Desirable Imperfection in Product Materials

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Abstract
Manufactured products are customarily made with materials having ‘perfect’ surface qualities, such as uniformity, flatness, glossiness, repetition etc. They are generally devoid of defects. Although the aesthetic of ‘material perfection’ prevails, this is not to say that alternative aesthetics based on ‘material imperfection’ are either irrelevant or undesirable. If we especially consider the pressing need to be more responsible about discarding ‘worn but still functioning’ products, alongside the satisfaction that can be gained from owning unique appearance products, then in principle there seems to be unexplored territory in ‘designing for desirable imperfection through materials’. This paper explores why and how imperfection in materials can be desirable. Literature sources are used to elaborate on the aesthetics of imperfection and the origins of material surface imperfections. Thereafter, graduate student design projects on the topic of ‘imperfection in product materials’ are presented, with their common attributes analysed so as to give advice to designers who may wish to adopt imperfect materials. The paper concludes that since material appraisals are highly contextual, designers must temper their ambitions towards material activism and user behaviour change by establishing boundaries beyond which material imperfection will be neither acceptable nor desirable.

Keywords
Imperfection; Product Design; Materials; Values; Activism

In the industrial manufacture of products, quality is invariably correlated to consistency. Should variations occur during manufacture, deviating from the intended product specification, the likely outcome is rejection of the ‘offending’ component or product. The near-zero tolerance for variability is understandable when considering intended and realized user experiences: all customers will receive an identical product, displaying known and pre-stated performance and aesthetic qualities. Everybody’s purchase will be perfectly the same: a principal theme of the mass production ethic.

Although this ethic remains firmly established within today’s manufacturing industries (Pedgley, 2009), we are simultaneously witnessing the emergence of many new product creation technologies and systems, as well as new social, cultural and environmental influences on the renewal of our material world. In the present era, we can be prompted to question whether a move away from the ‘perfectly cloned product’ towards the ‘perfectly imperfect product’ might bring an alternative route to satisfaction with our material objects. Rognoli & Karana (2014) suggest that present modes of production can be challenged, if we chase the idea that product imperfection should not be instinctively rejected but instead a legitimate way to bring about material-based product differentiation (even individualization) and new aesthetic experiences. For those involved in making products within crafts traditions, the idea of individualism through materialization is nothing new. Variability in crafted products is a central source of value, being associated with individuality and the preciousness of bespoke creations.

The research and subsequent design projects presented through this paper are intended as a modest platform for provoking and challenging society’s polarized values regarding material perception and appreciation in everyday products. One of the privileges of designers comes as an opportunity to adjust people’s perspectives about how our
designed products ought to be, regarding diverse facets including functionality, aesthetics, meaning attribution, and even behavioural responses (Schifferstein & Hekkert, 2008). What, then, is implied by a design goal to promote ‘imperfection’ as a desirable product attribute; as the antithesis of the mass production ethic? The answer is multifaceted. Certainly the shift towards more sustainable practices and sustainable living is a major factor, realized through products having appreciable aesthetic qualities directly linked to improved sustainability credentials (Datschefski, 2001; van Hinte, 1997; Saito, 2007; Walker, 1995). Hedonic needs are another important factor: the satisfaction that can arise from owning, using and admiring a product unlike any other – being captivated by its individual character and how its ‘flaws’ translate to essential characterful qualities. Such a view has crossovers with bespoke product design that can be supported by new developments in 3D printing (Campbell et al., 2003).

For this present research, the focus was on the specific role of materials in helping to achieve desirable product imperfection. The following questions were posed to guide the work, which was made through literature reviews, didactic activity and student product designs.

- What makes a product material imperfect?
- Under what circumstances does an imperfect material add value to a product, and when does it detract?
- How can designers be guided to use material imperfection as a desirable asset in their designs?

Before starting to tackle these questions, it became apparent that the over-arching issue of ‘perfect for what?’ or ‘perfect for who?’ should always be borne in mind. The idea of ‘contextualized material’ is discussed at length by Karana & Hekkert (2010), who conclude with the principle that people attribute meanings to a material not only because of inherent material properties (e.g. sensorial information, technical performance), but also because of the specific product in which the material is embodied, and the ways in which users are supposed to interact with that product. In other words, material judgments are made not by considering a material in isolation, but instead with reference to its application and intended use scenarios and environments. What may be deemed a ‘perfect’ material for one application can certainly be regarded as ‘imperfect’ in a different application.

Aesthetics of Imperfection

A sense of ‘imperfection’ about a product may arise from a wide range of physical attributes (Ostuzzi et al., 2011), e.g. its form, its proportions, its comfort, its performance – and for the focus of this paper – its materials. One of the sensitivities when discussing imperfection is valence: the issue of whether one looks at an imperfection with a negative or positive eye. These bipolar viewpoints lead to the consideration of imperfection either as ‘faulty’ or ‘incomplete’ (=negative) or ‘not perfect’ (=positive, or at least no direct negativity implied). The latter is a rather more optimistic outlook, resonating with the Japanese concept of Wabi Sabi (circa 900AD), referring to the aesthetic appreciation of impermanence, transience and evidence of use, against a backdrop of the ingenuity and efficacy of the natural world (Juniper, 2003).

Deyan Sudjic, Director of the Design Museum in London, proposed the theme ‘imperfection’ for the inaugural Istanbul Design Biennial in the fall of 2012 – an event that formed the catalyst for conceiving and developing this present work. He explains that the pursuit of imperfection requires explanation for each discrepancy and demands that the designer justifies why the “perceived norm” was not followed (Sudjic, 2012). He elaborates further:
"For a designer the tricky thing about looking for the qualities of imperfection is the demands it places on them to justify aesthetic decisions. Perfection is an aspect of an object that while it may not be easy to achieve, is conceptually straightforward. In the age of mass production, perfection has been taken to mean the ability to make hundreds, thousands or even millions of objects that are all exactly the same. The word itself suggests the existence of an original, with the special qualities that implies. Such objects are understood as perfect copies of something else, rather than objects that are to be understood as having their own individual qualities…” (Sudjic, 2012)

Thus a critical design challenge is revealed: in the context of volume production, to create objects with aesthetic value arising from individual qualities rather conformance to the aesthetics of replication and standardization. Although the aesthetics of imperfection is distant from the aesthetics of the 'cloned', it is not necessarily distant from the practicalities of conventional mass manufacture. Sudjic (2012) provides some practical possibilities: “…shiny glossy surfaces can be replaced by lesser degrees of polish. Pure geometry is not the only possible formal language. Pure colour can give way to muddy mixes. Symmetry is not the only option". We can make comparisons here with moves within the skincare and fashion industries to adjust their marketing away from a stereotypical slim model with perfect skin towards a body image and skin qualities that more realistically depict human ageing (see, for example, Unilever/Dove ‘Campaign for Real Beauty’).

**Material Perfection / Material Imperfection**

To understand how we might recognize and come to appreciate imperfection in product materials, it can be helpful to first understand what makes a 'perfect material'. The two general points found in literature are that a 'perfect material' is complete and flawless in one or both of the following characteristics.

1. excellently suited to the functional or hedonic expectations of a product (i.e. a perfect material choice) or;  
2. has an exquisitely uniform surface quality that contributes to the allure of the product (i.e. a perfect material skin).

If we reverse the meaning of the first perspective – such that imperfection implies a material choice that is not excellently suited to the product – then we quickly see that the scope for serious design exploration is limited, since material choices in industrial design should not compromise the functioning of the design proposal. For example, there is little point in using a material with a low melting point for high-powered lighting fixtures; or allowing the compromise of structural integrity of outdoor play equipment through specifying unfinished mild steel.

The second perspective is more promising. It makes use of the term product 'skin' (Boradkar, 2004) as a reference to the sensorial qualities of materials that become important if we regard materials to be part of the total user interface of a product, outwardly communicating to users. We should however be careful that this perspective does not develop into a superficial view of materials and material properties. Materials still have inner matter, as properly recognised in the first of the definitions. So, reversing the meaning for 'perfect', we arrive at a definition of material imperfection as having surface qualities that are not homogenous or consistent from one region to another, creating an irregular effect to the eye or to the touch.
Origins of Material Surface Imperfections

Material surface imperfections can arise at several points along the lifespan of a materialized product. In reviewing literature on design and imperfection, it became apparent that three points in time during a product journey are relevant to the creation of material surface imperfections: (i) material sourcing (at the start, where inhomogeneity drives imperfection), (ii) material processing (early on, where variability in shaping and finishing processes drive imperfection), and (iii) material ageing during use, where temporal effects drive imperfection.

Material Sourcing

At this stage, material imperfections are essentially ‘built in’ to a raw or semi-finished material. The material is inhomogeneous with regard to its properties and/or sensorial qualities. Wood, for example, fits into this description by having grain, figure and texture that are unique from piece to piece. The combination of these material properties, alongside differences in colour between species, contributes to the appreciation of wood in manufactured products (Kotradyova et al., 2012). Recycled plastics and natural fibre composites often have material surface disturbances. ‘Distressed’ materials also fit to this description, for example denim that is used to give a ‘worn in’ look to off-the-shelf jeans. Randomness apparent in surface qualities can be thought of as a ‘ready made’ source of imperfection (Pedgley & Sener, 2012).

Material Processing

In the transition from material to materialized artefact, industrial shaping and finishing processes offer a great many ways to realize imperfect material surfaces. Imperfections occurring at this stage may be consequential or planned for. For example, industrial defects (such as pronounced swirling, knit marks or ejection pin indentations on injection moulded components) can be embraced as a way to achieve ‘standard unique’ products rather than rejects (Salvia et al., 2010). Alternatively, during the manufacturing there may be a purposeful ‘letting go’ of control, such as with the ‘Sponge’ polyurethane armchair by Peter Traag for Edra (2004), which consists of many irregular upholstery folds. Prior to manufacture, at the stage of computer modelling, randomness can be applied to bring about surface imperfections. One route is to incorporate random elements within CNC (computer numerically controlled) machine code, to generate unique surface patterns and textures (Vectric, 2013). Another is real-time manual intervention into usually predictable and repetitive manufacturing processes, resulting in surface imperfections (Alpay, 2013). One further route can be the digital creation of bespoke 3D forms with unique texture, relief, cross-section, colouring etc., for example as part of a mass customization or personalization methodology, to be later realized through 3D printing and rapid prototyping (Campbell et al., 2003).

Material Ageing

Not all materials are ‘born’ with age-defying resilience (Woolley, 2003). Relatively few materials retain an impeccable and untarnished skin decades after first use in a product. Temporal effects turn ‘new’ material surfaces into ‘old’ through alteration of sensorial qualities. What matters here is whether those temporal effects are acceptable – even desirable – or not. The concepts of ‘graceful ageing’, of product materials obtaining a ‘worldliness’ through accumulation of years of interaction (Candy et al., 2004), and of ‘emotionally durable products’ (Chapman, 2009) are central to these discussions, as Rognoli & Karana (2014) elaborate.

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1 Distressing may also be regarded as a material processes, or refinishing process, if carried out after the production of an artefact.
“Some materials ‘degrade’ while others ‘mature’ by maintaining or improving certain qualities. The positive term of maturity is usually used for natural materials such as stone, paper, wood, and leather, which over the years can acquire scents, colours, and textures: characteristics that far from diminishing their quality, instead acquire an aura of antiquity and preciousness.”

Contrast this with the generally negative ageing of plastics, which tend towards an unsightly aesthetic degradation over time (Fisher, 2004), involving colour fading, scratching and brittleness. Salvia et al. (2010) refer to temporal effects as “time and use signs”, regarding product materials as a dynamic and affectable entity. Karana (2012) refers to “traces of life”. Materials age through a variety of means: sometimes simply through the natural passing of time (e.g. metal patina); on other occasions, the ageing process may be accelerated through wear and continual use (e.g. scratches, rub marks, indentations); unplanned surface modifications may appear through personalization or vandalism (e.g. stickers, graffiti, damage); permanent distortions in surface geometry may arise through adaptations to long-term user-product interaction (e.g. a comfy seat, a well worn shoe).

It is intriguing to note that in circumstances where ageing is valued (e.g. in antique furniture, in walking boots), Candy et al. (2004) contend that it cannot be faked. Sensorially, they say, people are too clever to accept a fake (bringing into question the value of ‘distressed’ materials), and from the perspective of utility, ‘brand new’ sometimes just does not fit or work satisfactorily – some materials need to be ‘worn in’ before they reach a satisfactory level of performance or expression.

Istanbul Design Biennial Projects

The principles and arguments uncovered and presented so far in this paper were used as foundations for a seven-week graduate-level research and design project entitled ‘Imperfection in Product Materials’, carried out under the umbrella of the Istanbul Design Biennial Academy Program theme of ‘Imperfection’ and later exhibited at the inaugural Istanbul Design Biennial between October and December 2012. The aim of the project was to provide a platform for highlighting society’s views regarding material perception and appreciation in everyday things, through unusual and/or innovative design proposals. Eleven industrial design MSc and PhD students worked on the project, which involved an initial analytical phase followed by a longer creative phase. The project progressed through a combination of formal lecture inputs, class exercises, take-home assignments and design critiques.

Analysis Phase: Exemplifying (Im)perfection

Students were asked to analyse existing products with an eye to polarizing perfection and imperfection in materials and identifying product examples with (im)perfect material surfaces. We started off by making a material classification of ‘perfect’ and ‘imperfect’ materials using physical product and material samples. We then made analyses of the perfect/imperfect material attributes of products that students brought as A4 printouts, by making various X-Y plots and discussing their efficacy and problems (Figure 1).

The final plot agreed upon through in-class exercises had the following labels: ‘negative impression – positive impression’ (x-axis) and ‘perfect material surface – imperfect material surface’ (y-axis). The x-axis provided a simple measure of valence, whilst the y-axis helped to position the product materials based on a factual (objective) description of surface properties. The plot led to the labelling of four quadrants (Q1-Q4) in which material judgements could be placed: ‘negative perfect’ (Q1), ‘positive perfect’ (Q2), ‘negative imperfect’ (Q3), and ‘positive imperfect’ (Q4 – our target quadrant). During the
in-class exercises, students debated across each other’s product printouts until they were satisfied that each was placed into its ‘correct’ quadrant (Figure 2).

Figure 1: Snapshot of students’ material classification activity using changeable X-Y plots, May 2012. Photograph by Owain Pedgley.

Q1 contained products with perfect material surfaces that some students viewed negatively. The perfection typically led to products being judged as too synthetic, too controlled, too predictable, too samey, too sterile, too boring, overused or cliché. The design proposition to jump to Q4 from here was to use material imperfection to redress boredom or provoke inspiration.

Q2 contained products with perfect material surfaces that some students viewed positively. The perfection was usually linked to remarkable material properties, such as being strikingly flat, having mirror-like gloss, displaying superior engineering, or having exceptional control over detail and quality. The design proposition to jump to Q4 from here was to use material imperfection to conceive a rebellious, disobedient or non-conformist alternative product.

Q3 contained products with imperfect material surfaces that some students viewed negatively. The imperfection for these products was unwelcome for reasons such as ungraceful ageing, unfinished appearance, tasteless application, and defective quality. The design proposition to jump to Q4 from here was to adjust the intensity, quality or subject of imperfection.

Q4 contained products with imperfect material surfaces that some students viewed positively. The imperfection for these products typically added value through product uniqueness and the charm or wit of individual character. Products within this quadrant exemplified what might be possible for students to achieve in their own projects.
Creative Phase: Designing for Positive Imperfection

Having forged their own understanding of the potential value of material imperfections, the students were briefed to propose and visualize a creative solution for the positive transfer of imperfect material surface qualities into a product (or product sector) where normally perfection in surface qualities is expected or sought. In other words, the objective in students’ product design work was to arrive at a concept that fitted into Q4: *an imperfect material surface that leaves a positive product impression*. Students were free to define their own starting point, for example an existing product in any of the other quadrants Q1-Q3 having potential benefit of migration into Q4.

Portfolio of Product Designs

Table 1 contains summary information for the portfolio of eleven product designs proposed by students. We may call the offered concepts ‘defiant products’, in the sense that they are disobedient or rebellious to normal material surface choices. In the portfolio, we see designs making varied use of the three origins of material-based imperfection (material sourcing, material processing, and material ageing).
Table 1: Portfolio of eleven product designs having desirable material-based imperfections

<table>
<thead>
<tr>
<th>Product Name &amp; Image</th>
<th>Product Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stratis Computer</strong></td>
<td>Product finishing is made with semi-permanent, multi-layered and coloured patterns, revealed by the removal of upper layers through daily wear or intentional surface rubbing, leaving a ‘grunge’ visual effect.</td>
</tr>
<tr>
<td><strong>Lollyware Eye Glasses</strong></td>
<td>The arms of the glasses have a roughened irregular texture made from food-based resin: as an expected behaviour, users bite the arms, thereby receiving a sugar boost and exaggerating the irregular appearance.</td>
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<tr>
<td><strong>Pestone Bowl</strong></td>
<td>Each pebble stone used in the bowl has a unique irregular form and surface qualities. Furthermore, the order of stones and their rotational position provide endless ways to re-configure the product.</td>
</tr>
<tr>
<td><strong>Cordy Suitcase</strong></td>
<td>The use of freely extruded thermoplastic in constructing the exoskeleton for the suitcase results in imperfection not only in the solidified material surface but also in the sinuous suitcase structure, because of manual intervention in directing the extrusion head.</td>
</tr>
<tr>
<td><strong>Torna Lamp</strong></td>
<td>A re-interpretation of an IKEA product, this time using materials that have inherent imperfect surfaces: wood, aluminium foam, and temperature sensitive glass able to chromatically change over time. The goal was to achieve irregularity across multiple sensory modalities.</td>
</tr>
<tr>
<td><strong>Seedy Shoe</strong></td>
<td>The use of seeds as a soft filler material for shoes creates visual and tactile non-uniformity. Combinations of different seeds, having variegated or unusual colours, results in further diversity in sensorial effects.</td>
</tr>
</tbody>
</table>
**Karmacha Waste Basket**
Assembled from thin rolled strips of recycled paper, the wastebasket has a multi-coloured but somewhat vulnerable surface quality as well as asymmetrical from.

**Bitty Coffee Table**
The work surface of the table is created from leftover wood pieces cut into non-uniform profiles and joined together with adhesive. Each piece has visual and tactile irregularities, but the table as a whole is harmonious.

**Topless Slippers**
Corrugated cardboard, with its rough and non-homogeneous surface, is used for these hotel slippers – accentuating the product’s disposability and vulnerability.

**Leaky Shoes**
Inside the sole of these shoes is a structural gel that leaks out, solidifies and bridges any cracks that may occur during use. The sole therefore assumes an irregular form over time, depending on the load bearing areas of an individual's foot.

**Eco-Top Kitchen Counter**
The porous and random surface qualities of terracotta bring an overall sense of imperfection allied with homeliness. Irregularly placed ceramic dots adjacent to the hob support hot pans, whilst an aluminium tube dish drainer in a chaotic form supports wet dishes.

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**Project Analysis and Discussion**
In their explorations of imperfection, students suggested keywords – usually adjectives – to articulate their understanding of underlying concepts and to explain design intent. By clustering students’ suggested adjectives under the (im)perfection attributes established earlier in the paper (i.e. material sourcing, material processing, and material ageing), it is possible to present a polarization of the nature of perfection and imperfection in the context of material surfaces. Figure 3 assembles the various adjectives used, for the purpose of guiding designers in the future towards valued imperfections.
Alongside the adjective pool, it is also useful to consider whether a conceptual framework diagram for ‘imperfection in product materials’ can be created, synthesising the literature-based work presented in the earlier sections of this paper with the product analysis and design proposition work presented just now. Figure 4 presents a draft diagram prepared by one of the students completing the Istanbul Design Biennial project, intended to visualize for designers plausible entry points for the creation of imperfect material surfaces. Although this diagram is preliminary – and it requires development with a stronger and more obvious temporal dimension – it has nevertheless been conceived according to typical conceptual framework parameters with practical application in mind, namely:

- Factors (what to consider?)
- Categories (how to cluster factors under sharable category headings?)
- Hierarchy (which factors/categories are most/least prominent and/or important?)
- Relations (how do the factors affect each other?)

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**Figure 3: Adjective pool describing perfection and imperfection in material surfaces.**

<table>
<thead>
<tr>
<th>PERFECTION in material surfaces</th>
<th>IMPERFECTION in material surfaces</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATERIAL SOURCING</td>
<td></td>
</tr>
<tr>
<td>Cloned</td>
<td>Bad Fake</td>
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<tr>
<td>Complete</td>
<td>Individual</td>
</tr>
<tr>
<td>Consistent</td>
<td>Unconventional</td>
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<tr>
<td>Even</td>
<td>Disrupted</td>
</tr>
<tr>
<td>Finished</td>
<td>Disruptive</td>
</tr>
<tr>
<td>Flawless</td>
<td>Inhomogenous</td>
</tr>
<tr>
<td>Precise</td>
<td>Uneven</td>
</tr>
<tr>
<td>Harmonious</td>
<td>Different</td>
</tr>
<tr>
<td>Homogeneous</td>
<td>Irregular</td>
</tr>
<tr>
<td>Impressive</td>
<td>Distinguishable</td>
</tr>
<tr>
<td>New</td>
<td>Natural</td>
</tr>
<tr>
<td>Structured</td>
<td>Unique</td>
</tr>
<tr>
<td>Synthesis</td>
<td>Unfinished</td>
</tr>
<tr>
<td>Uninterrupted</td>
<td>Imprecise</td>
</tr>
<tr>
<td>Uniform</td>
<td>Non-uniform</td>
</tr>
<tr>
<td>Inconsistent</td>
<td>Unstructured</td>
</tr>
<tr>
<td>Independent</td>
<td>Quirky</td>
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<tr>
<td></td>
<td>Random</td>
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<td></td>
<td>Unusual</td>
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**MATERIAL PROCESSING**

<table>
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<tr>
<th>Controlable Mass Produced Crafted</th>
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<tbody>
<tr>
<td>Engineered Obedient Disobedient</td>
</tr>
<tr>
<td>In Control Planned Handmade</td>
</tr>
<tr>
<td>Manmade Predictable Out of Control</td>
</tr>
<tr>
<td>Standardized Unpredictable</td>
</tr>
</tbody>
</table>

**MATERIAL AGEING**

<table>
<thead>
<tr>
<th>Ageless Unaged</th>
<th>Aged Deteriorated</th>
<th>Clockwise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immortal Unblemished</td>
<td>Alive Faded</td>
<td>Dried</td>
</tr>
<tr>
<td>Lifeless Untarnished</td>
<td>Blemished Lived-In</td>
<td>Stained</td>
</tr>
<tr>
<td>Resilient Untouched</td>
<td>Broken Mortal</td>
<td>Tamished</td>
</tr>
<tr>
<td>Virgin</td>
<td>Defective Non-durable</td>
<td>Vulnerable</td>
</tr>
<tr>
<td></td>
<td>Deformed Oxidized Warped</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Degraded Peeling</td>
<td>Worn</td>
</tr>
</tbody>
</table>
Conclusions

This paper has sought to open-up discussion on why and how imperfections in materials could be embraced by designers, rather than too quickly dismissed as undesirable and for elimination. Various strategies for bringing desirable imperfection through product materials have been argued through literature and demonstrated through student design proposals.

It is clear that imperfection will not be to everybody’s taste. Just as a production-line McDonald’s quarter pounder with cheese or a Starbucks caramel macchiato look, taste and feel (reasonably) the same around the world, so there will always be people seeking out, or happy to consume, a more varied and local variety of burger or coffee. Localized differences, we might say, make all the difference, on an experiential level. The same can be said of material imperfection: those localized material nuances away from the expected and normal can define the unique and appealing character of a product, irrespective of its concept, functioning, comfort and so forth.

The largest challenge facing designers within this subject area is one of persuasion: of designing products where imperfect material surfaces are seen as a contributor to product value rather than a source of devaluation. This is certainly not a straightforward task. If designers get the material-product combination wrong, then people’s judgement of that product’s quality, its esteem, and the meanings people attribute to that product can all be predominantly negative.

Figure 4: Conceptual diagram identifying entry points for imperfection in material surfaces. Diagram prepared by Hande Isik.
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