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THEORETIC STUDY OF MATERIALS AND TECHNIQUES USED IN INDUSTRIAL PRODUCTS DESIGN

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Abstract: An article that provides insight into the design of products with particular emphasis on ergonomics and ease of use, describe their definition of design, approach to product design.
Key words: materials, products design.

1. INTRODUCTION

What Influences Product Design. Figure 1 suggests five – the market, technology, investment climate, the environment and industrial design. It is a simplification, but a useful one.

The central circle represents the Design Process, the workings and dynamics of. It is subject to a number of external influences, indicated in the surrounding branches.

A good designer is always alert to developments in technology, deriving from underlying scientific research.

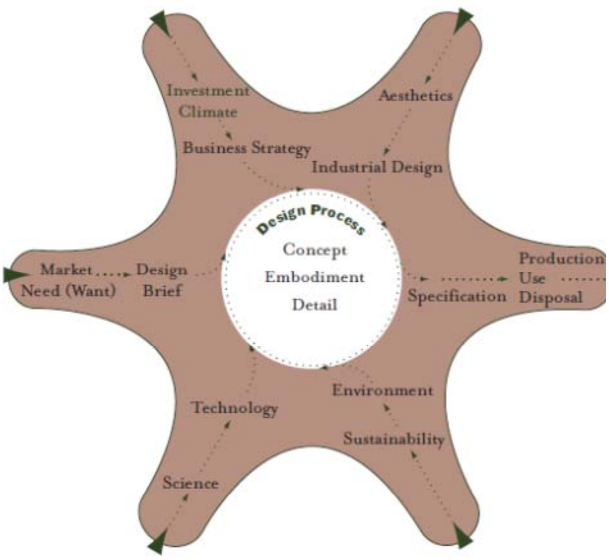

Figure 1. Inputs to the Design Process [11].

New technology is exploited in ways that are compatible with the investment climate of the company, itself conditioned by the economic conditions within countries in which the product will be made and used.

Concern to minimize the ecological burden created by engineered products heightens the awareness of design for the environment, and, in the longer term, design for sustainability.

2. MATERIALS CLASSIFICATION

The scientific study of materials – materials science – seeks to understand the fundamental origins of material properties, and, ultimately, to manipulate them. The origins of many material properties derive directly from the atomic and electronic structure of the material: among these are density, stiffness, thermal and electrical conductivity, optical transparency and many others. These are now well understood, and can, within the limits imposed by the laws of physics, be manipulated. Composites, one of the great technical advances of the last 40 years, combine the properties of two very different materials: polymers and carbon fibers in sports equipment, elastomers and steel in car tires, metals and ceramic fibers in aerospace components. Material science has developed a classification based on the physics of the subject **Table 1.** The science based classification emerges from an understanding of the ways in which atoms bond to each other,.

Table 1.

Family	**Class**	**Member**	**Technical Profile**	
Metals	Elastomers	ABS	Physical attributes	
Polymers	Thermoplastics	Polyamide	Mechanical attributes	
Ceramics	Thermosets	Polycarbonate	Thermal attributes	
Composites		Polyethylene	Electrical attributes	
		Polypropylene	Optical attributes	
		Polystyrene	Eco-attributes	
		Polyurethane	Processing attributes	
		PTFE	Acoustic attributes	
		PVC	Tactile attributes	

For example, in **Table 2** we can find the attributes (properties) for polypropylene. This information is largely numeric: values for modulus, strength, toughness, hardness, thermal conductivity and expansion coefficient, electrical resistance and so forth.

Tab. 2

Physical Attributes	
Density kg/m^3	900–910
Mechanical Attributes	
El. modulus GPa	1.14–1.55
Yld. Strength MPa	31–35
Tensile strength MPa	33–36
Comp. strength MPa	37–45
Elongation %	100–350
Toughness kj/m^2	10–11
Fatigue limit MPa	11–15
Hardness Vickers	9.2–11
Thermal Attributes	
Max use temp. C	90–105
Th. conductivity w/m·C	0.11–0.12
Th. Expansion /c · 10^6	145–180
Molding temp.C	210–250
Electrical Attributes	
Dielectric constant	2.2–2.3
Dielectric loss %	0.05–0.08
Resistivity ohm·cm	$3\cdot10^{22}$–$3\cdot10^{23}$

3. MAPPING TECHNICAL ATTRIBUTES

Asking if two colors are “similar” can be answered by comparing their wavelengths. how can we make technical attributes visible? One way is by plotting them in pairs, to give a sort of map of where they lie. Figure 2 is an example. Here the first two of the attributes from 4.3 – elastic modulus, e, measuring stiffness, and density, _, measuring weight – are mapped, revealing the layout of the e-_ landscape.

The dimensions of the little bubbles show the range of modulus and density of individual classes of material; the larger envelopes enclose members of a family.

Metals cluster into one part of the map, polymers into another, ceramics, woods, foams, elastomers into others.

Like maps of a more conventional kind, it condenses a large volume of information into a single, easily readable, image.

But that was only two technical attributes. Materials have many more. Plotting them,‹ you find the same groupings, but the overlaps that are not the same. If the classification you want is one based on technical, “engineering” attributes then it looks as though the right one is the one the scientists propose.

Maps like that shown in Figure 2 can suggest composites and blends of two materials.

The most common composites are fiber or particulate-reinforced polymers. Glass fiber is stiffer and denser than nylon; adding glass fibers to the nylon gives a material with stiffness and density that lies somewhere in between.

Polymer blends, similarly, have properties intermediate between those of the pair of polymers that were blended.

The maps allow this to be visualized, suggesting combinations that might meet a specific need. So visual presentation of data can reveal similarities that are hard to see in other ways.

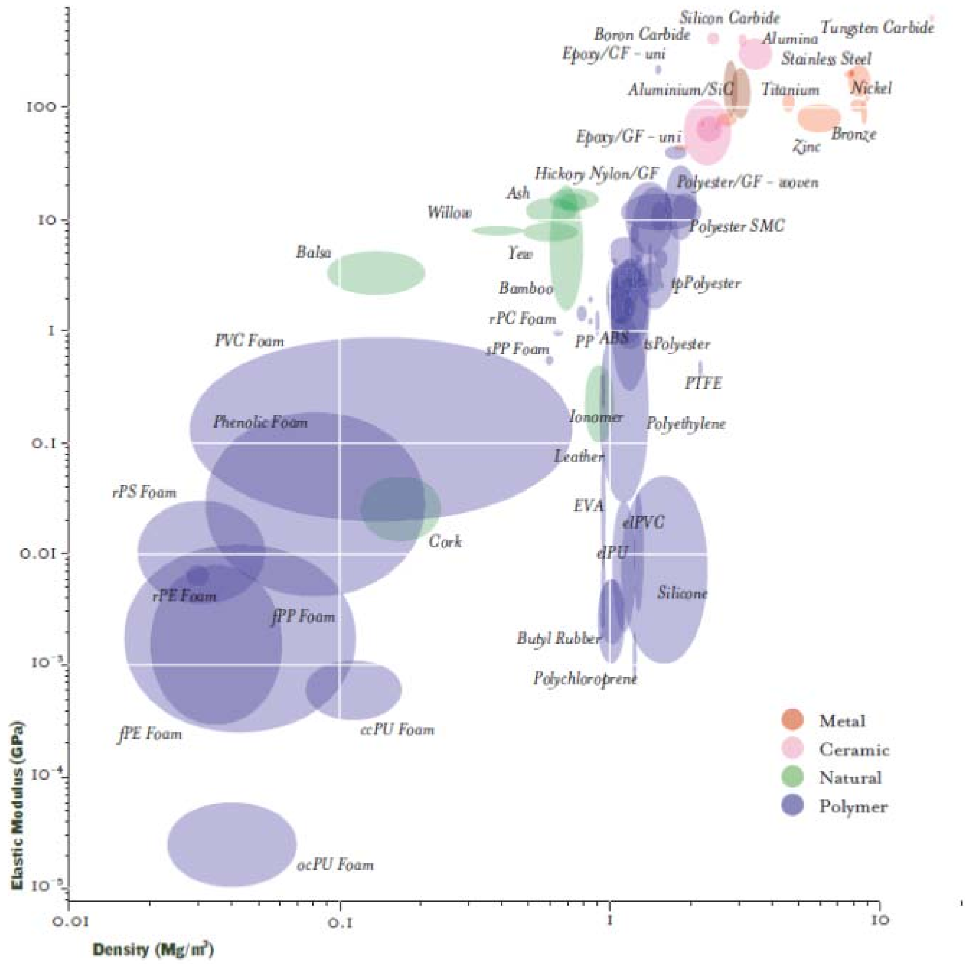

Figure 2. Elastic Modulus and Density [11].

Figure 3 is an example. It is an mds map for engineering materials based on 15 of their mechanical and thermal attributes. This map show similarity between materials based on their mechanical attributes

Ceramics, metals and polymers each fall into separate groups; and within polymers, thermoplastics and elastomers form overlapping groups.

The analysis has led to groupings that in most ways resemble the families and classes of material science.

The frequency of sound (pitch) emitted when an object is struck relates to two material properties: modulus and density.

A measure of this pitch, is used as one axis of Figure 4. Frequency is not the only aspect of acoustic. response – another has to do with damping.

A highly damped material sounds dull and muffled; one with low damping rings.

3. CONCLUSION

Inspiration – the ability to stimulate creative thinking – has many sources. One of these is the stimulus inherent in materials. It is one that, since the beginning of time, has driven humans to take materials and make something out of them, using their creativity to choose function and form in ways that best exploit their attributes. The most obvious of these attributes are the engineering properties – density, strength, resilience, thermal conductivity and such; it is these that enable the safe and economical design of products. The enormous economic importance of technical design in any developed society has given material and process development to meet technical needs a high priority; there are established methods to select them, widely taught and extensively documented in texts and software. But a material has other attributes too: color, texture, feel, a sort of "character" deriving from the shapes to which it can be formed, its ability to integrate with other materials, the way it ages with time, the way people feel about it. These, too, can stimulate creativity – the kind of creativity that gives a product its personality, making it satisfying, even delightful.

Attributes of aesthetics and perception are less easy to pin down than those that are technical, yet it is essential to capture them in some way if their role – and it is obviously an important one – is to be communicated and discussed. There are words so describe visual, tactile and acoustic attributes; they can even, to some extent, be quantified. Perceptions are more difficult. A few, perhaps, can be identified – gold is, almost universally, associated with wealth, steel with strength, granite with permanence, plastics with the modernity… well, even these are uncertain. Perceptions depend on time, on culture, demographics, taste, and more. But the consumer encounters materials only in the products in which they are used, and these are designed to appeal to a specific culture, demographic and taste; within these boundaries perceptions are much sharper. Words can be attached to them with a significant degree of general agreement; it is through the shaping, joining and surfacing of materials that they are created. So, we conclude: materials have an intrinsic personality, but one that is hard to see until brought into sharp focus by sensitive product design.

The success of a product in the marketplace depends heavily, we have argued, on its industrial design – on its appeal, visually and emotionally, to the consumer.

But this presupposes that it works – that it performs its technical function well, safely, and at acceptable cost. The responsibility for this rests with technical design, and technical design relies on sound material data.

The information they contain provides the necessary inputs for technical design, using the standard methods of engineering: stress analysis, thermal analysis, optimization methods and simulation.

All of these are supported by sophisticated software tools. This sounds reassuring – and it is – but one real challenge remains. You can find technical data for a material if you know the one you want.

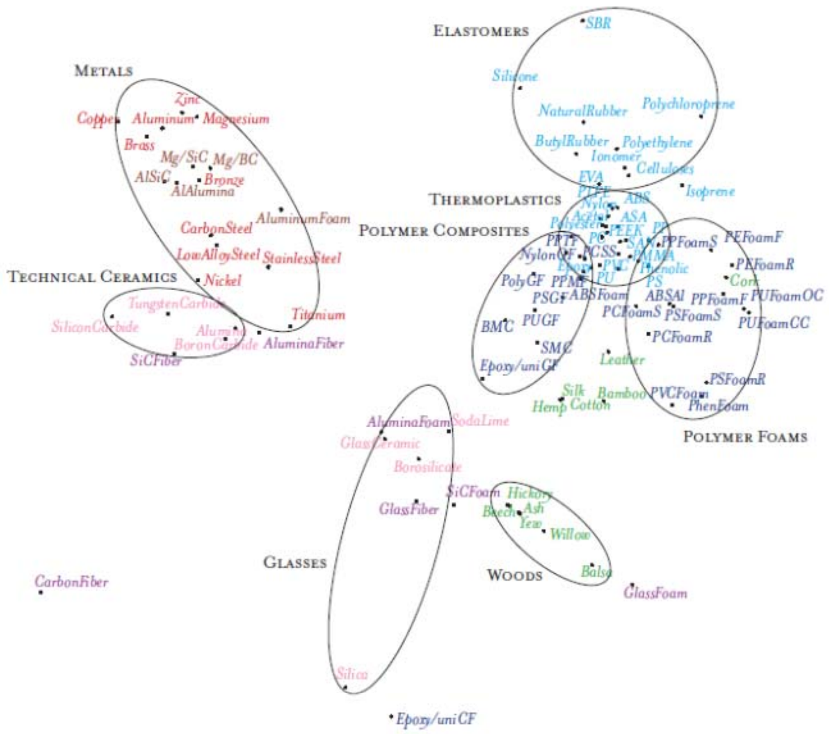

Figure 3. Multi-dimensional Maps Mechanical Attributes. (data from CES 4, 2002) [11]

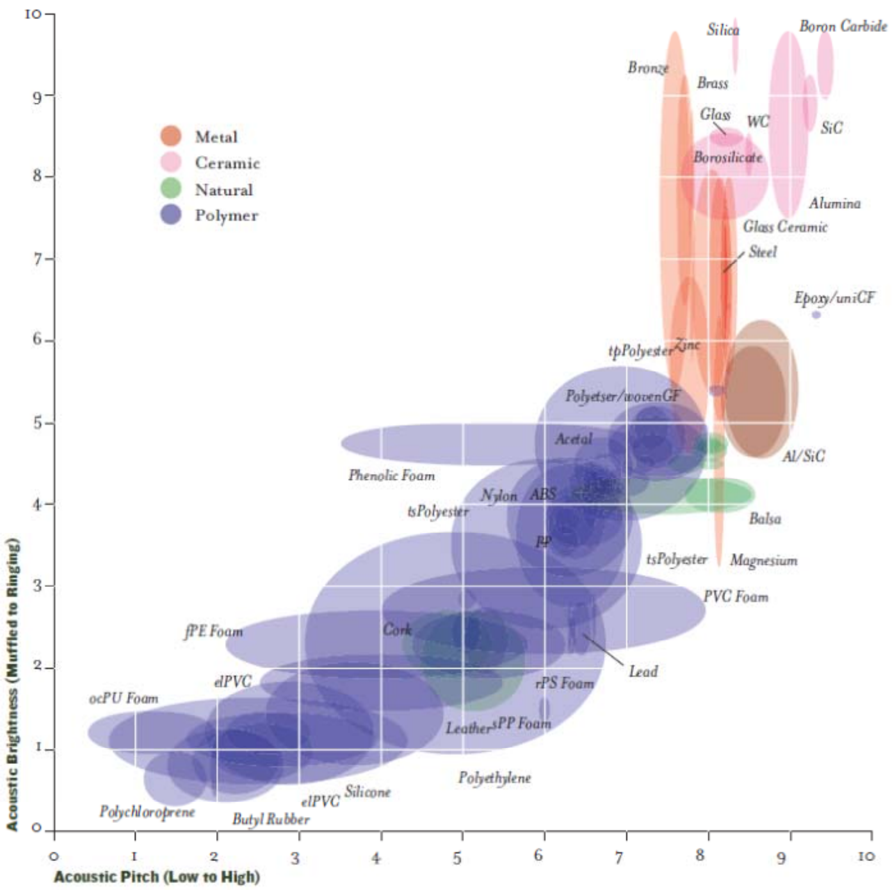

Figure 4. Pitch and Brightness Diagram [11]

But how do you make that choice? And how do you make sure it is compatible with the other "dimensions"?

Everyone knows the tv with the switch so cleverly integrated into the styling that it can't be found in the dark, the tap too smooth for soapy fingers to turn, the hairdryer so noisy that you can't hear the phone… well, the list is long. Each of these products works but has a poorly designed interface – it is difficult to *use*. Well-designed products not only work, they are convenient, safe and easy to interact with – they are userfriendly.

The design of a product's interface has three broad aspects: the first concerns the matching of the product to the capabilities of the human body; the second, matching to the reasoning power of the human mind; and the last, matching with the surroundings in which the human lives and works. Collectively, these are known as human factors and their study is called ergonomics, interface design, or human-factor engineering, which we now examine

The products with which we interact today are more complex and have more functionality than at any time in the past. Much of the functionality now derives from, or is controlled by, electronics. Electrons, unlike simple mechanical things, are invisible and give few clues of what they are up to or that they are responding to the user's wishes. Thus two sorts of communication must be built-in to the overall design – the passive one, indicating function, and the active one, indicating response to an input.

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Studiu teoretic asupra materialelor şi tehnicilor utilizate în proiectarea produselor industriale

Rezumat: In acest articol s-au discutat cele mai semnificative etape parcurse în cercetarea experimentală care oferă o perspectiva in proiectarea de produse cu accent special pe ergonomie şi uşurința utilizării. Acest articol descrie definiția de proiectare si abordare a designului de produse.

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