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KEEPING DESIGN RECORDS

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ABSTRACT
Design does not happen in isolation. Each design evolves from earlier work, is carried out in parallel with other designs, and influences later designs. The design process is an investment of significant amounts of money, time and effort concentrating on the resolution of a challenge to meet a need. The resulting product is only a partial return on that investment. The next time a similar challenge arises, we start all over again having lost the information gained the last time. Legislation on design responsibilities, warrantee issues, new versions of products, and end-of-life decisions would all benefit from a more comprehensive understanding of the original design process. A new initiative at the British Standards Institution, BSI, is exploring the opportunity of providing guidance on the information we need to keep. One key theme is that it is vital to record design reasoning and decisions as they happen, including the rejected options. The need to instil the habit of keeping records of design thinking as it happens must begin in design education and may require an adjustment to the curriculum.

Keywords: Design records, archive, experience, IPR.

1 INTRODUCTION

The great engineers of the nineteenth century, George and Robert Stevenson, Thomas Telford, Isambard Kingdom Brunel, and the rest, recorded all they did in a daybook. Notes on whom they met and what was discussed, sketches of proposals, details of expenses and surveys, all were recorded. These books could be used to keep track of all the various activities, which must be co-ordinated to make up a major project. After a project was complete, these books became a record, which could be used for any subsequent work, contractual disputes, or other problems which might arise. As engineering became more of a team activity, with few having an overall view, the total volume of paperwork generated became uneconomic to store and long term record keeping was reduced to the bare necessities, usually concentrating on the manufacturing documentation.

The catalyst for this paper was a conversation with other colleagues, one of whom had been asked to design a new attachment for an existing complex product. This had been manufactured for some years but had recently gone out of production. The design department hadn't worked on it for a long time, and their records were lost. The works had stopped making it, so their drawings had been binned. The equipment had to be reverse engineered to get the information needed to design the new attachment. We began to discuss other times when information was needed and soon realized that there were strong reasons for keeping a more extensive design archive and records of product cycles.

Manufacturing documents, particularly drawings, are the "end product" of the design process. They provide the detailed information needed by the various manufacturers to produce the product designed to meet the customer requirement. In modern parlance, they are the Technical Product Specification (TPS) and usually conform to some standard of presentation. Most drawings now meet the international ISO standards, (specified in the UK in BS8888 [1]), or other equivalents. The main advantage of these new standards is that symbols are now used for most key notations, particularly tolerances, and can be correctly interpreted in different parts of the world, where the local language may be different.

In addition to the TPS itself, there may be test or safety certificates, notices of compliance with various regulations, transport and storage requirements, installation instructions, and other necessary documents. Operating instructions and maintenance manuals are rarely produced by the design team itself but are usually produced by specialist writers. (For some mass produced products, an independent organization can profit from producing comprehensive user friendly manuals; for example the “Haynes” series of manuals for car maintenance.)

There is a growing realization of the value of the intellectual content of a design cycle and the rise of Knowledge Management as a new field of management thinking. For some decades, Japanese companies have made a habit of recording the learning experience of a design activity. They often continue to develop unsuccessful proposals to see where they lead and retain any promising outcomes for future reference. In the West the implementation of such policies is sparse and patchy, particularly amongst SMEs (small and medium enterprises).

We soon realized that there were other reasons for keeping design and other records. For example, were involved in setting standards with the British Standards Institution (BSI), including the BS8887 series titled “Manufacture, Assembly, Disassembly and End-of-Life Processing (MADE)” [2]. This is providing a coherent view of product life cycles and ways in which the energy and materials used in their production can be at least partially recovered, when their service life is over. This changes the business case for purchase decisions. Some record of the manufacture and assembly of a product, perhaps no more than a marking on the product itself, could significantly improve its value for its next cycle.

A proposal for general guidance on the benefits of keeping records of design and product cycles, and the ways in which they could benefit a manufacturing organization, was made to the BSI and I now chair the new committee to carry this forward, known by the catchy title “TDW/4/5”. At the time of writing, we are still exploring our options and the factors to be considered. Below some of those factors are explored in more detail.

2 CURRENT RECORDS

Records that do exist are no longer the “diary” record of the old daybooks, but more often are tidied-up, rationalized versions of the final decision process. Rarely are the unsuccessful suggestions recorded in any detail, nor the reasons for making a particular choice. A design organization may keep some records of analytical or test work, particularly of the final version of the product, at least until any ongoing contractual obligations are satisfied.

Some information may be retained for use by those compiling any manuals for installation, operation, maintenance and end-of-life disposal. These records of analysis, prototype testing and certification are usually kept for a while, but eventually “weeded” from the files to make room for the next set. Electronic copies are kept until the software to read them has been superseded. Even the people who worked on a design project are soon scattered to other projects or move on. It is very rare to find a record of the reasons why design decisions were made, other options were rejected, or plan B never saw the light of day outside the personal records of individual designers. Few records are explored in detail to learn the lessons to be carried forward to new projects.

Some industries keep extensive records of use of equipment in service. The aircraft industry keeps a complete record of each fuselage, engine and other major assemblies throughout their service life. The railway industry keeps more basic records of each vehicle. Many cars have full service records, particularly for the early years when still under warrantee, but these often become fragmented as they get older. While such records may be a rich source of information for later designs, they add nothing to the story of the original design work.

A few years ago I supervised an undergraduate project based at the Science Museum in London. They had come into the possession of the last printing press to be taken out of Fleet Street. This was an American “Woods” press, three stories high, which had been in use since the 1920s. Although only one third of the whole installation, the press took in large rolls of newsprint at the lowest level and produced complete folded newspapers at the top, the whole assembly being driven by a single, very large, electric motor. The project was to inspect the press, initially in pieces for conservation work, but later assembled at the Museum’s Wroughton site, to find out how it worked and provide a demonstration exhibit. The only remaining documentation was a few printed sheets of operating procedures and the sparse records of a company, which no longer existed. The project was completed to the Museum’s satisfaction.

3 THE DESIGN PROCESS

The TPS is far from a complete record of the design process. Its prime purpose is as a communication between the designers and the manufacturers. It must be clear and unambiguous and specify everything only once. It does not contain any reasoning, analysis or alternative options. It is also, in effect, a statement that if the product is manufactured, operated, and maintained in accordance with these instructions, it will meet the customer's requirements. The responsibility for the validity of this statement is the designers'. The design process includes the whole activity from the point where the product was conceived, to the completion of the TPS and all necessary work to enable the designers to take on those responsibilities with confidence.

More extensive records could include: minutes of formal meetings, notes of informal meetings (including telephone calls and e-mails etc.), sketches and schemes, analysis records, laboratory and prototype testing (including for example, photographs taken specifically for record purposes), project management records (Gantt charts, etc.) and more. All records would have to include the names of the people involved, particularly those responsible for decisions. The level of detail would depend on the type of product and any safety issues. Although this mass of documentation should be ordered and catalogued, it should not be rationalized or edited. The design process is inevitably a series of proposals and suggestions at different levels of detail, some rejected after a moment's thought, others explored and analysed as viable options until a choice is made of just one to go forward. The full learning experience comes more from the reasons why options were rejected than from any logical tale of the final choices.

4 MODIFICATIONS, EXTENSIONS AND NEW VERSIONS

It is rare for a successful product to appear in only one form, sell for a reasonable time and then disappear forever. Success tends to encourage other companies to produce rival products, which in turn spurs the original company to produce an improved version, and so on. An improvement may be an adaption of, or addition to, the original product, so that it continues to be produced, or an upgraded design, which supersedes the original. The revenue a successful product generates, may allow the designers to reconsider an early design option, previously rejected as too expensive, and produce an even more successful product. Without good records of the decision process, and the arguments made, many of these options would rely on the memories of those involved, or be lost. The project described above, which required a reverse engineering exercise, is a typical example of the problems and costs which can arise when records are not kept.

5 WARRANTEES AND BREAKDOWNS

Warrantees are a written assurance that a product will be repaired or replaced, should it not perform in a satisfactory way. Those responsible for that assurance may be the retailer, the bank providing the credit card used to pay for the product, or the named manufacturer. They may in turn recover their costs from others in the delivery chain. Should a similar problem crop up consistently, then the design itself may be brought into question. Full design records would allow the relevant design decisions to be pinpointed and appropriate action taken. Otherwise it may require an expensive reverse engineering exercise to find out why the problem has occurred.

We live in a changing world. More than twenty years ago, UK consumer protection legislation included a clause making designers personally responsible for any safety related consequences of their design decisions. This could theoretically include a charge of manslaughter should a design fault result in a death. This could even happen after a product had been in service for some years, provided it had been manufactured, used and maintained appropriately. More recently, other legislation has given similar definition to corporate responsibility for faulty products. Neither of these pieces of legislation has yet been fully tested in court, but the need to keep full records of the design process would seem prudent.

6 INTELLECTUAL INVESTMENT AND IPR

Each design represents a learning process and an investment of time, money and effort. Although it has an immediate effect on the product in question, the longer term value of the exploration of materials, processes and alternative options can only be realized if the information is retained. In Japan, it has long been the policy to catalogue these learning experiences. Rejected, but still promising design options are often followed up to complete the learning process, which is then archived. Later projects benefit from the tried and tested ideas from earlier work saving considerable effort in not having to repeat the same processes. In the USA, an investigation of the costs and benefits of the

Apollo space programme revealed that the advances in new materials and processes, computing and control systems, project management techniques and spin-off products benefitted the American economy by about ten times the cost of the project. Political pressures ignore such information and as a result most of NASA's current space projects are based on work done in the Apollo era and the spin-off benefits to the American economy have dwindled.

When design work generates a novel concept, it may be worthwhile to protect the intellectual property it represents. Design registration, a patent, or sometimes a copyright claim, can help to fend off competition or bring in valuable licensing revenue, particularly where a new technology can be applied in a different market. Alternatively, some enabling technologies can enhance sales if an "open access" policy is adopted. This allows third parties to considerably extend the usefulness of a product, as is happening in parts of the computing and communications industries. Here a clear record of the main design details may be made freely available for others to use. The contrasting policies of Microsoft and Apple are an interesting and ongoing case study of this.

7 SUSTAINABILITY

It is clear that our supplies of many raw materials are becoming scarce or more expensive to obtain. In some cases, alternative materials may help fill the gaps, but our future policies must include more efficient use of the materials available by extending the life of products, and re-using or re-cycling products at the end of their life. With new and more efficient technologies being applied in many products, designers need to incorporate features into products, which make it easier to replace worn parts and upgrade performance. In general this will tend to make the initial product more expensive, but significantly reduce the whole life costs. This may mean a more modular approach to products.

One consequence of this approach is the need for designers and manufacturers to consider alternative sources of components rather than always assuming that materials come from natural sources. This already happens in a few industries, particularly the automotive industry, where replacement parts are often made from refurbished components. The volume of the turnover makes it commercially viable to set up the systems for recovery of used parts. Under current regulations, such recovered parts cannot be sold as "new", even though they are indistinguishable in their performance.

If parts are to be designed to last through several product life cycles, then the definition of "new" may have to be re-thought. Records of the various "lives" of each component may have to be kept as a log, or noted by some permanent mark on the part itself. If parts are to be designed with re-use in mind, a product will have a significant value at the end of its life. This will change the business model for purchasing decisions, but it will be dependent on some way of recording, at least, the number of life cycles. The limits on re-use may depend on levels of wear and tear, which can be assessed, or on factors such as fatigue, which cannot be measured easily.

8 ARCHIVE RESPONSIBILITY

If records are to be kept, someone has to take responsibility for them. Most design teams are broken up and absorbed into other teams, so there is no-one left to keep the records unless they are assigned to a central archive or library. The rights to the design might be assigned to a client, who may wish to control the records, which might then not be available to those who could benefit from them. The records may contain proprietary information, limiting those allowed to see them. Records may be needed for any of the reasons described above, and be appropriately catalogued. Companies may have the long term stability needed to maintain a library of records, but such records would not have the impartiality required for some purposes. That implies an archive kept by industry bodies, perhaps the professional bodies, or even, for critical products, a government department. Such records would only be useful if access is available for those who need it.

9 THE EDUCATIONAL IMPLICATIONS

Students already keep notes and write reports to record their learning progression. A little encouragement should enable them to see lecture notes as a record they might wish to consult in their later career. Written reports should perhaps be formatted to be a comprehensive record for future consultation emphasising the learning experience. Projects, running through the course, could deliberately build on each other so that the value of keeping records can be learned and become a lifetime habit. This could be done without adding any additional material to the course.

Earlier, I described a project to recover the design information on a printing press. Such exercises are a largely untapped source of student projects giving a pragmatic learning experience and a sense of historic depth to all areas of design. There are many industrial museums which could provide useful projects to the benefit of design students and their own exhibitions.

10 GUIDANCE

Help is on the way, eventually. The new BSI committee is tasked to provide some guidance on the records of designs and products, which should be made and kept for future benefit. At the time of writing we have met twice and have been exploring the current situation to get a better feel for the scale of the challenge. It is clear that many documents are produced but incentives to keep coherent records for long term use vary between companies, industries and markets. This paper sets out our basic starting point. I do not expect it to be an easy task or be accomplished quickly. If any interested party feels that they can contribute to our discussions, either by communication or as a member of the committee, please contact me at your convenience.

REFERENCES

[1] BS8888: Technical Product Specification, BSI - *updated frequently*.
[2] BS8887: Manufacture, Assembly, Disassembly and End-of-Life Processing (MADE) – *ongoing series.*