Freeing information in engineering design

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1) Introduction

Throughout our species existence, technological and social development have been based upon information[1]. The creation of an artefact is the transformation of raw materials into a product using information. A consequence of this constructive use is that information can be seen has having value. This idea is at the core of the phrase:

> "Knowledge is power" (Sir Francis Bacon)

Before the advent of writing, information was held in the form of knowledge and transferred verbally (in the most part), since then it has been possible for information to be 'stored' separate from any one individual and as our society has developed, more advanced means of storing and exchanging information have been invented. Today information can be created and stored anywhere, and instantly accessed an infinite number of times from anywhere else (almost).

The value of information and its increasing availability has led companies to seek to control knowledge through the use of 'Intellectual Property Law' (IP).

> "IP rights [apply] to intangible things - to ideas, as expressed (copyrights), or as embodied in a practical implementation (patents)" (2)

The increasing availability of information has led to much tighter control over IP. With companies such as IBM who current holds over 40,000 patents world wide (3), making in the order of $1000 million per annum from licensing (4). This trend towards ever increasing control over IP has led to many groups claiming that this control on information has significant negative consequences and that society would benefit from reversing this trend by freeing[2] much of this information.

2) Aim

This essay will examine the potential benefits of freeing information within engineering by examining existing projects and the current extent of intellectual property management within the engineering community. An outline of the requirements of freeing information will be produced.

The economic counter-arguments to freeing information are beyond the scope of this essay.

3) Design as information

Before examining existing projects and the current state within industry it is worth exploring how information is used within engineering.

Within engineering, information is bound up in knowledge. A knowledge base has been developed over many years which is separate from that of the sciences and humanities (although grounded in both) (5). It is this knowledge which is called upon to develop concepts and design solutions (6). This knowledge is seen as having great value and traditionally is to be protected at all costs, however, in recent years this idea has been challenged. Many streams of thought have converged on the idea that restricting access to and use of information holds back the advancement of society (7).

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1 For the purposes of this essay 'Information' is taken to be: the result of processing, manipulating and organizing data in a way that adds to the knowledge of the person receiving it. (1)

2 'free' is meant in terms of liberty rather than price i.e. free as in speech.

3.1) Many streams

- The ability to access and use/modify information will lead to an increase in creativity and promote wealth generation based on value adding services (8)
- The sharing of ideas and techniques is essential for society to advance: "Why re-invent the wheel?"
- By putting a price on technology and knowledge, the developing world is disadvantaged (9)
- Companies limit the value they extract from their own knowledge by over-protecting it. By opening up and accepting some loss of property they could better exploit the information they possess (10)
- No value is seen in developing solutions for problems with no associated financial reward, but these problems still need addressing

3.2) Example: Free software

One area of human activity which already embraces the principles of freeing information is the Free Software Movement. They espouse the idea of freeing software to allow *anyone* to modify/copy/re-distribute it (8). The movement has rapidly developed software which is on a par with non-free software and has advanced the sector as a whole. Free software is widely embraced in the developing world as closed software is far beyond their purchasing power, and is used for many commercial applications with requirements for customisation and independence from a single supplier.

4) Defining freedom

Using the free software definition[3] as a guide the following points outline what might be considered free design/idea in an *engineering* context. Freedom to:

1. Use the design for any purpose
2. Study and modify the design
3. Distribute the design

and a similar condition on distribution must be applied to prevent exploitation:

> If distributing or re-releasing a modification of the design then the original freedoms must be maintained

Clauses such as the condition above to prevent patenting (or closed licensing) of something which has been released on a free basis. (8)

5) Existing projects

A number of projects based on the concepts of freeing design already exist in varying forms, the following section will identify and examine some of these projects in a qualitative manner.

3 Available online at: http://www.fsf.org/licensing/essays/free-sw.html

5.1) Thinkcycle

> "...[A]n academic, non-profit initiative engaged in supporting distributed collaboration towards design challenges facing under served communities and the environment."

The initiative provides a space for concepts and projects to be developed through the exchange of ideas amongst a wide range of engineers, designers, and domain experts. The infrastructure upon which Thinkcycle is based (ArsDigita Community System) is not tailored towards collaborative design. (11)

5.2) Honey Bee Network

This network aims to develop a diverse database of 'grass roots' innovations and distribute these ideas to other innovators. By aiming to extract, document, disseminate and abstract these innovations, a database of solutions to problems encountered world wide can be created. Honey Bee, however, maintains and indeed promotes the right of ownership of and the extraction of value from, the innovation. (12)

5.3) Instructables

A website for members to "Share ***what*** [they] make and ***how*** others can make it.". The site allows for the creation of simple tutorials as well as much larger projects, based on individual and collaborative models. The site encourages the use of images and video to represent designs, and it has developed a vibrant and constructive community. The designs are based on step by step instructions, limiting it to relatively simple projects. (13)

5.4) RepRap

The RepRap is a project to develop a replicating 3D printer. By placing the ability to manufacture a variety of components , this machine has capability to produce a large range of products including a copy of itself. The aim being to drive down the cost of production. By freeing the design of the machine, collaborative development and incremental improvement is encouraged. RepRap is an example of a project firmly rooted in the production of physical goods, using the medium of the internet and the protection of free licensing, with the intention of advancing society. (14)

6) Within industry

As commercial ventures engineering companies do not make their designs freely available. However, they do employ collaborative design methods to develop their products. Collaboration can involve teams within one company (but separated geographically) working together, and increasingly it can involved many companies collaborating in a typical supply chain manner or risk sharing partnerships.

Airbus works collaboratively with an extensive chain of direct suppliers, as well as risk sharing partners to develop major subsystems such as the undercarriage (Goodrich) and engines (Rolls Royce). A tool used by Airbus during the development of the A380 was a common 3D digital model of the aircraft, designers were able to make changes which would then be reflected in the models of other teams around the world[4]. This idea of pooling information has become widely used within industry and is known as Knowledge Based Engineering (KBE).

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4 Information gathered during a site visit at Filton (14/03/06)

The design tools used within industry are appropriate to their function, and are used by professionals familiar with their operation, these design suites, such as Dassault's CATIA are very powerful and very complex.

7) Discussion

From the existing projects and trends within industry (§5 & 6) the following principles have been identified as being important the process of freeing design.

7.1) Target

- It is important to concentrate on those problems most in need of attention - The developing world is not catered for by traditional engineering firms. (9)

7.2) Collaboration

- A diverse range of designers and users will produce a more holistic design.
- Tools such as 'brain storming' are based on the idea that "quantity produces quality" (Alex Osborn, 1941) i.e. the more people who contribute, better the quality of the design.
- By listening to feedback and ideas from many sources and rapidly releasing updated designs collaborators will be encouraged to continue contributing. (15)

7.3) Enablers

- All of the projects identified have used the internet as a medium for the exchange of ideas.
- Free tools which provide contributors with a simple method of collaborating on designs are required to enable collaboration on complex projects.

7.4) Production

- Because the majority of the value added by manufacturing companies is in the design process, if an attempt is made to free that aspect of the system, the manufacturers will resist to protect their interests. Creating a separate manufacturing infrastructure will be required for free design to take hold as the creation of artefacts and enrichment from them will likely prove the greatest encouragement for participation in further design.

Using the points examined above it is possible to gain an idea of a development model upon which a free design system might be built (*Figure 1*).

8) Conclusion

The potential benefits of freeing information in engineering have been examined. An analysis of existing projects and the methods currently used within industry have yielded valuable insights into the steps necessary for the development of free engineering design and a potential model for such a system has been outlined.

There are still some technical and social barriers to overcome before a free design system can be created. Were a free design movement to be tried today, it would have to rely upon conventional manufacturing systems for anything more than the simplest items, and that system can not be expected to support the process of its own downfall. A project would be most likely to succeed if, initially, it tackled problems for the developing world, thereby catering for those most in need and not threatening existing manufacturing companies.

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Figure 1

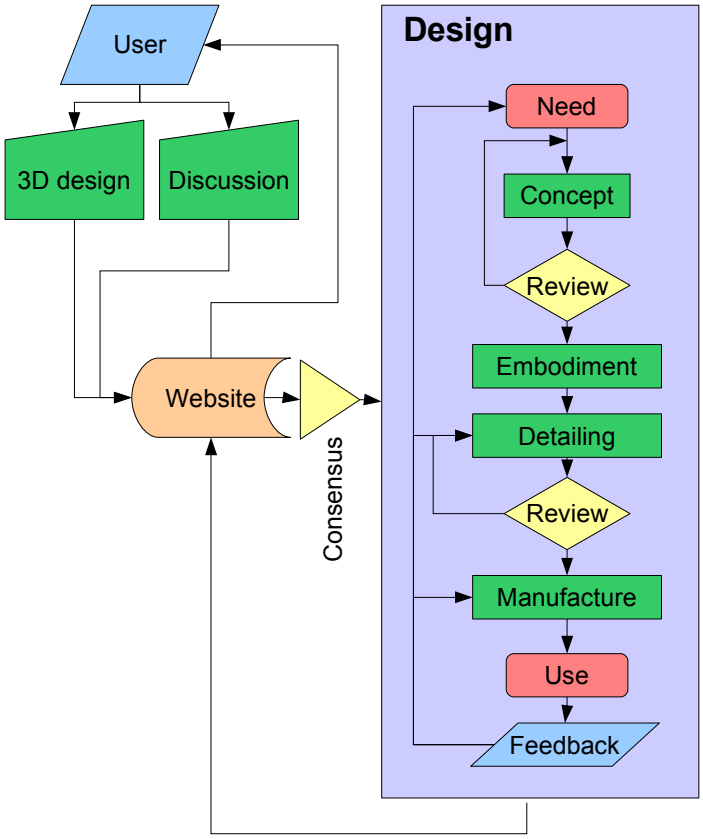

Figure 1: A diagram of a collaborative design process.

Notes:

- ***User*** *– design and domain experts and the endusers*
- ***3D design*** *– simple, free tools to aid visualisation*
- ***Website*** *– stores all information and designs*
- ***Feedback*** *– refinement loops allow for continuous improvement*
- ***Design*** *– the design process is based on a generic process*