EDUCATING THE FUTURE DESIGNERS OF 'INTELLIGENT' PRODUCTS

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Introduction

The premise of this paper could be construed as being technologically deterministic, but the intention is to argue against this philosophy of product development when using emerging technologies. By bringing to the attention of designers and educators a field of technology that is rapidly becoming an important factor in product design, that of software driven artefacts, it is hoped that a better understanding of the appropriate application of this emerging technology will develop. A product, whose functionality is predominantly determined by virtual instruction, potentially allows more flexible and adaptive user interface solutions. This provides yet another challenge to designers involved in developing interactive devices.

We live in an information rich society. Most aspects of our lives, from work to play, our experiences and emotions are documented in some format, somewhere in the world. The advent of the world-wide-web has brought about a revolution in communication and access to this information has literally become 'child's play'. In an attempt to further commercialise information technology developers are now attempting to integrate IT capabilities into every day products. We are asked to consider buying the 'intelligent' refrigerator or the 'smart' microwave. However, such products do not represent the true potential of Artificial Intelligence (AI) based systems, nor the complex issues associated with their use. As artificial intelligence research advances it is becoming apparent that humans could, in the future, rely on machines more and more to make complex *autonomous decisions*. But how confident are we in using such machines and do they have a future in society? Careful consideration has to be given to the human factors involved when designing products that have the potential to act autonomously or even as our advocates in a virtual domain or indeed in the real world.

Computing technology in the commercial sector has seen an unprecedented growth over the last twenty years. This has been expedited not only by miniaturisation but also with the development of software techniques and practices. With technology such as electronics already well established in both secondary and tertiary design education, then surely elements of software engineering, which embodies much of today's technological products with functionality, will swiftly follow. Already there is evidence to suggest that the use of hardwired electronics such as glue logic is declining in product design and design & technology education, whilst programmable devices such as PICs are becoming more commonplace. Although, at present, they are limited in terms of operational speed and memory, such micro-controller devices are cheap, flexible and offer a fast development time. In addition they enable students to learn the fundamentals of digital electronics and programming with an economy of effort. With such an appealing direction for educators to follow it can only be a matter of time before more complex software driven applications, including methods of artificial intelligence, are seen in the classroom.

This paper provides a brief and very limited summary of the state of the art in AI with some historical reference, but does not attempt to outline an educational approach to AI. The paper is aimed at creating an awareness of some of the many issues concerning the future design and use of interactive technological products. From this standpoint it is more about "why" and not "how" AI is applied and taught. In particular it focuses on the *appropriate* use of such technology in product design and the awareness of these facts in education. Furthermore, it is argued that there is a need to understand and counteract the apprehensions and possible anxieties that could be experienced by the end users of products that may, in the future, exploit the full potential of AI.

What is Artificial Intelligence?

A typical text book definition of AI, and one perhaps more biased to an engineering approach, is given by Elaine Rich & Kevin Knight,

> *Artificial Intelligence is the study of how to make computers do things which, at the moment, people do better.*
>
> (Rich & Knight 1991, p.3)

However, the mere use of the word "computers" belies the true multidisciplinary aspects of the area. AI has been described as a two-strand discipline of science *and* engineering, with science attempting to understand the mechanisms of intelligence, and engineering attempting to apply the findings in the design of useful machines, (Sloman 2000). Of course, arriving at a consensus for a definition of intelligence or how it works has plagued scientists for many centuries, and it therefore follows that modelling intelligent behaviour with machines is equally problematic. At best, AI techniques have been developed upon experimental observations of behaviour and a series of hypothetical concepts.

It has often been said that the state of the art in AI bears little resemblance to natural intelligence. Ultimately, existing artificial systems are purely reactive. The physical components that constitute the memory and central processing unit of a modern computer merely provide a method of information storage and the software provides a degree of controlled automation in accessing that information. Today's machines possess as much 'intelligence' *per se* as Charles Babbage's Analytical Engine clanking its way to a numerical solution. Cleverly engineered, but innately stupid. Indeed, many critics of AI are of the opinion that intelligent action will never be achieved with machines, insisting that the fundamental physical and operational differences between biological and inorganic systems guarantees failure (Carlson, 1990: p.230).

It is apparent, however, that over the last ten years AI research has yielded significant and usable results that provides the designer with exciting new possibilities and the potential to create highly interactive products. Whether such techniques are true representations of natural intelligence or not, the fact is methods have been devised which enable machines to behave in a *pseudo* intelligent way. After all, aeroplanes fly…but not by flapping their wings!

Distinguishing AI from "Smart" Technology (or, what AI isn't)

'Smart Technology' is a term that, historically, has been used in a somewhat cavalier manner often accelerated by media hype and commercial exploitation. In the mid-nineteen eighties the development of shape memory alloys led to the tag 'Smart Materials'. 'Smart Cards' were developed, a simple memory device on a piece of plastic the size of a credit card which contained user profiles to operate user dependent machinery such as bank teller machines. The media reporting of the so called 'high tech' war waged in the Gulf showed scenes of 'Smart bombs' homing in on allegedly valid targets. Given the fact that these missiles landed in positions predetermined by human strategists (Military 'Intelligence'!), one can only conclude that these weapons were perhaps more accurate. Designing a missile that, during flight, exercises some discretion, by refusing to land on civilian targets for example, would at least be a step in the right direction towards being smart. However, the end result is that there are now many commercial products that carry the 'smart' label. This conveys, intentionally or otherwise, a high-tech sense of efficiency to consumers.

A common misconception is that AI and Smart Technology are one and the same thing. The understanding and appreciation of AI as a philosophical science and an engineering discipline should, however, refute this. There is no doubt that these disciplines are related, but only by the fact that many smart technologies were discovered as a consequence of AI research. In much the same way as electronic calculators have become mere ubiquitous tools and that computers are no longer thought of as great electronic brains, then so the addition of a programmable chip to a product doesn't miraculously make it smart or even more misleading, intelligent.

When searching for a definition of AI, Douglas Hofstadter asked the then chief scientist at Apple, Lawrence Tesler to comment. Tesler introduced the dynamic nature of the field in his response, which has since been named 'Tesler's Theorem', which simply states,

> *AI is whatever hasn't been done yet*
>
> (Hofstadter 2000, p. 601)

There are various ways of interpreting this somewhat surprisingly succinct statement including claiming that the field of AI widens, as more appropriate tasks become apparent. But additionally, if we take this statement literally, it could also be interpreted that as specific tasks are accomplished then they cease to be considered a legitimate area of AI. What remains are tried, but possibly not thoroughly tested, techniques that could be considered to be within the realm of smart technologies.

Can Products be Intelligent?

> *Knowing a great deal is not the same as being smart; intelligence is not information alone but also judgement, the manner in which information is co-ordinated and used.*
>
> (Sagan, 1981: p.297).

So, although data can be abundant and unrestricted communication enable its fluid transaction, one of the many complex keys to intelligent operation is how to;

i) translate data into useable information and
ii) *use* the information autonomously and constructively.

Translating data into a usable format can be construed as reasonably straightforward. Computers work on the principle of converting binary voltages into 'computer information' (or machine code), performing calculations and translating results into an understandable format for humans to interpret. The computer, however, has no intrinsic understanding of these procedures and, like Descartes clockworks, reactively follows its predetermined path. A product that incorporates IT in the form of www access for instance is merely presenting the user with data or passing the data to another machine. Ultimately, this form of IT is a method of transferring data from human to human. What is lacking in terms of "intelligence" is the ability for such machines to make *autonomous reasoned decisions* based on acquired data and information. At present human operators provide the processing power to translate data into information and then *use* it in a productive way.

A third vital ingredient to intelligent operation is the ability to provide *explanations*. As humans we can generally explain our actions through a specific use of language. Other than events that are often described as instinctive or tacit, our lives provide us with a free will and our activities driven by a prognosis of cause and effect. We are capable of speculative and retrospective analysis and are able to communicate and reason about our actions. A problem presently being addressed by AI researchers is that of developing systems capable of providing reasoned explanations in conjunction with decision-making functions. However, AI has not reached the stage where reasoned arguments and justifications can be automatically generated by operational systems, at least not to the level of complexity required to make it useful.

So can machines realistically provide these human elements? Can a machine *think* for itself? AI protagonists have generally considered the 'Turing Test' (Turing, 1950) as the ultimate challenge of artificial intelligence. In the paper 'Can a Machine Think?' (*Ibid.*), Turing describes an 'imitation game' whereby a pre-programmed computer and a human (both referred to as 'witnesses') are isolated from each other. A second human (the 'interrogator') is further isolated but able to communicate with both witnesses through an impersonal medium such as a VDU. This ensures that the interrogator neglects the physical appearance of a witness. The interrogator then poses suitable questions to both witnesses. The machine is deemed to have passed the test, and hence be classed 'intelligent', if the interrogator is unable to discern the difference between the 'real' and 'artificial' witnesses based upon the responses received. Although originally conceived as a thought experiment the game has provided a major practical hurdle ever since. There have been some valiant attempts and, in some cases, an interrogator has been fooled, at least for a while. However, the originators of such programs freely admit to employing tricks to create illusions and it's generally only a matter of time before continual "conversation" reveals the impostor (see Grand, 2000).

The Turing Test itself presents us with a paradox in that the computer needs to be "programmed" to include the fallibility of the human if its identity is not to be revealed. For instance, completing a complex calculation faultlessly in a fraction of a second is a distinctly non-human characteristic (see Hofstadter, 1999: pp.594-600).

When considering such issues as human traits, Turing advocated that computers could be 'educated' over a period of time and be subjected to a learning process rather than simply programmed (Turing *op cit*). This has prompted one of the major thrusts in AI research, *machine learning*. In this area, software programmes are developed that can change the operating characteristics of a machine depending on its environment. This is programmed as an automatic update function and results in an apparent learning process. The goal is to produce a machine that adapts to different environments which, in practical terms, yields a system with variable but optimised operational capabilities. An additional and crucial aim is to provide a system that will not fail when faced with novel, not previously encountered environments, but will respond with a sort of ‘educated guess’ based on its previous experience. Theoretically, the overall result is an adaptable, flexible and fault tolerant machine. The penalty however, is a machine capable of providing wrong answers!

In June 1999 Sony launched a commercial example of machine learning in the AIBO™ (Sony, 2000), an 'entertainment' robot that takes the form of a small dog (Fig 1). AIBO (the name means 'companion' in Japanese) is described as,

> *an autonomous robot that acts in response to external stimulation and its own judgement. It displays various emotional expressions and learns by communicating and interacting with human beings.*
>
> *(Ibid.)*

Although some of these comments may be debatable in terms of philosophical issues, the AIBO certainly demonstrates that present technology is capable of providing products that exhibit a persona, a feature expedited not only by sympathetic packaging but also by including its own idiosyncratic agenda. Although designed specifically for the purpose of entertainment, future adaptations could yield more serious applications. With 3,000 units being sold within the first 20 minutes of the launch, the popularity of the AIBO surely guarantees further commercialisation.

Figure 1.
The Sony AIBO™

Of course, the AIBO is designed for entertainment and as such its appeal is enhanced by the user’s knowledge that their electro-mechanical pet is responsible only for its own autonomous behaviour. But the creation of the AIBO certainly raises further questions about interactive technology. The fact that some people are intrigued or in some cases enthralled by the AIBO is indication of the willingness of people to communicate with such products. Could this lead to a future society that interacts regularly with a host of mechatronic personalities?

The Usability of Smart Products

It is readily accepted that the primary agenda of any design process is to yield a product fit for purpose. Many texts on the subject quote, and consequently adopt, the International Standards Organisation (ISO) definition of usability as the,

> *extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.*

(BS EN ISO 9241-11, 1998: p. 2).

Although written specifically for the usability of visual display terminals it is considered generic enough to be used for any kind of product.

Stanton (1998) summarises the following factors for defining usability:

1. Learnability	acceptable performance levels with the product should be achievable within a specified time.
2. Effectiveness	a specified percentage of the user population should achieve acceptable performance levels over a stipulated range of tasks and environments.
3. Attitude	a limited personal cost in terms of fatigue and stress should be experienced by the user.
4. Flexibility	the product should be suitable for a limited range of tasks outside those first specified.
5. Perceived Utility	an evaluation of how much a product is used.
6. Task Match	an acceptable match between user requirements and system functions should be evident.
7. Task Characteristics	an analysis of the specified task frequency and variability.

In addition, Stanton considers the necessity of ‘*user characteristics*’ as a factor. The ‘knowledge, skills and motivation of the user population’ is acknowledged to play an important role in the perception of usability. These human factors are not only important for general design purposes but are crucial in designing products which are intended to support intelligent dialogue. It is therefore necessary to develop more precise and structured analytical methods for studying the psychological effects of smart product interaction.

Many of the attributes of usability, when specifying highly technological products, can also be linked to a sense of perceived operational reliability. The malfunctioning of a product will inevitably cause frustration and could even undermine considerably the user’s confidence in the product. The lack of confidence in one particular technical product can often lead to a cynical view of technology in general. It is therefore important not only to create an operationally reliable product but also to minimise the possibility of malfunction through human error.

> *If an error is possible, someone will make it. The designer must assume that all possible errors will occur and design so as to minimise the chance of the error in the first place, or its effects once it gets made. Errors should be easy to detect, they should have minimal consequences, and, if possible, their effects should be reversible*
>
> (Norman, 1998: p. 36).

Fault tolerance needs to address both technical malfunctions and human operator errors. Risk analysis and reliability have become established fields of engineering design. Although the basic concepts are simple,

> \- *the important thing to remember is that fault tolerance has to be designed into a product*
>
> (Dummer, Tooley & Winton, 1997: p. 63).

For the design of smart products, the risk analysis concerns both hardware and software, which needs to be tackled very early in the design phase. Although hardwired intelligent systems are feasible and are being developed (see Mead, 1989, and Murray, 1995, for example), at present the majority of AI and Smart applications employ a software model or algorithm to simulate an intelligent function. The flexibility of software often enables a ‘graceful degradation’ aspect or a degree of fault tolerance to be designed into the source code, which in turn, needs to be reflected by the product interface. It is, however, extremely rare for product designers to become involved with this level of technical software detail. But the combination of hardware and software is what endows smart products with functionality. The software language and platform on which it is run plays a fundamental role in enabling interaction and intelligent dialogue.

AI researchers have acknowledged that there is a noticeable lack in communication between AI developers and designers wishing to apply the technology. In nineteen ninety-eight an international workshop to discuss the acceptability of specific state of the art AI techniques in industry, noted that the development of usable systems was significantly hindered by failures in recognising the importance of human interaction issues, (McCardle, 1998). It was noted that these issues are not the sole responsibility of ergonomists and designers; it is also a necessary consideration for computer scientists and AI developers. Furthermore, to ensure the success of smart products, it will be an ever-increasing responsibility of designers to find common ground with software engineers, computer scientists and electronics engineers.

Many products can be seen to conflict usability requirements. Even simple automatic functions can cause the user frustration and annoyance. Auto focussing cameras, auto text formatting within software packages, voice-activated controls and speech generating alarms are examples of where the intended added functionality can ultimately result in user aggravation. Designing for usability certainly provides a foundation to study further the development of smart products, but the implications of ceding control to the machine and perceptions of reliability need to be explicitly considered.

What do products need to interact effectively?

Autonomous operation has been one of the major elements in designing purposeful smart products. Being able to pre-programme a device to carry out a specific task unsupervised has been, in the main, the prime desirable function, if not the only function present machines are capable of. There is a tendency to make these operations as transparent as possible to the user. The development of *operational invisibility* has the effect of creating the 'black box' syndrome of technology. The user is intentionally removed from the operational process once the start button is pressed and the algorithms set in motion. In effect, this encourages the user to ignore what the machine is doing or how it is doing it. It is a sort of 'need to know basis' of operation.

When discussing the 'foibles of computer systems', Norman (1998) takes two approaches to invisibility, taking the *operational* and *usability* functions as separate areas within which to apply it. When dealing with *operational* criteria Norman lists actions NOT to be adopted and states,

> *Make things invisible. Widen the Gulf of Execution: give no hints to the operations expected. Establish a Gulf of Evaluation: give no feedback, no visible results of the actions just taken. Exploit the tyranny of the blank screen.*
>
> (*Ibid*.)

However, in contrast, Norman describes the *usability* of computer devices as being ideally invisible, suggesting that using machines should be a natural and transparent process and therefore readily integrated into everyday life. Invisible computing is a trend that is set to increase. In the book 'Visions', Kaku (1998) describes the onset of ubiquitous computing and describes it as becoming so commonplace that eventually it ceases to be obtrusive. As miniaturisation enables physically smaller and faster computing power the technology will infiltrate most if not all areas of life. Wearable computers, smart cards, digital money and electronic commerce will soon be inescapable and the functions of everyday life will become unavoidably computer driven. Someday, using smart technology will seem as ordinary as wearing a pair of shoes. Failing to engage with technology could result in social exclusion.

For such ubiquity and seamless integration to be achieved successfully a fluent dialogue needs to be created between the operator and the product. To provide any form of pseudo intelligent dialogue necessitates the transaction of salient information. This can be tackled from the point of view of domain or context specific application where the designer imposes suitable constraints on the design of the product. Superfluous information, if presented, can create the impression of importance to the user, which often leads to confusion (Jordan, 1998: p.34). In humans there appears to be a congenital 'filtration system' which aids the selection of the most relevant information from the vast amount available to the human senses. There is no inherent ability within a machine to create an abstraction of the real world and it is left to the engineer and designer, of both hardware and software, to artificially create constraining environmental models.

Such information sifting processes are presently being developed in the form of 'intelligent software agents' (Brenner *et al*, 1998). The world-wide-web presently stands as a largely unregulated arena for information exchange, and represents a bottomless cauldron of news, views and trivia. The web is characteristically dynamic, the cauldron boils and bubbles as information is added and discarded, updated and relocated. Agents are software objects that can be programmed to remove the drudgery of sorting the wheat from the chaff as they invisibly roam through the virtual domain of cyberspace searching out appropriate information. Johnson (1997), describes three classes of agents which are regularly encountered:

1. *Personal agents* - which reside within the machine and monitor the users behaviour offering help where necessary.
2. *Travelling agents* - which roam the web reporting back only on receipt of relevant information.
3. *Social agents* - which exchange information with other agents they seek out or encounter by chance.

There have been attempts to personify agents, for example the all too familiar Microsoft paperclip assistant. But although the embodiment of agents within cartoon characters maybe comforting for some and intend to promote user friendliness, the facade does not, of course, endow intelligence. It is the apparent autonomy that merely creates the impression of intelligence. However, these entities provide a family of virtual assistants to whom we can delegate mundane tasks. This seems innocuous enough and, on the surface, an obvious path to take. The result, however, is the empowerment of the machine. This raises further questions, and presents potential dangers associated with removing a human operator from direct control. Johnson takes a seemingly sinister view, describing decision-making agents as working within

... an invisible regime of indirect manipulation

(*Ibid.* p.179).

Do such 'decision machines' and ghostly agents have a place in the design of future products other than those associated with web access? Success will depend upon how well they are designed to integrate effectively into society by means of perceptively usable products. The acceptance will be based upon the technology being trusted by potential users. Gaining the confidence of users is no easy task, especially with unproven technology that has no coherent guidelines for design, implementation or testing.

In describing hurdles to the design of intelligent products, Bonner (1999) raises pertinent questions that need to be addressed. Such issues as adaptive interfaces that communicate to users 'how intelligent' the product is under particular circumstances are cited. Further problems associated with the levels and types of feedback in dynamic situations are also highlighted, indicating that present conventional Human Computer Interaction (HCI) methods do not adequately cater for such scenarios. If such functions are to be utilised within consumer products, the designer is faced with the problem of how such adaptability can be related to the user. In the majority of design scenarios utilising conventional HCI methods, machine interfaces are constant and therefore behave in a consistent and perceivably reliable manner. However, by introducing adaptability the consistent behaviour would, by definition, be lost. Unless such devices possess a form of explanatory interface that relates the concept and level of adaptability, the user would be faced with a seemingly inconsistent machine and one that could consequently be perceived as unreliable.

Furthermore, Bonner (*Ibid.*) considers alternative ways of interacting with intelligent agents embedded within consumer products. With many products it is not viable to use conventional computer peripheral interfaces such as keyboards. New methods of interaction will be required and Bonner states that such interaction,

… would represent a major departure from conventional HCI dialogues

and,

> *…. little is known about how these types of 'mediating' dialogue could be used and how viable and acceptable it would be.*
>
> (*Ibid.* p. 59)

Interactive Technology may not be for all –The Technophobia Phenomenon
The aim here is not to discuss clinical reasons for phobias, but to examine some of the complex reasons why potential users of autonomous products may experience anxiety and sometimes abhorrence when engaging with technical devices. Brosnan (1998) states,

> *It* (technophobia) *affects up to one third of the entire population. The notion that this technophobia is a passing phenomenon affecting older individuals is being disproved. Much research suggests that things are getting worse rather than better.*

Brosnan continues to cite many reasons for this worrying trend including social, gender and psychological issues. By building upon past research from many sources, Brosnan has produced a psychological model of technophobia. The model traces user criteria and perceptions and plots causal relationships to the final stage of computer usage (See figure 2). The primary factors underlying the appearance of the phenomenon are listed as:

1. *Anxiety* - anxiety is reduced if the technology is perceived as fun to use and the user is self confident in performing general tasks (*self-efficacy*).
2. *Ease of use* - the perception that the device takes little effort to operate.
3. *Experience* - levels of good or bad past experience with technology.

These three factors are combined to reveal a level of perceived usefulness. So those who are not anxious, and have encountered computers before and find them easy to use will further perceive them as useful. Furthermore, the perception of usefulness will predict a 'behavioural intention', which, in turn, brings about computer usage. Brosnan does not quote this model as definitive, but it does highlight some of the complex interrelationships of personal attitude and experience, which dictate the potential utility of computers.

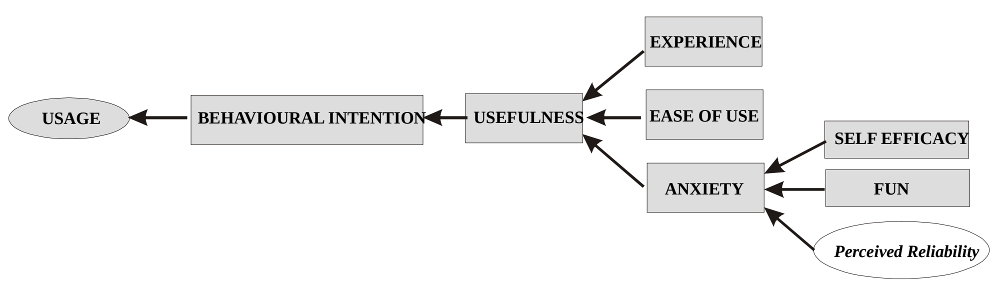

Figure 2.
Human factors underlying technology usage (based on computer usage by Brosnan, 1998).
(Italics added by McCardle, 2001)

Although not cited as an explicit factor by Brosnan, again the perception of *reliability* of machines must play a major role in assessing usefulness. In terms of past experience, it is possible to have had only successful contact with technology but still be very well aware that statistically, it could fail. Even high levels of self-efficacy through the thorough understanding of the technology can have adverse affects on the perception of reliability, like the anecdotal tales of the aeronautical engineer who refuses to fly!

User reassurance against catastrophic failure and the perception of possible snowballing implications need be catered for in the design of interactive products. Appropriate levels of feedback to the user assist in alleviating fears of ‘fatal’ system breakdowns, but in addition addressing the fundamental cause by designing for fault tolerance would ultimately prove more successful.

Inappropriate Application of AI and Smart Technology

The way people react to products is often a reflection on the ease with which they can interact with them. Many of today's electronic consumer products are labelled ‘intelligent’ or ‘smart’ which implies that they have an ability to make complex decisions and thereby aid usability. However, in many cases these claims of 'intelligent' decision making are not only unfounded but also the added functionality can be seen to interfere with the usability of the product.

Typical examples of this are given in figures 3 and 4. A leading US retailer of assorted consumer products sells these gadgets under the banner, ‘Tools That Think’. Figure 3 illustrates the ‘Smart Coffee Scoop’ a device that will apparently enable you to make “consistently delicious coffee every time”.

> *…the Smart Coffee Scoop tells you exactly how much coffee to use, so you always brew a perfect pot. Simply enter how many cups you're making and choose the strength: strong, medium or mild. The easy to read display responds with how many scoops to use in your coffee maker or percolator.*
>
> (Brookstones, 2000a)

Figure 2 shows the PastaSmart™ which,

> *….tells you when your favorite (sic) pasta is cooked to taste, from al dente to fully done. Choose from 11 popular pasta types—from angel hair to ziti—the amount you're cooking, and then how you like it. Pasta Smart does the calculating for you, and the timer beeps when it's ready to serve. Bar graph displays cooking progress.*
>
> (Brookstones, 2000b)

Figure 3.
The Smart Coffee Scoop

Figure 4.
The PastaSmart™

These products are examples of many that claim to enrich and streamline our lives, enabling us to perform tasks effortlessly and without expert knowledge about that task. The questions that seems to have been omitted to be asked when designing these products are,

i) exactly how much knowledge is required to make coffee or pasta?

And,

ii) when comparing the time and thinking required to either pre-programme these tools or simply reading the instructions on the packet of coffee or pasta, do these products really constitute a useful economy of effort?

There is a real danger when applying smart technology in that the end products become mere novelty items, undermining the justification for their existence by actually rendering tasks more complex. Operational complexity can be perceived by the consumer as the price to be paid for added functionality. The time and effort required in learning to operate products by reading manuals, programming and then fixing them if they go wrong, has to be adequately rewarded by significant user value. This is where a great number of existing products fail.

Future Research Tasks

The “chips with everything” attitude towards technology is a phenomenon predominantly driven by economic and commercial gain. The commercial implications of using technology to create a unique selling feature or appeal to technophiles is all too familiar. Important factors in how best to include AI techniques or smart technology in products to improve *usability*, is ill defined. Factors including the potential users' perception and understanding of the technology alongside their confidence in depending upon such products are presently rarely considered. The acceptance of technology in the market place often depends on the way in which it is designed *into* products for use in real world human situations. Gaining the confidence of users needs to be a principle task in ensuring successful design.

In terms of usability, AI and smart technology should be viewed as a method for supporting a working dialogue with a product. Establishing the dialogue therefore not just an ergonomic relationship or IT function. It can also encompass the complex manipulation of information and the interaction with embedded “knowledge”. If we are ever to design products that exhibit helpful intelligence then we need to understand the implications associated with their use. And the implications run far deeper than just communication protocols and automated functions as provided by today's so called ‘smart’ devices.

Conclusions

Embedding AI into products is not just about IT. Designing usable ‘intelligence’ into a product is a serious challenge to designers requiring careful consideration of complex interdependent factors. Criteria such as effective usability, functionality and product semantics are a seemingly obvious requirement but, in addition, the user’s capabilities, self-efficacy and trust in the technology are also major factors. These final points are ones that are often overlooked which can result in user anxiety and a reduced perception of usefulness.

Technophobia is a real and increasing phenomenon. There is evidence to suggest that present guidelines for product usability can go some way to alleviate problems associated with anxiety and attitude towards technology. Nevertheless it is necessary to develop more explicit and precisely controlled methods of design and product analysis and to evaluate more thoroughly the interaction issues involved.

Adopting a policy of invisibility through ubiquity is not an immediate solution to technology acceptance. More research is required into the design of appropriate adaptable and dynamic interfaces and this needs to be a joint task for both AI developers and applications designers.

The design of intelligent products is inevitably technical and multidisciplinary and presents a clear challenge to designers and engineers to improve communication during the conceptual stages of design and to maintain a concurrent engineering approach as best practice. Educators in design and applied technology need to reinforce this approach to students when embarking on the design of smart products.

As techniques for embedded AI increases, the prospect of realising usable smart devices grows larger and it becomes more feasible to design and produce accessible interactive products. The scope for such products is vast and if used wisely, will support the remit of designers to enhance the quality of life and help shape the society of tomorrow.

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Biography

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