

# The need for human factors in design and technology

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Teaching National Curriculum Technology makes great demands upon design departments and upon individual staff. It is quite correct that pupils experience of design, technology or design and technology mirrors the complexities of professional design practice in one important respect and this is that the subject should expose pupils to a variety of conflicting factors. Such activity may require pupils to confront issues of materials or ingredients, construction or manufacture, economics, electronics, mechanics or history. However, exposure to one vital factor is sadly lacking in many design courses and because of this the pupils involvement with the others lacks meaning and significance.

The missing factor is so many of these courses is the 'human factor'. It is obvious that the products of design and technology activity are meant to be used by humans to a greater or lesser extent but few resources exist to assist teachers to integrate this into their work. This is hardly surprising since the human factors of design is not a small topic — to be dealt with in one double period — but a vast field of information, involving studies of not just peoples physical size but also their mental processes in using and interpreting the environment that surrounds us all.

This article is intended to provoke discussion of the human factors of design and to encourage a greater awareness of them in our teaching of design and technology. It is also, unashamedly, a promotion for a new publication which is aimed at GCSE-level courses in design and technology. The sooner pupils start to design with a sensitivity to human factors the greater will be their appreciation or criticism of the decisions made by those responsible for the products — the artefacts, systems and environments — in our society.

There has been an explosion in design resources for schools published in recent years and many of these have made an attempt to encourage an awareness of human factors as an integral part of design and technology. However, terms such as ergonomics remain as much a mystery to design professionals as the teachers and pupils. This may be partly due to the complexity of the subject (there are no quick and easy answers for designers and there is certainly no checklist to evaluate whether a design will work from a human factors point of view). It is also due to the lack of resources, in the field of human factors, that aim to distil complex information into simplified and readily usable advice. There are countless publications dealing with the detail of the subject and very worthy they are. But what saddens me is the lack of resources that take as their starting point the motivation of young people to become involved with this human science and its application in the field of design and technology.

Before examining the breadth of human factors let me attempt to clarify my use of the term 'ergonomics'. It is a relatively new term which was coined to assist the definition of a number of wartime studies that were taking place around 1940. These studies involved the scientific examination of people operating various pieces of military equipment such as transport, artillery and communications. The word 'ergonomics' is credited to Professor Hywell Murrell who joined the Greek terms 'ergon' meaning work, and 'nomia' referring to management or organisation. With the development of a professional body of researchers the term



ergonomics has gradually come into more general use, particularly in the design-related occupations such as architecture, engineering and the crafts. Ergonomists would consider their activities to include (a) the consideration of human beings in the creation of products; (b) the development of procedures for performing work and (c) the evaluation of the things people use. In America the term ergonomics is rarely used. They refer to this area more directly as human factors engineering. As a teacher of design and technology I prefer this as it implies a variety of constituent parts which make up the total field of human factors. One can readily refer to different types of human factor and each can become the focus for learning activities. Human factors and ergonomics can mean the same but check the definitions offered by the authors when using books in the classroom.

Clearly neither human factors or ergonomics were first exploited only fifty years ago. Part of the pleasure of examining old tools, clothes or buildings is to discover something about the way the particular makers designed and built for the particular user groups. This can be extended back to the first flint tools that were shaped to fit comfortably into the hands of primitive man or woman. A consideration of human factors is evident from the earliest times which makes it all the more surprising that we now pay so little attention to it in our schools. Perhaps it is the very complexity of this field of human factors that denies access to pupils and teachers. Certainly the products of design and technology are (usually) far more complex than a flint axe. The greatest development since these prehistoric times is the requirement placed upon humans to interpret information which has been perceived by the senses. It is insufficient for artefacts systems and environments to merely suit our physical sizes — products must nowadays allow us to understand them and to act upon our understanding by manipulating them. The interface between us as humans and the products of our 'high tech' society have forced designers to seek out and to apply the studies of not just the physiologists but also the psychologists.

By referring to the human factors of design rather than ergonomics pupils can be introduced to the physiological factors that may have a bearing on their project or subject of study. Similarly the term psychological factors can be introduced early on in the course and the content can increase in complexity as the pupil develops. The content of these two groups will be discussed in greater detail in following sections along with one other area of human factors that is not ideally located in either of the other two domains. This refers to those factors evident when humans work, gather or otherwise interact in groups. They have been termed the sociological factors of design and are particularly relevant in the design of such things as trains, large buildings, sports stadia and housing estates. The terminology involved here need not be a barrier if it is introduced gradually and logically and I would prefer to see the subject building up a technological vocabulary so as to facilitate discussion and debate.

## □ The Physiological Factor of Design

It is important that pupils appreciate that whether we are at home, at work or just relaxing, the products that we use should relate to the actual dimensions of our bodies. While we may own things that were made to suit our particular requirements (spectacles, for example), most of the products we possess are identical with thousands of others as a result of mass-products. It is important that pupils appreciate the requirements of manufacturers in addition to the users requirements. It is this apparent contradiction that provides a useful starting point for developing an integrative or holistic approach to design issues. Statistical information is vital to any consideration of the physiology of intended users but tables of figures on their own are open to naive or inappropriate interpretation. Pupils can fool themselves into thinking that merely by following the heights, reaches or sizes provided in 'anthropometric' tables a satisfactory or (to use an often heard phrase) 'ergonomic design' can be produced. Pupils need to be guided through a consideration of where these statistics come from; what do they refer to; are they 'averages' and if so who in the class is 'average'? The use of selected examples allows pupils to discuss the application of statistics — and to understand that mass production can leave out sections of our society who are too short or tall, too thin or fat, too young or old or too handicapped. This is not an appeal to merely increase the knowledge of the pupils — rather an appeal for their learning to be structured such that it develops and challenges their notions of design in society.

While the physiological considerations can be seen to have immediate and obvious applications in the design of environments such as kitchens, cars etc., and in larger domestic products such as furniture they have a much wider application. In addition to static studies the physiological factors of design also exploit measurements of dynamic situations where the human body moves and works. While it is relatively easy for pupils to undertake their own anthropometric surveys, studies of grip strength, for example, form useful starting points for design and technological activity in its own right.

The physiological interface can be shown to exist continually around each and every pupil — whether they are writing, playing a sport or riding a bicycle. Products can be evaluated and criticised for apparent failures to conform to the physiology of the intended user (calculator buttons too small to press or bottle-tops too difficult to remove). However, the physical contact is rarely meaningful without interpretation by the brain and there is a vital need for pupils to confront the issues of the second group of human factors which can be termed the psychological factor of design.

## □ The Psychological Factors of Design

Our eyes, ears, nose, tongue, skin and whole body continually provide information to the brain and clever designing can harness this potential. Today technological products increasingly make demands both on our senses and on our brain which make sense of the information. Take the relatively common activity of driving a motor vehicle: The driver must watch the road ahead and turn the steering wheel



accordingly whilst being observant of the mirrors which relay information from behind. The sense of hearing usually confirms the location of traffic seen but may also provide the first information on such things as sirens, a pedestrian shouting or that strange knocking noise! Actually, it is just as likely that mechanical faults with the vehicle will be felt as heard — through the hands on the steering wheel or through the body. To understand speed a glance at a dial or other display is required and at any time a visual or verbal warning may be produced by the vehicle to inform the driver of such things as high engine temperature, low fuel or brake wear. In addition to all this the driver may be talking to passengers and listening to the radio! Car designers must pay particular attention to this interface between the driver and the vehicle but the psychological factors of design are becoming increasingly important in most categories of products. They already form an important area of research for a diverse range of industries including, foodstuffs, packaging, fashion, consumer products, interior design as well as the motor industry.

Transferring information from machines to people is not easy. Human beings are fallible and the information may be missed, forgotten, ignored or misinterpreted. Therefore design studies need to include something on human perception if we are to become involved in the improvement of the products around us. Attracting attention and the feeding back of information can be achieved with coloured or flashing lights and in cases such as a rotary lawnmower, where there is potential danger, a spinning indicator is provided in a prominent position. Modern technological advances may make great demands upon our perceptive capabilities. Take for example the relative advantages of digital displays over analogue displays. Is it obvious that digital displays are automatically appropriate for such products as wrist watches, speedometers, gas meters or power stations? Similarly with our daily contact with computer technology — how do different groups of people prefer to receive information from a video display terminal? Experiments which explore these questions can be a valid part of design and technological activity.

Considering that most of the products of design and technological activity are tangible items it is surprising to note just how under-rated our sense of touch is (or has become). Our fingers enable us to differentiate thousands of textures and appreciate millions of forms but the advantages of tactile and visual detail are usually completely overlooked in school-based activity. Forms can dictate how and where to hold certain products, just examine the latest generation of cameras or steam irons for example. The term 'product semantics' was developed, not merely to describe a product's potential to communicate intangible qualities such as style or personality but to assist in the definition of these psychological attributes. The use of texture on a micro scale (for example, on switches or controls) and on a macro scale (for example, in architecture or town planning) is all around us and cries out to be understood as an important design factor. Similarly, colour can contain messages that direct our actions or affect our choice.

For the cynics amongst you who believe that it is possible to remain unaffected by the application of psychological factors

of design are you certain that the reasons you bought your car were totally practical and not in some small way based upon some perceived impression of image or status? When shopping at your favourite supermarket are you sure that the packaging, food colouring, lighting and music has no effect on your choice? Have you ever misused a product because it seemed 'obvious' to do it an incorrect way? If you waiver on any of these perhaps you should consider using the design and technology syllabus to introduce these psychological factors to children so that they may productively apply them in their own work and be critical of their exploitation by others.

## □ The Sociological Factors of Design

People tend to live and work in large groups. Our houses are clustered together to form villages, towns and cities and we travel in groups in trains, buses and planes. While the reason for this may be partly economic the fact that it occurs requires the designers of environments or large systems to attend to group rather than individual requirements. Many mistakes were made in the early days of high-rise accommodation simply as a result of the cumulative effect of poor or naive design decisions. Even in modern housing developments we see evidence of people silently disagreeing with the designers as they take 'short-cuts' across flower beds or personalising their dwelling. Shops, offices and corporate buildings may look very nice on the drawing board but legislation requires architectural practices to design for groups not individuals. This will have implications for fire exits, noise reduction, lifts and staircases, decor, maintenance, toilets, and access by the disabled.

Crowd situations can affect our levels of stress or comfort. Clearly space on public transport is a shared commodity but buses and trains which do not allow a certain degree of 'personal' space have failed to meet the user requirements and may be one of the contributory causes to lack of use. A bus is a good example to use with pupils because it is one situation that they are likely to be familiar with. The average able-bodied teenager may find little difficulty in using a bus but the real learning experience starts when asked to observe a cross-section of the public doing so at a variety of times. Watching mothers with young children, elderly people and shoppers crowding on and off a bus on a cold, wet Friday evening can be a salutary experience for young designers who think that improvements are neither necessary or possible. Such studies could lead to work involving, amongst other things, graphic displays, space planning, seating, materials, mechanics or transport policy. The use of examples such as the bus enables teachers to highlight the integration of human factors that is evident in so many of the products around us. In the same way that human factors pervades all stages of design and technological activity so there are no clear distinctions between the physiological, the psychological and the sociological factors of design. Case-studies of products from cutlery to the construction industry and from graphics to textiles are likely to reveal this to be the norm rather than the exception.



## □ Designing with Human Factors

Undoubtedly human factors as a subject area has received an increase in publicity in recent years. Not only is there a growing body of research and published literature but manufacturers such as Volvo promote in their advertisements the ergonomic studies on which the design of their cars is based. However, one has to remain sceptical of less scrupulous manufacturers who exploit the word 'ergonomic' in their literature purely because it is fashionable to do so. Professional design practice increasingly demands that those responsible for product research and development take due consideration of the use and possible misuse of their products. Consumer legislation in Europe and America has forced many manufacturers to employ both ergonomists and designers to ensure that products suit the users as much as the manufacturers. Steeply rising development costs mean they must get it correct in the shortest possible time.

The integration of human factors with design and technology is not simply a construction of our product industries however. They are profoundly inter-connected, depending on each other in a symbiotic fashion. Human factors research in the field of product design exploits user trials but user trials that exploit only those products currently available are rather limiting. Development is only likely to come about when speculation on possible developments can be evaluated. Such speculation is the lifeblood of designers who exploit all manner of modelling techniques to visualise or otherwise bring into being ideas and conjecture. So a development system based on rigorous and controlled evaluation combined with the communication, to the intended users, of creative improvements forms a logical design model — one with automatic application in schools.

The motivation for attempting a book on the human factors of design came from my experiences as a teacher of design and technology and finding little assistance in the form of relevant publications for pupils between the ages of 14 and 16. There is much work still to be done by designers and ergonomists in not only making their working practices understandable by pupils but, more importantly, motivating young people to exploit both of these relatively young areas of knowledge.

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