A Captured Screw
and Other Tales from the Real World

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Introduction

The nature of industrial design requires that the designer weigh the pros and cons of any design concept and/or direction with regards to the problem being addressed. After completing an education that focused on design for sustainability, the coauthor Hans Wissner joined BW Technologies, a company that designs and manufactures hazardous gas detectors. This primarily industrial market segment did not at first inspire a great deal of confidence in the value or even applicability of sustainable product design. After three years with the company the authors, comprising a practicing designer and his former professor of industrial design, wanted to reflect on the experience and see if any relationships could be found between the theoretical ideas and principles of sustainable development and sustainable product design, and the realities of the real world.

This paper will briefly characterize both the emphasis of the 'sustainable product design' education and the nature of the industrial environment in which business priorities and user safety are paramount, and where traditional industrial design is little known. Reflecting on these issues, and relating stories, examples, working practices and discrete instances led to a number of important observations and conclusions about the significance and relevance of education in the complex subject of sustainable product design.

Sustainable Design Education

The focus of a sustainable design education here was to address the three "E's" of sustainable development— environmental, economic, and ethical considerations— through the design process itself, with particular emphasis on localization. Specifically, this meant:

?? Investigating the meaning of 'local' design in contemporary culture in terms of authenticity, materials, aesthetics, and so forth.

?? Considering the means and boundaries of the local and the need for integrating manufacturing across various scales of production (global, regional, local).

?? Considering the practical benefits of such an integrated approach in terms of sustainable design.

?? Consideration of sustainable product types for illustrating an integrated approach with emphasis on the local for product design, manufacturing of selected parts, product assembly, distribution, and maintenance.

?? Designing illustrative examples and producing prototypes (see figures 1 and 2).

By exploring the relationships that exist among 1. the notion of the 'authentic' object, 2. the principles of sustainable development, and 3. product design, the design education experience showed that when product design addresses the economic, environmental, and social considerations of sustainability in a meaningful and responsible manner, then the design process and the designed product can be both authentic and sustainable. After exploring 'authenticity' in terms of self awareness, self reflection, and personal responsibility, and 'sustainability' with particular reference to its implications for the design and manufacture of material goods; the economic, ecological and social ramifications were identified, which resulted in a set of succinct guidelines for the designer.[1]

Through the application of the theoretical discussion by direct engagement in the design process, a number of furniture pieces were explored, leading to a presentation of 'product as metaphor' which, through physical design, symbolized the integration of materials and techniques, across various scales of production (large scale, mass production; regional scale, batch production; small scale, craft production) that must become reconciled if 'sustainable product design' is to be achieved in ways that are progressive, feasible, enriching and 'authentic.'

The design explorations that resulted were based in the desire to manifest authentic interpretations of sustainable design principles. As an exercise in exploring some of the important issues relating to sustainable design, the willow-back chair provided an example ideally suited to promoting sustainable initiatives at the local level. In forcing together different scales and approaches to design, the willow-back chair is a manifestation of synthesizing radically different design paradigms and finding a successful resolution within one exploration.

Figure 1.

Willow back chair.

Where the willow-back chair was a physical, metaphorical expression of sustainable ideas of scale-integration, the HLC series of lamps are a more pragmatic, product-oriented design, influenced by the principles set forth in the authenticity and sustainability sections of the paper and inspired by the issues raised in the willow chair exploration.

Using commonly available off-the-shelf mass-produced electronic components, simple unprocessed raw materials, and elements salvaged from the waste streams of local manufacturers, the lamps are grounded in the desire to combine various elements and levels of production in a manner that supports local manufacturing initiatives using energy-efficient and low-capital manufacturing techniques.

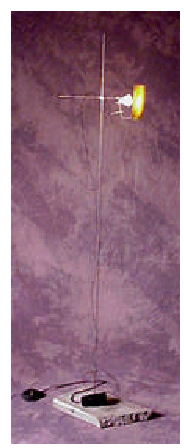

Figure 2.

HLC lamp.

The Real World: BW Technologies

Following the education described above, the coauthor Wissner, joined BW Technologies (BWT), a manufacturer of hazardous gas detection products and equipment. The key role within this context is to provide industrial design expertise within the design and development of gas-detection instruments encompassing a range of applications, from small handheld and wearable gas-monitoring devices to components for large-scale, fixed-in-place systems located in industrial environments.

The main design criteria in this industry include: function, ease of manufacture, cost reduction, usability and ergonomics. From its early beginnings, BWT has been a strong advocate of industrial design. Early products were designed for simple, cost-effective manufacture utilizing local vendors and suppliers. Despite limited financial resources, BWT recognized the advantages of employing the creative expertise of industrial designers, resulting in instruments and equipment with a reputation for innovative features and simple, reliable operation. Bringing industrial design into the product-development cycle at the early stages helped BWT identify significant design opportunities that resulted in important innovations, many of which have become industry standards. As a result, BWT has been able to cultivate a unique aesthetic in an industry where products have traditionally had a decidedly industrial appearance.

The principle function of the BWT aesthetic is the communication of user features and is seen primarily as a tool for market penetration and product differentiation. Giving industrial products a more friendly face, and delivering products with common features and functions has proven to be confidence inspiring for users. Workers like to use instruments that are easy to use and easy to understand. Employers want to provide instruments with a low cost of ownership and minimal training requirements. Environmental issues have historically not been a high priority. However, they are becoming increasingly important, mainly because of corporate policy, which is driven by both increased corporate awareness and more stringent legislation, especially in Europe. BWT's customers buy gas detectors to help ensure a safer workplace environment; and many key clients (oil, water, gas, and electricity suppliers) themselves have a profound effect on the environment. As more companies pursue ISO 14000 approval, environmental and sustainability issues become more and more important.

Is a Sustainable Design Education relevant in the Real World?

The question posed by the authors– practitioner and professor– was this, "Do these apparently disparate and largely unrelated approaches overlap, at least in the approach of the designer who has been educated in the principles of sustainable product design?"

Discussions and conversations between the two authors revealed that the connections are neither obvious nor direct, but they became apparent after considering some specific examples encountered in the 'real world.' Each of these will now be briefly summarized before conclusions are drawn.

A Captured Screw

After several months on the job, it was determined that a designer needed to be dispatched to the site of a potential problem, and Wissner was elected to visit several natural gas production platforms in Mobile Bay, Alabama. This environmentally sensitive site is home to one of the largest natural gas fields in the US, containing particularly high concentrations of hydrogen sulfide (H2S), an extremely toxic component of natural gas. Due to the ecological sensitivity and harsh weather conditions in Mobile Bay, the costs associated with producing gas from these fields are very high. Subsequently, any problems resulting in loss of production capacity are frowned upon. It had been determined that some of the H2S detection sensors were showing signs of water ingress, leading to false alarms and subsequent shutdown of the production platform.

After servicing the heads on one of the platforms, we determined that while the sensors had been regularly tested and calibrated, they had not been serviced in several years. When asked why this had not been done, the personnel explained that since the screws fastening the sensor enclosures together were not captured in the plastic, they were frequently dropped. While this did not seem to be too tragic, it was explained that anything dropped into Mobile Bay had to be retrieved at substantial cost, with severe financial penalties for non-conformance. Now, the water in Mobile Bay is quite clean, but is shallow and gets very muddy, making the locating of small objects very difficult. The construction of an offshore platform is mostly steel grating, with large voids through which small objects can easily pass. These factors created a very real, albeit simply addressed design problem.

By adding a detail that would capture the screw, this small problem was eliminated. By improving the serviceability of the sensor heads, several associated issues were resolved:

?? The danger of dropping screws into Mobile Bay was significantly reduced.
?? The frequency of false alarms due to poorly serviced sensor heads, and the associated plant shutdowns, were reduced.
?? The reliability of the sensors themselves was improved.

Figure 3. Production platform– Mobile Bay.

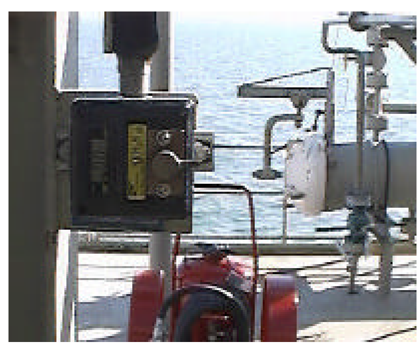

Figure 4. Plant rat H2S sensor

Rechargeable Batteries

Recently, a large firm announced a major request for tender, BWT initially proposed the Defender, an instrument that uses the Black & Decker VersaPak rechargeable battery. The leading contender was an instrument that used disposable alkaline batteries. This instrument was preferred by the firm due to the perceived convenience of having a commonly available battery. Despite the fact that the VersaPak would have saved approximately 7 million batteries per year from reaching the landfill, the convenience of the disposable battery was preferred. In this case, real-world demands and realities seemed to be a more important consideration for the operations group within the firm than the sustainability initiatives promoted by the marketing group.

In order to compete, BWT revised their tender offer to be based on a new instrument, the GasAlertMicro, then still in design development. Based partly on the experience gained from this tender, it was decided that this instrument would provide the option of using either rechargeable NiMH batteries, or commonly available AA alkaline cells. Since the power cells would be the largest single components in the instrument, this decision had a profound effect on the design direction, and on the final product. Taking advantage of the design opportunity provided by this experience has contributed significantly to creating a more sustainable product and also to the overall business success of the GasAlertMicro.

Public Tenders

Increasingly, large corporations are requiring suppliers to outline their own sustainability initiatives when submitting tender offers. As one of the UK's largest purchasers, with an environmental influence that extends well beyond that of its own staff and workplaces, British Telecom (BT) has identified 'Procurement' as one of eight company activities that has an impact on the environment. As lead designer on the GasAlertMicro, I was asked to compile some of the initiatives we had taken in terms of sustainable design principles for a tender document being prepared for BT. It was an interesting exercise, since the design direction that we took was based primarily on economic factors and on producing a more functional, user-friendly design. Upon closer examination, it became apparent that many of the design decisions we had made were very much in line with the BT's own product stewardship principles, procurement initiatives and corporate policies regarding sustainable development.

> "The concept of sustainable development has increasingly come to represent a new kind of world – a world in which economic growth delivers a more just and inclusive society, at the same time as preserving the natural environment and the world's non-renewable resources for future generations . . . . Within BT we tend to use the term corporate social responsibility (CSR) more than sustainable development. This is because we identify CSR as the voluntary actions a company can take to contribute towards the wider societal goal of sustainable development."[2]

> "Product Stewardship is a set of principles designed to reduce the environmental impact of a product throughout its life cycle. Because it focuses on the design stage, when critical decisions affecting the product's future performance are made, Product Stewardship plays an important part in sustainability. By incorporating eco-design into products, it is possible to reduce manufacturing, use and recycling costs, because issues such as energy use, durability, materials content and recycling options are considered at the design stage, when recommendations for improvements can be more easily adopted."[3]

The GasAlertMicro design incorporates many features that has reduced the number of components, made it more economical to produce and easier to assemble. Designing for two-shot overmolding technology has substantially reduced the number of plastic parts, improved the environmental sealing of the product and given the GasAlertMicro a distinctive appearance. By choosing surface mount components wherever possible to take advantage of BWT's in-house SMT manufacturing capabilities, solder usage has been optimised, tedious and time-consuming through-hole soldering has been reduced and quality control has been improved.

Surface Mount Technology (SMT)

Due to a downturn in the electronics manufacturing sector in Calgary, BWT was able to purchase an SMT manufacturing line at a substantial discount. Acquired primarily as a cost-cutting measure, the surface mount line has also been instrumental in reducing the amount of solder used in the population of circuit boards. The speed and accuracy of the pick and place machines has given BWT an enormous manufacturing advantage over many of its competitors. Through the incorporation of this technology, BWT has been able to better apply its skilled workforce by eliminating much of the tedious and unpleasant through-hole soldering procedures previously required.

Of course, using this technology optimally requires that the design of the products mirror the capabilities of the machines. Designing around this technology was initially seen as a disadvantage, due to a perceived reduction of electro-mechanical component choices. However, it quickly became apparent that the surface mount capability provided BWT with many new and exciting design opportunities. Designing for SMT enables BWT to better take advantage of the attributes of injection moulded parts to mate with components on the PCBs. Incorporating surface mount components such as piezo-electric buzzers, alarm LEDs and momentary switches that mate accurately with features designed into the enclosures has helped reduce the overall number of parts required for assembly. This also promotes the use of common components in different products, promoting a reduced inventory of parts kept on hand.

Hazardous Locations Approvals

As most of BWT's products are often used for the detection of toxic and explosive gases, it is necessary for these products to be approved for use in hazardous locations. This requires that the instruments and equipment adhere to a rather restrictive set of design and production guidelines. While much of the impact is seen at the circuit design stages, there are several issues that must be addressed by the mechanical design. Restrictions on component spacing, material choice and encapsulation techniques have a direct bearing on the physical design of the product, and impact the product from the earliest conceptual design stages.

BWT markets its products around the globe, often requiring unique approvals for the varying regions of the world. North America, Europe, South Africa, and Australia all require different and unique approvals and have varying requirements. These requirements are most often based on differences in the nature of the hazards that can be reasonably expected in the local workplaces. A particular requirement within Europe is that instruments being used in hazardous locations must be constructed of a conductive material in order to reduce the chances of static discharge, which could ignite gases within potentially explosive environments. One of the major challenges during the design of the GasAlertMicro was finding a material suitable for overmolding with transparent polycarbonate that also provided the necessary conductivity to meet approval requirements for Europe. In this case, any environmental considerations would have to take a back seat to the critical safety requirements of the product.

Since most plastic resins are inherently insulative in nature, making them conductive is usually achieved through the addition of additives such as stainless steel fibers or carbon loading, which in turn preclude colored products. Not only do these additives make recycling problematic, they also have detrimental effects on the adhesion to polycarbonate in overmolding applications. As the product in question was to be bright yellow in color and had to be conductive, the material-selection process became particularly challenging. Despite the difficulty, a material was eventually found that could be colored, met the surface resistivity requirements of the approval bodies, and provided a good chemical bond to the polycarbonate substrate. As an added bonus, the material met these requirements without the addition of steel or carbon particles.

These approval requirements often restrict the ability to design for recycling, as in the case of rechargeable battery packs. Batteries that are used in hazardous locations must be protected against leakage under fault conditions, this is most often accomplished by encapsulating the entire assembly within a "potting" compound. This makes it virtually impossible to separate the components of the assembly for reuse or recycling. In this case again, the safety requirements laid out for the instrument take precedence over the environmental concerns associated with design for sustainability.

Reflections and Conclusions

As a high-tech manufacturer, competing in the global marketplace, BWT must provide products that have a perceived value at a reasonable cost. As a publicly traded corporation, it must also show growth and profit for its investors. As a professional designer within the company, Wissner is expected to provide expertise in designing products that will facilitate these goals. As a conscientious designer, he wants his contributions to be effective in furthering the success of the company, but also to do it in an ethically responsible manner.

Working within the realities of the gas detection industry, with its narrowly regulated and restricted requirements is challenging. The examples described above are but a small fraction of problems faced by the designer in bringing products to market in a competitive and sustainable manner. While it is not always possible to satisfy all three 'E's' of sustainable development, it has been possible to address parts of them. Reflecting on the designer's role within the company and the experiences gained, it is apparent that there can be a tangible and valuable relationship between a sustainable design education and the pragmatic nature of the 'real world' of corporate design.

Theoretical ideas and principles of sustainable product design learned in the classroom cannot simply be directly and dogmatically introduced wholesale into a company— especially by a junior designer new to a company. Change is less direct, longer term and more subtle than that— we have to be sensitive to the realities and, for changes to be lasting, they should be understood, accepted and incorporated over time. An existing condition exists where proven practices are known and effective. That said, no industry can afford to stand still, there are always possibilities for improving the existing condition (for example the 'captured screw' example, above) and there are constant and evolving pressures from the 'market' (for example, the new legislations and requirements coming from the European markets, mentioned above) that instigate new approaches and new design challenges.

A designer educated in sustainable product design has both the knowledge and the design project experience to understand the nature of change that is needed to evolve more sustainable directions. Rather than being intimidated by discussions of environmental or sustainable congruence, the 'sustainably educated' designer can contribute in positive and constructive ways to both accommodating and instigating change.

Furthermore and importantly, the academic and industrial examples discussed here reveal that a heightened awareness of sustainability issues, through the nature of the education, created in the design practitioner what might be termed an "attitude of receptivity," which otherwise may not have been present. This attitudinal shift or refinement can alter how we view the environmental and social issues associated with product design— from one of reluctance based on lack of knowledge and/or often ill-founded perceptions of 'more expensive', 'more work', and 'delay', to a positive attitude that sees such changes as both design opportunities and constructive contributions. This is a critical shift and bodes well for the future— but it is difficult to define and impossible to quantify, which in turn makes it problematic to justify. However, as design schools increasingly incorporate sustainable principles, knowledge and examples in their curriculum, then over time there is the potential to see this attitudinal shift affecting and informing more and more of our designers and more and more our 'real world' industries. This is a crucial role of both design education and the educated, informed designer.

References

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2. http://www.btplc.com/Betterworld/Sustainability/Sustainability.htm
3. Ibid.