SO, WHAT COMES NEXT? CONSTRUCTIVE RANDOMNESS WITHIN PRODUCTS

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ABSTRACT

Product design is most often about building order and predictable functions into objects. There exists however a fascinating array of products that possess some purposeful disorder and unpredictability. These products embrace the concept of randomness and interaction with such products brings an experience of being out of control. This paper discusses the concept and application of randomness in product design through a two-pronged methodology: partly a survey of prior academic art and partly an analysis of twenty products. The findings show randomness to be exhibited in products for a variety of reasons: entertainment, security, ambient effects, and gambling. From the findings, general suggestions for how to integrate constructive randomness into products are made. The primary purpose of the paper is to act as a stimulus for designers, researchers and educators, giving insights into a product attribute that has good potential for more widespread application in future products.

Keywords: interaction, experience, design, randomness, unpredictability.

INTRODUCTION

Forrest Gump (1994) famously sat on a park bench and remarked, “My momma always said: life was like a box of chocolates; you never know what you’re gonna get”. Such is the case with products that exhibit randomness. We cannot tell what the product is going to bring us next. This paper discusses the concept of randomness as manifest in products and related software and services. Products possess randomness broadly in one of two possible ways: either by exhibiting an unpredictable variable state, or having an initial state that is unpredictable. What makes this class of products fascinating is that it counteracts the general approach to product design, which is to build order and predictable functions into designed objects. Desmet *et al.* (2008) introduced such concerns within the context of product personality: “consistency makes it easier to predict how people will behave and respond during social interaction, which may also apply to humane product interaction. Note that reducing the mental load is not the only possible design strategy. In some cases it is more favourable to deliberately use inconsistencies to design products that are perceived as innovative and rich in their interaction…” (p474).

The purpose of this paper is to provide designers and researchers with a useful ‘starting point’ reference for the major issues of concern in the area, based on literature reviews and an analysis of product examples. This was considered worthwhile because advice on how to link randomness to the design of products is very sparse, despite randomness being a quite common feature of many types of everyday objects. The work was sparked by curiosity from graduate-level teaching in the area of user-product interactions: what can we learn about the characteristics of products exhibiting randomness, in order to define some principles for creating desirable ‘random dimensions’ within a newly conceived product?

The basic characteristics of randomness, including rates of change, dynamism and unpredictability are outlined in the paper. Philosophical explanations of

randomness drawn from sources outside of design are used to help understand the randomness exhibited by product examples. In one of the few studies of randomness and consumer products, Leong *et al.* (2006) note that randomness exhibited by music playback devices can bring positive or negative connotations depending on context. As will be shown later, this observation is shared by theoreticians and leads to the useful distinction between constructive randomness (generally good) and deconstructive randomness (generally bad). Thus, the focus throughout the paper is to try to expose what designers can do to design for constructive randomness in products.

CHARACTERISTICS OF RANDOMNESS

Eagle (2005) provides a high-level philosophical account dispelling some arguably mistaken views on what randomness is, and what we mean if we say that 'randomness is unpredictability'. Randomness is said to be present if there is no way to predict the occurrence, value, state, etc. of something. Concomitantly, something is not considered random if the governing rules and constraints (patterns) for occurrences, values, states etc. are known and can be used to predict outcomes. Most times, we do not know or cannot decipher such rules, so that the unpredictability appears to be random. Dembski (1991) posits that "without patterns, objects are just objects, not random objects." In other words, a lack of pattern is a key property of random phenomena, and such patterns are recognized through the peculiarities of human perception and cognition. We may conclude that an event experienced is seemingly random, because we are ignorant of the underlying rules that determine the variability. These issues have been grappled for eons, and are well known to have occupied the minds of Greek philosophers. Most importantly, it is a person's *perception* of randomness that is a central point here (Frigg, 2004), and one that will be revisited throughout the paper. Other people, for example the makers of products, may be privy to explanations of the changeable or uncertain states and be able to correctly predict what comes next. For example, there are many algorithms (based on arithmetic or cellular automation) that can generate pseudorandom numbers. If the 'seed state' and the algorithm used are known, the behaviour of the system can be predicted.

A useful distinction accompanying the concept of randomness is that of *process* and *product* randomness (Dembski, 1991; Earman, 1986). We may also refer to these as randomness *cause* and randomness *outcome* or *effect*. The distinctions are as follows.

- Randomness in process / cause. Operating without definable principles or which cannot be adequately modelled.
- Randomness in product / outcome / effect. Reliant on interpretation by an observer, who can discern no underlying pattern.

Frigg (2004:24) reminds us that process and product randomness need not be bound by a causal relationship, nor is it obligatory for the presence of randomness to be shared by both process and outcome: "so-called 'random number generators' in digital computers… are programs that are set up in a way that the sequences that they produce look random, but all the program performs are simple arithmetical manipulations of numbers which do not involve any stochastic element."

A common approach to describing and understanding randomness is to take a perspective of probability and chance. Devices for creating chance include lots, spinners, dice and lotteries. Chance was especially important in primitive societies for three basic reasons, "to ensure fairness, to prevent dissension, and to acquire divine direction" (Bennett, 1998:12). In other words, taking away controlling influences of human intervention. Bennett argues that the key to understanding and predicting random events to some degree of success is to examine whether a series of random outcomes demonstrate a *sequence*. For Dembski (1991), the test is to see if random events (sequences) fail to be described through statistical tests or short verbal descriptions. Dembski explains that the most apparently random sequences are those for which "After repeated attempts you find you cannot describe the sequence any better than the sequence describes itself. Hence you conclude that it is a genuinely random sequence" (p34). A simple example is as follows, where two lots of forty coin flips

result in the following two sequences (1 = head, 0 = tail).

Sequence 1 =

1111111111111111111111111111111111111111

Sequence 2 =

10101100111101110010011011110000101011 10

Sequence 1 can be given the short verbal description 'repeat '1' forty times'. Its simplicity suggests to us it is very probably not a sequence arising from a random process. Sequence 2 apparently has no shorter verbal description than the sequence itself, which suggests to us it is very probably a sequence arising from a random process. Incidentally, sequence 2 is the result of an actual sequence of forty fair coin flips. A crucial point here is that we are less inclined to believe that something is the result of a random process if the probability of the sequence occurring is very slim. In the case of coin flipping, we are easily misled into thinking that sequence 1 is less likely to occur than sequence 2. As a chain of 40 individual steps, both have an equal probability of occurring - $(1/2)^{40}$ (approximately one in one million million chance) – and thus both can be valid outcomes of a random process.

From a product design perspective, if '1s' and '0s' represent changes in state of some element of a product, clearly sequence 1 would be static and uninspiring, whilst sequence 2 would be dynamic but tedious. We would feel that a product purported to exhibit randomness but which delivered a static outcome would be a fraud. So it is most important for product design that randomness is exhibited as *changeability* or *avoidance of repetition*. For the former point, if we take the coin flips example, we can say that of the $(1/2)^{40}$ possible outcomes, the vast majority include changes of state in the 40-event sequence, rather than long stretches of continual states. So the experience of the user will mostly be variability. However, the variability will indeed be limited to just two states, '1' and '0'. Thus to heighten the possibility of changeability, and to realize an engaging level of randomness in a product, we should have a larger number of possible states than just two. Of course, if there are a large number of possible states, with a very high frequency of change, user experiences become chaotic. So we may say that a middle ground in unpredictability is likely to be most relevant in the design of products exhibiting randomness.

Three further concepts tying randomness to product design are now shortly mentioned: bounded randomness, controlling influences and pseudo-randomness.

BOUNDED RANDOMNESS

This is the term used to describe randomness that occurs within a limited set of definable possibilities. For example, games of chance involving simple gaming devices (coin, dice) are a good example of bounded randomness. The number of possible outcomes is very slim: two for a coin, six for a dice. We are more likely to get lucky in correctly predicting what will come next where very simple probability models are involved. Thus the excitement attached to product randomness is not really maintained in highly bounded situations (as represented by the tossed coin sequences 1 and 2).

CONTROLLING INFLUENCES

There may be physical influences on the outcome of random processes, giving distance of the end outcome from human intervention. For example, in a roulette wheel, such as found at a casino, the behaviour is very sensitive to initial conditions (studied in chaos theory) in which the wheel and ball are impacted and set in motion. With such circumstances, players have greater confidence that the outcome of the process has not been unfairly manipulated or rigged. This idea of removing control from people is an important qualitative aspect of randomness as applied to product design.

PSEUDO-RANDOMNESS

An unpredictable experience from a product, for example not knowing the flavour of a chewing gum before opening the wrapper, may not necessarily be anything random. For instance, all of the packages sent to a shop may contain melon. Labelling the package as 'unknown' merely gives ambiguity to the customer; the manufacturer may be fully in control and used no random assignments at all. In such cases, it is said that there is the presence of pseudo-randomness. The experience of the end user can be

contrasted with the principles of production used by the manufacturer, to determine if pseudo-randomness is a valid option for a new product.

CONSTRUCTIVE AND DECONSTRUCTIVE RANDOMNESS IN USER-PRODUCT INTERACTION

Now that some of the basic principles of randomness have been established, attention can be turned to ways in which randomness might conceivably arise within products (or people's interactions with products more specifically). Randomness implies some continual change in state, in a product, or an unpredictable influence on the initial state of a product. Randomness can manifest in the materiality of an object (e.g. a random surface texture), in its utility (e.g. having a shuffle mode) or in user-product interaction (e.g. pressing a button without knowing exactly the outcome or effect). For user-product interaction, erratic behaviour is clearly not desirable in many circumstances. It is therefore crucial to properly examine contexts when assessing the appropriateness of including a random factor in products. For example, randomly functioning washing machines and randomly dispensing cash machines have only comical value, but random image projections and random web page generators do have clear uses. Designing for randomness has overlaps with designing for serendipity, since both include instances of chance: "chance leads to the possibility of new behaviors, new patterns, new ideas, and new structures. It allows people to change their behaviour in response to a context, in the moment, however fleeting" (Danzico, 2010). Similarly, designing for randomness can be one approach to offering users a design that has no fixed state or configuration, promoting a personal and playful exploration by users (McCarthy & Wright, 2004). In combination, these various points lead to the notion of 'constructive randomness' and 'deconstructive randomness' within products, as shown in Table 1.

	Constructive Randomness	**Deconstructive Randomness**
Keywords	*Variability, flow, dynamism*	*Chaos, disorder, confusion*
User Affectation	*Positive*	*Negative*
User Experience	*Curiosity, refreshing, engaging, surprising, serendipitous.* *Excitement of the unknown.* *Pleasantly out of control.*	*Frustration, distracting, off-putting, jarring, irritating.* *Overburdened because of the unknown.* *Unpleasantly out of control.*

Table 1: Characterization of constructive and deconstructive randomness

EXAMPLES OF PRODUCTS EXHIBITING RANDOMNESS

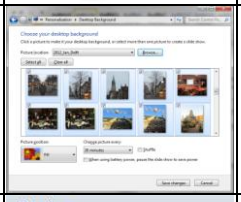
There exist many intriguing products, across product sectors, which are built on the integration of randomness. In other words, they have designed-in disorder. Table 2 provides a gallery of twenty products exhibiting randomness. They were chosen to show a wide range of applications, including electronic products, software, food, games, toys and manufacturing. Randomness in materiality, utility and interaction are all represented. Twenty was deemed a sufficient quantity of products to allow a reasonably deep analysis of the randomness characteristics and to identify some commonalities (see section 5).

It will be appreciated that the extent of the randomness varies across these products. It can be either (i) the essence or the main reason for existence and hence the desirability of the product, or (ii) provided as a feature of the product, but does not define its raison d'etre.

SUGGESTIONS FOR INTEGRATING CONSTRUCTIVE RANDOMNESS INTO PRODUCTS

In this section, suggestions for integrating constructive randomness into products are theorized based on an analysis of the randomness characteristics of the products presented in Table 2. The points raised can be used to help conceive plausible new products for

which randomness is an important and desirable attribute. The analysis involved an examination of three dimensions: (i) the generator of the randomness (G1 = software algorithms, G2 = laws of physics, G3 = packaging / distribution, G4 = mathematical possibilities); (ii) whether a random event must be triggered manually through interaction or if it is continuously offered without interaction (I1 = interaction, I2 = without interaction); and (iii) the primary reason for the inclusion of randomness (R1 = fun / entertainment / games, R2 = security, R3 = ambient effects, R4 = gambling). The results of the analysis are presented in Table 3.

Product Sector **Product Name**	**Image**	**Extent of Randomness** **Description of Random Outcome**
Electronic product *iPod Shuffle*		FEATURE Varied audio track playing order
Electronic product *Mains outlet switcher*		MAIN REASON Varied on-off supply of electricity
Electronic product *Lava Lamp*		MAIN REASON Varied light and physical movement
Electronic product *Projection Clock*		MAIN REASON Varied light colour
Electronic product *Security Key*		MAIN REASON Varied passwords
Software *Wallpaper Changer*		FEATURE Varied background images
Software *PowerPoint*		FEATURE Varied transition between slides
Software (Web) *Wikipedia*		FEATURE Varied encyclopedia entries
Software (Web) *Garanti Bank*		FEATURE Varied PIN code sent to mobile telephone
Software (Web) *SkypeMe*		FEATURE Varied connection to Skype members

Food *Kinder Surprise*		MAIN REASON Varied novelty toys
Food *Cadbury Revels*		MAIN REASON Varied tastes, smells, textures, appearance
Game *Top Trumps*		MAIN REASON Varied shuffle position of cards
Game *Roulette Wheel*		MAIN REASON Varied wheel-ball locations
Game *Lottery Ticket*		MAIN REASON Varied numbers
Game *Monopoly (Dice)*		MAIN REASON Varied performance in game
Toy *Kaleidoscope*		MAIN REASON Varied visual effects
Toy *Speaking Telephone*		MAIN REASON Varied musical and visual feedback
Furniture *Vectric CNC machining*		FEATURE Varied surface patterns and finishes
Furniture *Peter Traag Sponge Chair for Edra*		FEATURE Varied upholstery folds

Table 2: Gallery of twenty products exhibiting randomness

GENERATOR OF RANDOMNESS

It can be seen from Table 3 that software algorithms are the dominant cause of randomness not only for desktop and web-based software but also for artefacts such as toys and electronic products. Microprocessors deliver randomness in a very efficient manner and can be coupled to a wide variety of product functions and features. Furthermore, as seen in the case of Vectric CNC machining, software algorithms can also be used in the creation of a product, to create unique aesthetic qualities that become part of the product's materiality. For lottery tickets, it is usually possible to request a machine-filled ticket rather than filling in the lottery numbers by hand.

Sector	Product	Generator	Interaction	Reason
Electronic Product	*iPod Shuffle*	G1	I2	R1
Electronic Product	*Mains Outlet Switcher*	G1	I2	R2
Electronic Product	*Lava Lamp*	G2	I2	R3
Electronic Product	*Projection Clock*	G1	I1	R3
Electronic Product	*Security Key*	G1	I1	R2
Software	*Wallpaper Changer*	G1	I2	R3
Software	*PowerPoint*	G1	I2	R3
Software (Web)	*Wikipedia*	G1	I1	R1
Software (Web)	*Garanti Bank*	G1	I1	R2
Software (Web)	*Skypeme*	G1	I1	R1
Food	*Kinder Surprise*	G3	I1	R1
Food	*Cadbury Revels*	G3	I1	R1
Game	*Top Trumps (Card Shuffling)*	G4	I1	R1
Game	*Casino (Roulette Wheel)*	G2 + G4	I1	R4
Game	*Lottery Ticket*	G1 + G4	I1	R4
Game	*Monopoly (Dice)*	G2 + G4	I1	R1
Toy	*Kaleidoscope*	G2	I1	R1
Toy	*Speaking Telephone*	G1	I1	R1
Furniture	*Vectric CNC Machining*	G1	I2	R1
Furniture	*Peter Traag's Sponge Chair for Edra*	G2	I1	R1

Table 3: Analysis of randomness dimensions.

Laws of physics and the generation of randomness through constraints in the physical world are also represented in Table 3. A lava lamp relies on laws of thermodynamics and gravity, whereas a kaleidoscope relies on laws of gravity coupled to mirror reflections. For the Sponge Chair for Edra, the randomness in the surface material qualities arises because of a free-flowing folded approach to upholstery. Dice and roulette wheels make use of physical collisions as well as gravity to achieve a random outcome, and the use of labelling restricts the possible outcomes to certain mathematical possibilities. Finally, randomness for Kinder Surprise and Cadbury Revels is achieved via the packaging process (in the factory) and the distribution process (from factory to warehouse to retailer to consumer). To the consumer, the outcome is like a lottery. Such randomness in these foods is allied to concealment and can be used to entice people to purchase in greater volumes by, for example, hiding bank notes in crisp packets or issuing special 'golden tickets' inside Wonka Bars (Dahl, 1964).

PRESENCE OF INTERACTION TO ACHIEVE RANDOM OUTCOME

Table 3 reveals that the majority of the analyzed products require manual interaction for the random event or phenomenon to be triggered. That is, for the majority of the listed products in Table 3, the decision to experience randomness, and the time at which it is experienced, is firmly within the control of the user, even through the random outcome is not. Only a few of the products offer a form of continual randomness without the necessity of interaction. Products falling into this latter group were all (except one) driven by

software algorithm randomness: iPod Shuffle, mains outlet switcher, wallpaper changer, PowerPoint transitions, and Vectric CNC machining. We also see randomness exhibited in many websites, without the necessity of user intervention, for example in changing home-page images to create a fresh and renewed outlook. The notable exception in Table 3 is the lava lamp, which offers non-interactional randomness but based on laws of physics rather than software algorithms.

PRIMARY REASON FOR INCLUSION OF RANDOMNESS

This section discusses the four primary reasons for inclusion of randomness within the products listed in Table 3. It attempts to provide a greater depth of characterization than the 'computational purposes' and 'artistic purposes' posited by Leong *et al.* (2006).

Fun / entertainment / games

The majority of the analysed products fall into this category. The original Apple iPod Shuffle was accompanied by the marketing slogan "random is the new order" (Wikipedia, 2012). It emphasized that it could be hip to step out of line; that we could be just as entertained by being out of control as being in control of music playback. The enjoyment and fun aspect is strong in the products of this category. Wikipedia's random entry function takes the user on a discovery of unexpected knowledge, becoming filled with trivia. Similarly, the SkypeMe function within Skype allows access to random new contacts (although the function as now been removed from Skype because of user confusions and reservations). Consumption of Kinder Surprise and Cadbury Revels is about enjoyment of the unknown, of anticipation, either with the chocolate itself, or the toy contained inside the chocolate.

In shuffle card games (e.g. Top Trumps, Old Maid) and dice throwing games (e.g. Monopoly, Risk), the factor of chance provides the essence of intrigue and engagement necessary to play the game. In a Kaleidoscope, it is the motivation to create and view endlessly different patterns that is the reason for including randomness, whilst for a speaking telephone a toddler can enjoy guessing what might be next and repeating the spoken phrase. The last two products of Table 3, Vectric CNC machining and the Sponge Chair for Edra, are both the result of an unpredictable processes that adds value to the surface qualities of a product and delivers unique aesthetics.

Security

The mains outlet switcher is a product that can turn a mains electricity outlet socket on and off at different times. At night time, if connected to a light, an unoccupied house can appear to be occupied and thus deter any potential burglars. The security key product generates random numbers, which when combined with a user's own (fixed) PIN number, can allow access to any secured product or system, such as a locked room, a computer, a server etc. Similarly, the Internet banking system provided by Garanti Bank (Turkey) involves the transmission of a one-time alphanumeric passcode to the user's mobile telephone, which acts as an additional layer of security on top of customer numbers, PINs etc.

Ambient effects

The lava lamp, projection clock, wallpaper changer and PowerPoint transitions all include randomness to achieve an ambient effect. It is noticeable that for all of these, only the visual sense is affected. The colourfulness, visual dynamism or visual interest of the ambient effect is what draws our attention and might affect our mood. Versions of these products not incorporating randomness exist (or in some cases the randomness can be turned off), but the addition of randomness provides a sense of intrigue and freshness. These feelings are not universally experienced, of course. In the case of random PowerPoint transitions (interestingly a function removed from the latest version of the software), it may have negative connotations such as indecisive, attention seeking, distractive and unprofessional.

Gambling

The product examples falling into the category of gambling (i.e. Casino roulette wheel and lottery ticket) have strong crossovers with the attributes of card and dice games reliant on the randomness associated with chance. The intrigue and engagement are both present. However, the reliance on external factors to generate random outcomes brings a higher level of

credibility and reassurance that the gambling is based on fair rules rather than bias.

CONCLUSIONS

The inspection of how randomness in products is achieved reveals that in some cases the unpredictability is not strictly random, although from the user's perspective it appears so. Irrespective of the 'trueness' of an apparently random phenomenon, it is the witnessing of surprise that connects randomness to product experiences. Randomness can bring invigoration and engagement through changes, alternative outcomes, breaking monotony and counteracting boredom.

Randomness is clearly not desirable in a great many circumstances, and if applied with poor judgement could lead to built-in chaos in an unconstructive and frustrating way. Contexts are crucial to the appropriateness of a random factor in products. Where a clear cause-and-effect relation is deemed necessary, randomness in product operation is highly undesirable. But in products where a degree of ambiguity and surprise can be acceptable – or even desirable – randomness can be harnessed to good effect. The challenge for product designers is to know how to integrate randomness constructively within a product to add value, and increase desirability. This paper has delivered suggestions for product design considerations or variables that should be at the forefront of a designer's mind if designing for randomness: bounded randomness, controlling influences, pseudo-randomness, extent of randomness (feature / main reason), definition of random outcomes, causes of randomness (laws of physics, mathematical possibilities, software algorithms, packaging / distribution), presence (or not) of interaction to achieve random outcomes, and primary reasons for including randomness (fun / entertainment / games, security, ambient effects, gambling). In future work, particularly product design research, the effectiveness and desirability of product randomness from users' perspectives can be examined.

Products having different properties based on the listed variables may be presented to users for empirical testing, with the aim to answer questions such as: 'what degree of change is pleasant and desirable; what becomes distracting, annoying or undesirable?', 'in what contexts does randomness work well?' and 'in what products does randomness work well?'.

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