy for services, but anything that ultimately ends up as a tangible object is unlikely to benefit from use of this Strategy.	18	-
27	**Cheap short-living objects** *A. Replace an expensive object or system with a multitude of inexpensive, short-life objects.* Relatively weak Strategy in the mass-customization context as it can very easily simply shift the cost trade-off from first cost to life-cycle cost.	-	-
28	**Mechanics substitution/Another Sense** *A. Replace an existing means with a means making use of another sense (optical, acoustic, taste, touch or smell).* *B. Introduce electric, magnetic or electromagnetic fields to interact with an object or system.* *C. Change from static to movable, fixed to variable, and/or from unstructured to structured fields.* *D. Use fields in conjunction with field-activated (e.g. ferromagnetic) objects or systems.* The transition away from mechanical systems offers extremely effective means of achieving product designs capable of adapting to different operating situations. This is particularly so when considering the use of fields.	3	9
29	**Pneumatics and hydraulics** *A. Use gases and liquids instead of solid parts or systems* Transitioning from mechanical systems to fluidic ones offers a very effective means of achieving adaptive properties – thus enabling one system to fulfil several shapes and/or functions	12	16
30	**Flexible shells and thin films** *A. Incorporate flexible shells and thin films instead of solid structures* *B. Isolate an object or system from a potentially harmful environment using flexible shells and thin films.* Very effective in delivering low-cost, adaptive systems.	13	5

31	**Porous materials** *A. Make an object porous or add porous elements* *B. If an object is already porous, add something useful into the pores.* Very effective in delivering highly adaptive solutions that use low quantities of material. Foam metals and plastics represent good examples.	14	3
32	**Colour changes** *A. Change the colour of an object or its surroundings.* *B. Change the transparency of an object or its surroundings.* *C. In order to change the visibility of things, use coloured additives or luminescent elements* *D. Change the emissivity properties of an object subject to radiant heating* Often under-exploited resource. Colour is often a very easy attribute to change in order to customize a product or service. The Strategy is especially powerful when used in combination with Strategy 3, Local Quality.	10	15
33	**Homogeneity** *A. Make interacting objects from the same material (or material with matching properties).* Specialised, but may have some minor role in mass-customization design strategies	-	-
34	**Discarding and recovering** *A. Make elements of an object or system that have fulfilled their functions disappear (by dissolving, evaporating, etc.) or appear to disappear.* *B. Restore consumable or degradable parts of an object or system during operation.* Most effectively used in a manufacture cost reduction context, but can also be applied to business model design for mass-customization.	-	17
35	**Parameter changes** *A. Change an object's physical state (e.g. to a gas, liquid, or solid).* *B. Change concentration or consistency.* *C. Change the degree of flexibility.* *D. Change the temperature.* *E. Change the pressure.* *F. Change other parameters.* Parts A-C are particularly relevant in the mass-customization context. The concept of adding flexibility to systems offers an effective means of adding adaptability without complexity.	4	2
36	**Phase transitions** *A. Make use of phenomena taking place during phase transitions (e.g. volume changes, absorption of heat, etc.).* Specialised, but nevertheless potentially very powerful mass-customization strategy – enabling systems to adapt to different situations according to some pre-designed trigger transition.	23	19

37	**Thermal expansion** *A. Use thermal expansion (or contraction) of materials to achieve a useful effect.* *B. Use multiple materials with different coefficients of thermal expansion to achieve different useful effects.* Specialised, but may have some minor role in mass-customization design strategies	-	-
38	**Strong oxidants** *A. Replace atmospheric air with oxygen-enriched air.* *B. Use pure oxygen.* *C. Use ionising radiation.* *D. Use ionised oxygen.* *E. Use ozone.* Specialised, but may have some role in mass-customization design strategies.	-	-
39	**Inert atmosphere** *A. Replace a normal environment with an inert one.* *B. Add neutral parts, or inert elements to an object or system.* Specialised, but may have some minor role in mass-customization design strategies	-	-
40	**Composite materials** *A. Change from uniform to composite (multiple) materials where each material is optimized to a particular functional requirement.* Increasingly used strategy – although so far generally being introduced at the mature end of system evolution. Time will tell whether new systems will deploy composite structures at an earlier stage. Composites in the mass-customization context offer the potential for varying properties under different operational circumstances.	-	10

Making Use of the Principles

The list of the 40 Strategies perhaps suggest a degree of generality that makes it difficult to see how they may be applied to useful effect. They have, however, been designed specifically to work in ways that are compatible with the manner in which the human brain operates when in a 'creative' mode (DeBono, 1992). The key in the case of, to pick an example at random, the Asymmetry Strategy, if it is suggested as a potential solution to a given mass-customization contradiction is to connect to symmetries in the existing system and explore what happens when they are turned into asymmetries.

A useful way to think about the Strategies is as an alternative to the 'random word provocation' technique recommended by Dr Edward DeBono. In this technique, a problem setting is defined – for example, 'how to design a shoe capable of adapting to changes in foot size' – and we then go to a dictionary and select a random word. Say we obtain the word 'cheese'. Then we use this word as a means of helping us to generate new ideas about our adaptive shoe problem. Thus we might say that cheese has holes, or is flexible and rubbery, or low-melting temperature, or smell, etc (experimental evidence suggests that because of our different life experiences, we will generate a very large number of different thoughts if we persevere). Some of the connections we make will be useful and others won't. What the systematic innovation method has effectively done is to identify that we don't need a whole dictionary in order to connect to 'out of the box' concepts, and that there are just 40 good words to use. Hence, a very simple way in which the 40 Inventive Strategies can be utilised is in a focused brainstorming activity – what does 'asymmetry' mean in the context of the problem? What can we segment? And so on. There are of course more sophisticated ways of deploying the Strategies (see Mann et al, 2003b, for example), but this focused brainstorm concept is often sufficient to develop some extremely elegant mass-customization solutions.

Conclusion

The large majority of enterprises conduct their business using traditional trade-off and compromise perspectives of the world. The overwhelming research evidence suggests that the most successful enterprises do not use such strategies when they are looking to improve the way they conduct their business. The research evidence further suggests that taken across every field of human endeavour there are thus far just 40 known strategies through which compromises and trade-offs can be challenged and eliminated. The paper brings these 40 Strategies together in the specific context of mass-customization situations for the first time anywhere.

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