TRADE ASSOCIATION STRATEGIES FOR PROVIDING TECHNOLOGY INTELLIGENCE TO SMALL AND MEDIUM SIZED ENTERPRISES – A STUDY OF UK TECHNOLOGY FORESIGHT PROCESSES

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Abstract

In the UK many industries are suffering as a result of business being lost to competition abroad. Raising the technical content of a company's product or service may enable them to increase its competitiveness and hence retain or even increase business. A Trade Association exists to represent the interests of its members. One way that this can be realized is by provision of technical information to its members to support raising the technical content of their members' products or services.

The provision of technical information entails sourcing information, collecting it and then disseminating it in an appropriate format. Ways of undertaking this are identified. The factors that are likely to influence the provision of technical information are determined. This is so that a Trade Association can build upon its strengths, diminish weaknesses, exploit opportunities and avoid threats. A strategy for provision of engineering technical information to trade association members was given. Four mechanisms were implemented on a test-bed Trade Association; utilising information technology communication capabilities, newsletters, collaborations and conferences.

Feedback and parameters were used to assess the strategy chosen for implementation on the test-bed. Taking this into consideration a revised strategy was established that can be adapted and applied by Trade Associations who wish to provide such a service in the future.

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Contents

1. Introduction to Research Topic

A Trade Association (TA) is an organisation that represents the interests of its member companies in a range of environments. Traditionally TAs have been the voice of industry to government. TAs were at their peak during the 1960s and 1970s [1], since then their role has been in decline. They are not for profit organisations existing for a social purpose, that is to say they exist to promote a particular group of people. Nevertheless, they are increasingly expected to behave like a business – in the past TAs had been seen as clubs [1] – in order to create revenue that can be used to improve current services and create new ones in order to make them financially viable.

In the UK many industries are suffering as a result of business being lost to competition abroad, especially in low cost-base countries [2]. Raising the technical, value-added, content of a company's product or service may enable a company to increase its competitiveness and hence retain or even increase business. One way that a TA can support its members, by increasing the technical content of their products, is to provide accessible technical information. **Emerging technologies** are of particular importance as they are technical innovations that represent a development within a field for competitive advantage [157]. It is also important that disruptive technologies are not ignored by a TA. **Disruptive technologies** are technologies often seen as irrelevant and inferior technologies that have been developed independently from the sustaining, dominant technologies [158]. If these are ignored they could quickly become a competitive threat to TA members and could transform the marketplace.

Technology intelligence is the systematic and informal implementation of activities that gather timely and reliable information to support decision-making for management of technology and general interests [155]. It takes into consideration facts and trends (opportunities and threats).

Although the research focuses upon UK TAs it was important that technology intelligence processes from other countries were studied. It was especially important to be aware of those countries that are seen to be very innovative, an indication of which can be gained from looking at a country's Research and Development (R&D) spend as a percentage of Gross Domestic Product (GDP). The latest statistics (2009) form the Organisation for Economic Co-operation and Development (OECD) [162] shows that Israel (4.9%) has the highest R&D spend, followed by Sweden (3.7%), Japan (3.4%) and then the USA (2.8%) [163]. The UK (1.9%) is slightly below the OECD average of 2.3%.

The **aim of the research** presented here is:

> The development of a strategy to provide technology intelligence to members of Trade Associations related to engineering.

The research looks at technology foresight processes as a way to gain technology intelligence. **Technology foresight** is the method of forecasting emerging technologies and assessing and communicating the emerging technologies to suppliers, consumers and stakeholders [157], or in this dissertation the member companies of a TA.

To achieve the aim the following objectives have been addressed:

1. Determine the factors that are likely to influence the provision of technical information by a Trade Association
2. Identify sources of technical information
3. Identify methods for collecting technical information
4. Identify methods for disseminating technical information
5. Assess, using a Trade Association as a test-bed, a selection of the most appropriate methods for gathering and disseminating technical information
6. Relate the factors that are likely to influence the provision of technical information to those methods for gathering and disseminating technical information that are implemented with the test-bed Trade Association

7. Establish a strategy that Trade Associations can use to provide engineering technical information to its members

Chapter 2 provides a succinct description as to what a Trade Association is and draws upon its role to substantiate why the provision of technical information is important. The following chapter identifies a variety of sources and methods for collecting information that are relevant to Trade Associations representing UK industries, hence addressing objectives two and three. The categorisation of sources of information is mentioned as this can determine what sources and subsequent methods are used.

A number of ways to disseminate the information gathered are given in Chapter 4, therefore attending to objective four. The advantages and disadvantages of each are highlighted in order to aid a Trade Association in choosing the most appropriate dissemination means. A SWOT analysis is presented in Chapter 5 that is used to determine the factors that are likely to influence the provision of technical information by a Trade Association, therefore fulfilling objective one. Chapter 6 presents the results of implementing a selection of technical information gathering and dissemination methods on a test-bed Trade Association so that the methods can be assessed – objective five. The factors likely to influence provision of technical information, presented in Chapter 5, are then related to the results of implementation, which realizes objective six.

A strategy that can serve as the foundation for a Trade Association to provide their own technical service provision is presented in Chapter 7. Chapter 8 evaluates the research and Chapter 9 concludes it.

2. Trade Associations and their Contribution to Technology Intelligence

2.1 Introduction

This chapter introduces the concept of Trade Associations (TA), their role and the type of services they provide.

2.2 Overview of Trade Associations

A TA is an organisation that exists to represent the interests of companies, usually from the same industries, who pay a fee to become members of the TA that best represents their industry [3]. It is believed [4] that a majority of TAs evolved from cartel type activities after World War II. Typically TAs were involved in 'resale price control' and market-sharing arrangements. The Restrictive Trade Practices Act [5] removed this role from TAs [6]. The income that TAs receive from fees can differ and especially between countries. For example an annual budget for a Japanese TA is approximately £2.7 million whereas the average budget for a TA in the USA is about £423,000 [164].

In the 1960s the Confederation of British Industry [7] (CBI) was formed by the government of the time in an effort to rationalise the number of TAs [4]. However, there was an increase in the number of TAs in the 1970s and 1980s [6]. This could have been due to the change of government, in 1979, weakening the role of the CBI as the main representative of industry. Thirteen percent of TAs were involved in a merger between 1989 and 1994, pointing towards rationalisation of TAs. The "Heseltine Initiative" in 1993 alleged that the large number of TAs was bad for UK industry [3]. It is believed that the initiative was a stimulus for change within TAs, including mergers, improving their own effectiveness and in turn improving their members productivity and hence competitiveness. Currently in the United Kingdom there are approximately 900 TAs [8]. This compares to about 2,200 TAs in the USA and 15,000 in Japan [164]. It ought to be noted that it is difficult to make direct comparisons as TAs

and their functions can differ between countries. For example, in the USA they have State Bar Trade Associations, which represents all the attorneys in a US state [164]. In the UK State Bar Trade Associations do not exist.

TAs have evolved [3] to provide improved services to their specific industry member companies and represent and promote their interests. In some instances members can purchase additional services [6]. It is the ability of TAs to do this that enables them to retain and grow their membership, and hence remain financially viable.

2.3 Services offered by Trade Associations

In 1994 May *et al* [6] conducted a survey of TAs in the UK. An outcome of this is Table 1, which shows the main services offered by TAs, in order, with the one most made the use of, by TA members, at the top.

Table 1: Table to show the provision of the main services offered by trade associations, as a percentage of those surveyed [6]

Rank	*Service*	*%*
1	General advice	88.1
2	UK government representation	84.9
3	Contact with other firms	81.9
4	European representation	76.5
5	Technical advice	73.0
6	Market information	67.0
7	Standards	66.5
8	Legal advice	57.0
9	Training	52.8
10	Environmental advice	51.2
11	Home sales promotion	39.8
12	Export promotion	25.3

Focusing on the subject matter of this thesis, technical information, 73% of TA members utilised technical advice, hence it was the fifth most provided service by TAs. With almost three quarters of TAs offering technical advice it is indicative that it is an important service to offer.

Other services like general advice and UK government representation, with 88.1% and 84.9% provision respectively, were more greatly utilised by members. Macdonald [3] reported that although representation has been a traditional role for TAs other services provided would be used to show the worth of a company's membership rather than representation. Many TA directors felt it would be difficult to assign an accurate value for representation, which was seen as an intangible benefit, whereas the worth of other services was easier to show. Exhibitions and conferences were seen as services that could be more easily seen as a tangible benefit, and hence could be used to demonstrate the value of members' subscription to a TA. Any strategy for providing technical information ought to try and offer tangible benefits so that its worth is valued by members.

It could be argued that two of the 12 services listed in Table 1, in addition to technical advice, could be considered as a technical service. Various standards can be of a technical nature. Training could be given on a technical subject. Depending on the definition of technical service, the number of TAs that already provides such a service could be greater than 73%.

No matter what definition of technical services it is clear that it is considered important to provide, otherwise at least 73% of TAs would not be offering it. A term commonly used for the method of gathering information and making it available to others is Knowledge Management (KM) [9]. Intellectual Capital (IC) is possession of the knowledge that results from experience and learning, which can provide an organisation with a competitive edge [10], and hence making it an important thing to possess. Furthermore, KM and IC management can play significant roles in producing innovation that creates value, and subsequent wealth, for the organisation. Innovation can contribute to increasing the market value of a company. To gain wealth an organisation must leverage its resources,

or IC, to produce innovation. In addition, organisations must prevent IC loss [11].

May *et al* [6] established that more than 50% of members, from three quarters of TAs, employed less than 30 people. Consequently the ability to buy services from a TA as part of the basic membership joining fee was essential. This would appear to be in line with the fact that at the start of 2006 there was an estimated 4.5 million business [12] enterprises in the UK. Of these 99.3% were classified as 'small' (0-49 employees). A reason for the large number of small companies being in membership of TAs is that small companies are not large enough to create direct links with government [1]. For the purpose of this dissertation the definition of a Small to Medium-sized Enterprise [13] (SME) will be taken from the official definition given by the European Union, which is in line with the aforementioned classifications. An SME is an organisation that can meet the following criteria:

- It is an organisation that is engaged in economic activity
- An organisation that has fewer than 250 employees
- It has an annual turnover not exceeding €50 million or does not have a balance sheet total not exceeding €43 million

TAs provide market information and legal advice reducing the need for member companies to undertake such activities that are essential to their business. These types of services are in line with the Heseltine Initiative by enhancing a company's productivity and hence competitiveness, as is the provision of technical information.

2.4 Case Study: Profile of the GTMA

The GTMA is a TA, in the United Kingdom, representing its fee paying member companies in precision engineering, metrology, rapid product development, toolmaking and tooling technologies. This TA will be the test-bed for the investigation of the prioritised technology foresight practises for TAs given in Chapter 6. It was set-up during 1942, during World War II, as part of the 'war

effort'. Its responsibility was to co-ordinate the manufacturing and distribution of special tooling and gauging for the production of armaments, aircraft and other defence equipment. It has experienced and survived many of the pressures that have been inflicted in TAs over the years, such as the rationalisation of TA number between 1989 and 1994.

Table 2 shows the main services that GTMA offers to its members [105]. The GTMA has approximately 300 member companies. The majority of which are SMEs or 'micro' SMEs, with ninety percent of member companies employing less than 30 people [103].

Table 2: GTMA member benefits and services

Type of Benefit	*Service*	*Description*
Business Assistance	Buyers Networks	GTMA networks with OEM and Tier 1 companies to further the UK engineering supply chain and provide business opportunities
	Sector Supply Chain meetings	Opportunities to network in the Aerospace, Medical, Automotive, Packaging, Oil & Gas, Composites industries
	Out-Sourcing	GTMA will source members requirements
	Business Development Training	Providing a funded business programme for management development
	Mediation Service	Free confidential service to resolve issues for members
	Industry Standards	Industry statistics for UK, Europe, Americas and Far-East
	Business Helpline	Providing unlimited specialist advice on employment and company law
	Health & Safety	Free health & safety audit and free unlimited helpline cover for members
	Insurance	Substantial saving for business insurance and private healthcare
Communication	Lobbying	GTMA lobbies government on issues affecting the sector
	Representation	GTMA is represented in Europe on new legislation and regulations in the Mechanical Engineering sector
	Marketing	Buyers Guide, GTMA News, GTMA website
	Business Briefings	Providing business information
	Trade Press	Promoting members
Promoting Excellence	Best Practise	Best Practise and evaluation programme
	World Class Profile	GTMA provides assistance on the World Class self-assessment profile
	Financial Solutions	Providing financial solutions for tool leasing, leasing of equipment and software
	Awards	Annual Apprenticeship and Engineering Excellence Awards

2.5 Concluding Remarks

An overview of TAs has been provided along with an indication of the typical services provided to TA members. As a result of rationalisation of the number of TAs they are now expected to go further in improving their members' effectiveness and competitiveness. This in turn should enhance the TA's competitiveness through offering a superior service and therefore being able to better retain and attract fee paying members.

It has been established that technical information is already an important service offered by UK TAs – the fifth most provided service. It is essential that a TA tries to show the tangible benefits of its services, such as technology intelligence, so that it helps its members realise the benefits of their membership. Member companies are pre-dominantly SMEs. Hence, technology intelligence services need to be aimed at this size of company – less than 250 employees.

A test-bed TA that was deemed representative of a typical TA was introduced. This was the GTMA. The strategy for providing technology intelligence is implemented using the test-bed TA, which is discussed in Chapter 6. The following chapter identifies sources of technical information and technology monitoring methods that could be utilised by a TA.

3 Technical Information Gathering: Sources and Methods

3.1 Introduction

This chapter examines how technical information can be gathered from a range of sources by a Trade Association. Sources and methods used by a variety of different organisations to gather information are presented.

3.2 Assessment of Sources of Technological Innovation

There are many information sources that can be exploited. Sources of information can be put into two main categories, primary sources and secondary sources [14]. It is important for a TA to understand the advantages and disadvantages of each as it may influence what type of source is used and when.

In this dissertation primary sources are defined as first-hand information from persons directly involved in an activity or event or speaking directly for a group – it is original information that has not yet been interpreted by someone else [15]. A secondary source is one that has not come directly from persons involved in an activity or event; it has been interpreted by a second or third party. The risk in using a secondary source is that a TA could provide a misleading notion if the secondary source had misinterpreted or added bias to the primary source of information.

Information can be both and primary and secondary source [15]. For instance a researcher may create a report on his or her findings. This report would be a primary source. Somebody from a magazine may interview her and produce an article about the researcher's work. This would then be considered a secondary source.

The definition of primary and secondary sources is not unanimous. In the field of competitive intelligence – the process where companies inform themselves of

their competitors' activities [14] – a secondary source is described as one that is publicly available and includes all written information. This definition is not used in this dissertation as it was considered the least used definition within relevant literature. When talking about primary and secondary sources with others it must be made certain that all are using the same definitions.

The credentials of sources, that is to say their providence, must be considered when gathering information; otherwise distribution of technical information from poor sources could result in a poor technical service being offered. This could result in companies having a low opinion of the provider, the TA.

Both primary and secondary sources exist internally within a company and externally. West [14] recommends that the following route should be taken when searching for information:

1. Internal secondary sources
2. External secondary sources
3. Internal primary sources
4. External primary sources

Table 2 highlights some of the advantages and disadvantages of internal and external primary and secondary sources, which gives reasoning for the route that West suggests should be taken.

Table 3: Table to show the advantages and disadvantages of using internal and primary sources, adapted from West [14]

Category of source	*Advantages*	*Disadvantages*
Internal secondary	1. Usually inexpensive (apart from books and access to journals) 2. Should be easier to obtain than an external secondary source 3. Usually quicker to obtain information than primary sources	1. The detail of information is usually low, and hence less useful
External secondary	1. Usually inexpensive (apart from books and access to journals) 2. Usually quicker to obtain information than primary sources 3. The detail of information is higher than for internal secondary 4. There is more scope for identifying external secondary sources than for internal 5. Scanning for information can be kept simple if there is a necessity to do this	1. Some of these sources can be easy to identify but can be difficult and take time to obtain 2. It is available to anyone who wants to collect it and although inventive ways can be used to collect and present it there is not enough possibility to obtain very unique information 3. It is often available after a time delay and therefore is not always brand new information 4. Some secondary sources can be bias i.e. company literature can paint a company and its technologies as being great when they are not
Internal primary	1. Unique information can be obtained 2. Can provide information on the gaps in knowledge left after using secondary sources	1. Deemed more risky to use than secondary sources 2. Wishful thinking by staff that their company is better than their competitors can affect the

Category of source	*Advantages*	*Disadvantages*
		accuracy of the information 3. Primary sources generally take more time to set-up and complete than secondary sources 4. More costly to conduct than secondary source information gathering. It takes time and more specialist skills to do this
External primary	1. The detail of information is higher than for internal primary 2. Can provide information on the gaps in knowledge left after using secondary sources 3. There is more scope for identifying external primary sources than internal ones 4. Unique information can be obtained 5. More up-to-date information can be obtained than for secondary sources. This makes it more valuable	1. Deemed more risky to use than secondary sources 2. It is usually the most difficult source to obtain information from 3. Is typically the most costly source of information 4. Some routes to exploit this source are considered unethical 5. Persistent contact with an external company or organisation could annoy 6. Primary sources generally take more time to set-up and complete than secondary sources. Especially so for external primary sources as contacts need to be identified and there is a reliance on their availability

It is advisable to use more than one type of source from Table 2 so that the disadvantages of one can be addressed by another. For example, a disadvantage

of internal secondary sources is its lack of detail. External secondary sources have the advantage of having a high level of detail, therefore nullifying the disadvantage of internal secondary sources. Using both types of source together complement each other.

Further classifications of knowledge, or technical information, are whether it is embedded or migratory [16]. Knowledge that is linked with social interactions, specifically knowledge that is in a person's head (tacit knowledge – Section 3.2.12), is referred to as 'embedded knowledge'. It is slow moving 'sticky' information. Another type of knowledge is 'migratory knowledge', which can be easily encapsulated in a physical format, such as formulas, manuals and blueprints. A TA should consider whether information from potential sources are embedded or migratory as the former is likely to be more time consuming to obtain.

Decisions regarding the sourcing of knowledge and technological inputs can affect the future innovative capabilities of an organisation [17], therefore, it is a decision that should not be made lightly. Due to the greater ease of providing information by electronic means, such as the internet, the likelihood of finding poor quality or inaccurate information is high [15].

There are ways of determining whether a source is credible or not. For example, Burnett [15] suggests that in order to assess the credibility of a web page four main elements ought to be considered: authorship; timeliness; purpose; content. In addition to this West [14] describes cross-checking as the ultimate test of authenticity. However these could easily be applied to other sources that a TA decides to use. Authorship is looking at the credentials of the author, which considers are they qualified to talk about the topic they have written about and are they affiliated with a good university or respected company. The age of the information (timeliness) is important, especially for technical information, as one does not want to promote something as state-of-the-art when it is not. The purpose for the source information being made available can help decide how credible a source is. For instance, company literature is likely to be biased in order to make the company appear in the best light possible – often to make it

more attractive to investors. By means of studying the content of an information source an idea can be gained about its credibility. It can be compared to current knowledge to see if it matches it or not. Other resources can be used to verify it. Poor spelling and grammar could be a sign of a lack of effort into producing quality work. Cross-checking is comparing the different sources to see if they uphold the same judgements. This is not a 100% guaranteed test of authenticity as many different secondary sources could use the same source that was inaccurate.

The time horizon for technology – the amount of time the current judgements on a technology are expected to be relevant and useful – can affect the knowledge sourcing relationships [17]. The **technology life cycle** is similar to product life cycle but applies to a technology from its birth to death [159]. Understanding where a technology is in its life cycle is essential to remain competitive so that resources are not spent on an obsolete technology [160]. Long range planning for what technologies and sources should be used ought to have the purpose of avoiding 'lock in' on technologies that may be superseded by new technologies.

It is believed that the intensity of use of different sources depends on the industry [18]. Table 3 shows how the intensity of use of different technology information sources varies between three industries. For example, in the market-driven automobile and machinery industries dominant designs usually exist and component innovations are common. The scientific designs need a longer time to become competitively relevant, therefore, information sources related to science are less likely to be used than in the pharmaceutical industry. Sources that are considered more important are product fairs, and supplier and customer interviews. These meet the information needs, such as communication with the market (customer interviews), and are within the appropriate time horizon – the time period that current judgements are expected to be relevant – as component innovations are likely to be exhibited at product fairs and by suppliers. A TA would have to give thought to the information needs of the industry(s) that its members are involved with to decide what information sources are most appropriate to use.

Table 4: Intensity of use of different technology intelligence information sources from three industries [18]

	Pharmaceuticals	*Electronics*	*Automotive/ Machinery*
Publication frequency analyses	●●●	●●	●
Publication citation analyses	●●●	-	-
Quantitative conference analyses	●●	●●●	●
Patent frequency analyses	●●	●●●	●●●
Patent citation analyses	-	-	●
S-curve analyses	-	-	-
Benchmarking studies	●●●	●●●	●●●
Portfolios	●●●	●●●	●●●
Delphi studies	-	-	-
Expert panels	●●●	●	●●
Flexible expert interviews	●●●	●●●	●●●
Technology roadmaps	●●	●●●	-
Product technology roadmaps	-	●●●	●
Product roadmaps	●●●	-	-
Experience curves	●	●●●	●●
Simulations	●●	-	-
Option pricing models	●●	-	-
Scenario analyses	●●●	●●●	●●●
Lead user analyses	-	●●●	●●
Quality function deployment	-	●●	●●●

●●● = often used
●● = sometimes used
● = rarely used
- = note used

The type and intensity of use of a source, and the chosen method for gathering it, are attributed, by West [14], to six determinants:

1. Characteristics of intelligence
2. Detail of intelligence

3. Frequency of collection
4. Manpower required
5. Time required
6. Budget required

Many of the determinants relate to the advantages and disadvantages of primary and secondary sources as presented in Table 3.

The first determinant, characteristics of intelligence, can refer to the level of uniqueness of information or the degree of potential bias that can be associated with a particular source. More exclusive information could be regarded as more valuable, but harder to get through use of primary sources. Using biased information could reduce the 'quality' of the source. A TA may have to opt for mainly primary sources – the harder route – in order to get the more valuable exclusive information and information that is likely to be less bias (as described in Table 2). On the other hand readily available, less exclusive, information could be disseminated if it were to be disseminated in a distinctive way that made it easier to comprehend and hence obtain a benefit from it.

The sources that were predominantly used over the range of industries (those that were stated as being 'sometimes used' or better across the three industries in Table 3 were:

- Publications (Section 3.2.1)
- Patents (Section 3.2.2)
- University contacts (Section 3.2.3)
- Consultants, external experts (Section 3.2.4)
- Scientific and commercial conference (Section 3.2.5)
- Co-operation and collaboration (Section 3.2.7)
- Information providers (Section 3.2.9)
- National research committees (Section 3.2.10)

The abovementioned sources are described in more detail in Sections 3.2.1 to 3.2.12, along with others seen as being most relevant for use by a TA:

– Product fairs and exhibitions (Section 3.2.6)
– The internet (Section 3.2.8)
– Personal observations (Section 3.2.11)
– Tacit knowledge (Section 3.2.12)

It is important to note that the sources of information and the way they can be accessed can change dramatically over time.

3.2.1 Publications

Publications include:

- Books
- Journals (periodicals dealing with a specialist subject)
- The trade press
- Industry newsletters
- Conference papers

These can either exist as hardcopy printed publications or electronically such as online catalogues. The advantage of a book is that it typically contains a large amount of information [14]. It is often considered that journals, rather than books, are the better source of information in technology [19]. This is because journals are considered to have the most up-to-date information. Customarily in journals contact information for the author(s) is given. The author(s) can be keen to discuss their work with others that have an interest in the same area [19]. Through contacting the author(s) their state-of-the-art ideas can be discussed further, if the author is willing and able to do so. References included in books and journals can offer many more sources of useful information related to the subject area and in essence could be considered a shortcut determining which further relevant publications could be utilised, rather than spending time using search terms in library or electronic catalogues.

The trade press can cover almost every business [14]. They tend to attract many news stories from companies. This endows them with an advantage as they can be relied upon to record a majority of the significant events within a sector.

Electronic publications of journals and books can be more easily searchable for information by using keywords to seek out sought after information.

Industry newsletters contain summaries of a collection of literature relevant to a sector. The benefit of using these is it can act as a shortcut for finding information in one place that has originated from many sources. West [14] states that conference papers are mostly produced by people working in companies and therefore can give an insight into their experiences within a company. West has focused solely on conferences held by companies to discuss a topic or topics. Conference papers are also available from conferences involving different people from industry and academia for exchange of information on one or more topics. These conference papers are likely to be more accessible than those intended for just one organisation's use. Conferences are discussed in more detail in Section 3.2.5. A plus for using conference papers is that because most of the papers are to do with a similar, if not the same subject, they can easily be compared to each other [19].

There are three main different types of types of trade press magazines, each with their own benefits of use:

1. Those devoted to a particular sector, which are the most specialised and therefore will cover all that happens in that sector, such as product launches and trade shows and exhibitions
2. Magazines that are focused on manufacturing techniques, for instance Practical Welding Today [20], which covers advancements in the technique for many sectors
3. Subject related magazines like Engineering [21], which reports significant events in the world of manufacturing

3.2.2 Patents

Patents are a secondary source of information [14]. Looking at what patents have been filed can provide information on new technologies [22] and indicate what areas of technology research and development companies are interested in

[14]. An advantage of this source is that it provides information on new inventions that should have an industrial application [22]. If something submitted did not have an industrial application it would not be granted a patent. As a source it also benefits by the fact that a clear description is given of the invention so that it is understandable for somebody to use the patent. References are given (Section 3.3.3) [14] that can be used to find further information. A patent search has a wide scope as it can bring attention to state of the art for many different industries [23]. Also, a patent is dated, which confirms how old an invention is. However, there is a slight time delay, of about one and a half years (1991), between an application being submitted and publication.

3.2.3 University Contacts

Universities not only offer a source of information through the library and electronic resources. People within a University, especially the academics, can be considered experts within their field [14]. The benefit of using a **university contact** is that their knowledge is often very good as they devote much of their time to their subject area. They are usually enthusiastic to talk to someone about their area of work. Some people do not see academics as being in touch with the 'real world' i.e. academics do not understand the pressures seen by companies. It should be pointed out that some universities will be seen as understanding the 'real world' and others less so. This can lead to reluctance in using university contacts. An indication of this as an issue is the efforts that have been set up to promote contact between academia and companies and also that it appears to be a significant research topic [24]. INnovation DElivers EXpansion (INDEX) vouchers [25] are an example of a scheme that promotes this. It allows SMEs to apply for a voucher that can be used to purchase academic support from specific universities. In subject areas, such as management, employees of companies have thought that academics have much theory but have little experience on applications. People outside academia often do not appreciate 'good' research practise that can involve rigorous empirical data for validity.

3.2.4 Consultants and External Experts

Like university contacts **consultants** have a large amount of information and knowledge within their chosen field [14]. In a survey, conducted by Wilkerson [24], that looked at views of academic research relevance (for the subject area of management) it showed that overall consultants were preferred to universities for information. Consultants are usually unwilling to provide information unless they are paid for it, unlike a university contact [14]. However, they normally provide a quicker response time. Sometimes they will provide information in exchange for something that will benefit them, such as access to another expert's knowledge or information source. A condemnation of consultants expressed in Wilkerson's results was the sales pitch that would often accompany provision of information [24].

Using people from outside as a source of information can bring the benefit of involving someone that is knowledgeable of other industries. This has the potential to bring in new ideas, hence promoting cross-fertilisation of technologies [14]. For a TA even government contacts, including national and international, can be used as an external source of information [26].

Rather than gather information directly from the sources organisations are increasingly sourcing part or all of their technical knowledge from external experts [17]. A reason for this trend in outsourcing is that the number of technologies per product (TPP) is increasing. Some organisations do not have the resources, or the in-house technological and knowledge capacity, to cope with the extra burden of keeping up with an ever increasing number of technologies, hence they seek outside support.

3.2.5 Conferences

A **conference** is a prearranged meeting for the exchange of information and discussion [27]. Conferences can provide the opportunity to meet people from academia and companies [14] and hence obtain information from those sources.

A benefit of conferences is that there can be a feeling of goodwill amongst the delegates due to the good social environment provided. This can result in delegates being more willing to share information. Also, most people come to a conference in a frame of mind to be open. There is often a charge made to attend a conference and this can vary depending on the length and type of conference. For example the cost of two conferences, with the central theme of rapid manufacturing, are £349 [28] and £423 [29], both of which last for two days. Some conferences will offer discounts. For instance if the organiser is a membership organisation, like a TA, a discount may be open to existing members or for those that join [30].

3.2.6 Product Fairs and Exhibitions

Some conferences will be run alongside an exhibition or vice versa [28]. An **exhibition**, or product fair, can provide information on companies' products and services. Like conferences they provide an arena for networking, especially considering most people who attend have a more 'open mind'. In particular an attendee can find out what product or service features are being promoted as unique or state-of-the-art [14]. It is more than likely that attendance at a product fair or exhibition would cost less than a conference, or even free to attend. Publications (Section 3.2.1) can also be collected and consultants and external experts (Section 3.2.4) can often be found at product fairs and exhibitions.

3.2.7 Co-operation and Collaborations

Co-operation is when a group work together, for example universities and companies may collaborate to develop a new product or technology. For a TA this could also include working with other associations and interest groups [26]. Some say that the popularity of outsourcing technical knowledge or co-operation has grown with the world economies merging [17]. Others argue that it is not a new phenomenon and collaborations have been in place since the late nineteenth century [31]. The driving forces for co-operation are usually [32]:

- Escalating research and development costs

- Shortening technology life cycles
- Increasing complexity of technologies
- Globalisation of technologies and markets
- Industrial competence being more widely dispersed geographically

The benefits that companies can gain through co-operation include [32]:

a. Sharing of costs
b. Reductions in risk associated with the development of a new product or process
c. Facilitation of the formation of compatibility of technologies i.e. mobile phone companies working together to licence a software operating system for third generation mobile information and communication services so that the same applications can run on many makes of phone [33]
d. Identifying a means of entering foreign markets
e. Innovative performance of a company can be increased when in co-operation with knowledge generating organisations, such as universities, government and research and development institutions as it increases access to 'star scientists'. Star scientists can more easily acquire high-quality information that can assist in better decision making.

Governments can encourage collaborations through offering funding for projects that promote the government's research interests, hence there is money available to utilise this source. Companies that already participate in government projects are more likely to be invited as symbolic partners in government projects.

It must be realised that collaboration is a supplement to its own research, rather than a replacement [17]. It should be seen as an additional source to act as an input into its own research activities. Howell *et al* [17] warns that caution should be taken when outsourcing research and development. A British reliance on the outsourcing of research and development has been blamed for hampering innovation amongst British companies prior to 1950. Some organisations are reluctant to outsource 'critical' technologies, but there is a growing willingness to outsource routine, low value-added research and technical activities.

UK SMEs that innovate successfully usually have dense external networks of partners [32]. A survey of companies in the West Midlands (UK) found that companies that co-operate with suppliers and buyers tend to increase their ability to innovate. Through utilising collaborations as a source it opens up opportunities to exploit other sources such as university contacts that may be participating in the project. There is some pessimism about the success of co-operations. Co-operations, especially global co-operative ventures, can be difficult to manage and prone to instability, and their failure rate is high [16]. This has been put down to problems with control, risk and competitive tension.

In specific relation to TAs, The Federation of Sports & Play Association [34] became a partner in a project based at the University of Sheffield – the Sports Science, Engineering and Technology Network (SET Network). This gave SMEs within the sector access to expertise and advice on sports engineering and technology, and design innovation, as well as other areas that were previously a weakness for its members. This has helped companies be more innovative [3].

The success of co-operations can depend upon the nationality of those companies or organisations involved [32]. This can be attributed to the 'societal effect' [16]. The term 'societal effect' has come from research that has shown significant national differences in the way work is organised and structured. For example the types of differences associated with how knowledge and skills are utilised and distributed can lead to mismatched expectations and conflicts projects between companies. It is important to note that the societal models may not be shown by all companies within a country.

The type of inter-organisational link is inclined to be nationally specific [32]. Previous research by Chang [32] has shown that company-research links play a major role, if not the most important role, in increasing innovative ability in Taiwan more so than in the UK. Strong financial support from government agencies, non-profit research and development institutions and national government labs supports pre-competitive technologies in Taiwan.

3.2.8 The Internet

There is a wealth of information available on the internet and much of it is available free of charge [37]. Sometimes it can be considered to provide the link to another source, like publications and patents. Certainly almost everyone can use the internet to find information, but it is becoming progressively more difficult to use the internet as an effective tool due to the rapid growth in the volume of data [38]. Erroneous information exists on the internet and there is a risk that this information is used. On the other hand there are ways for assessing the credibility of sources on the internet, as recommended by Burnett [15]. It is predicted that by 2010 the amount of digital information in the world will double every 11 hours [39]. With this multitude of information it may become more and more difficult and time consuming finding information on the internet that is relevant to the search.

3.2.9 Information Providers

Information providers are usually organisations or companies that specialises in provision of data and value added services [37] to the knowledge and information marketplace [40]. They can operate as both an information provider, such as a repository of online and published information, and as a service provider offering knowledge management software, information integration and retrieval systems (e.g. searching and browsing). Primarily information providers offer their repository or services on a fee basis [40], however, search engines, which are typically free of charge, could be considered to be information providers as they can retrieve many different formats of information [37]. Additionally companies and organisations that send out news alerts and science alerts etc. could be considered as information providers.

Nelson *et al* believes that as search engines become more sophisticated users of information providers expect more, for example desktop access to full-text documents rather than only abstracts and access to more varied information formats [37]. Better value for money is offered [40]. Cost of using an

information provider may be an issue for some. A possible benefit of using one is quicker access to relevant information. The latest technology for accessing technical information is continually changing, therefore, involving much investment to keep up-to-date. Using an information provider that utilises the latest technology means that the customer does not have to invest heavily in the technology. Furthermore it removes the risk of buying technology that may be underutilised, whereas the cost of using an information provider can be stopped if their services are not used.

News alerts and the like can be considered a form of SPAM (Section 6.4.2.1) [41]. This can cause annoyance to the recipient as they may be bombarded with such alerts, some of which may be rather lengthy, not relevant, arrive at inappropriate times and when the information is not required. This can get to a stage where the recipient is the 'slave' to the alerts as they spend much time scanning them and/or deleting them. The systems operated by information providers should be working for the user, not the other way round.

3.2.10 National Research Committees

The main roles for **national research committees**, or research councils, are to prioritise the research in their sphere of activity, to assess applications for projects that are requiring funding and to make recommendations for future projects [42]. Research Councils UK [43] is the partnership of seven UK research councils. A national research committee will have a particular theme, such as Engineering and Biological Systems and they are usually subordinate to another assembly. For example in the United Kingdom the UK Computing Research Committee [44] is an expert panel for computing research in the UK, which is subordinate to the Institution of Engineering and Technology [45] and the British Computing Society [46].

Within a committee there are people of relevant expertise that are brought together. Committees on the whole have regular meetings where minutes of the meeting are often taken – for certain committees' minutes are legally obligatory.

If publicly available these can be valuable sources of information to see where the committee, and the experts it is made up of, feels the priorities for future research lie. A disadvantage of this source is that a committee may come to undesirable compromises on an issue that would mean their decisions may not be the best. Partaking in a committee can be useful as it provides a place to share information amongst experts that would not normally get together. The disadvantage is that committees in general are well-known for procrastinating, so using this as a method for gathering information may be time consuming.

3.2.11 Personal Observations

Personal observations are when a person observes things like relationships, behaviours and processes [15]. This can provide a cumulative build-up of information. The credibility of this source is greater if the observer is trained in the area of investigation. Someone who is observing something they are partaking in can be known as a "participant observer". An advantage of this method of personal observation is that someone with hands on experience is considered more equipped to explain a subject than someone who has just observed or read about it. A risk with using this participant method as a source of information is that it may be biased and many generalisations may be made, although these can be supported by example and detailed notes and other sources.

3.2.12 Tacit Knowledge

Another source of information is **tacit knowledge** [47] – knowledge that people carry in their mind. It is the Intellectual Capital of an organisation [11]. Often, people are not aware of the knowledge that they possess and how this can be a valuable source of information for others. A disadvantage of this source is that it can be difficult to tap into [47]. It is time consuming tapping into tacit knowledge as it usually requires extensive personal contact and trust. 'We know more than we can tell', which implies a large part of human knowledge cannot be articulated [16]. Its rate of movement depends came be affected by the 'societal

effect', which is mentioned previously in Section 3.2.7. Furthermore people are apprehensive about sharing their knowledge as they can feel that they will be valued less if they share their knowledge with others [11].

The amount of tacit knowledge available as a source is reducing. Some traditional sectors of industry in the UK are facing high retirement rates [48] of those employed in them. For those sectors or entire industries that depend on an aging workforce, which is approaching retirement, the access to tacit knowledge is under threat of being significantly reduced.

The benefit of tacit knowledge, as a primary source, is it is by and large unique. Just like in personal observations the quality of the information is more likely to be higher if from someone with much experience in the relevant field. Tacit knowledge can come from the other sources like consultants (Section 3.2.4), scientific and commercial conferences (Section 3.2.5), and co-operations and collaborations (Section 3.2.7).

3.3 Technology Monitoring

There is a multitude of different methods for collecting technical information from the sources identified in the previous section. This dissertation focuses on a few methods that are largely seen to be used in the pharmaceutical, electronics and automotive/machinery industries [18]. Numerous methods can be used to collect information from many sources at the same time and some can also assist in interpretation of information gathered. Some of the methods described are more like formats that can be applied to assist the way information on technologies is collected, understood and presented. A TA should aim to interpret collected information bearing in mind the internet has made it much easier for its members to access information which TAs would have traditionally been privy to [1].

When a TA is deciding what methods to employ they should take the following into consideration:

1. Objectives of their members – is the information sought something they would require
2. The time horizon – some methods can be spot technologies that are relevant now, such as benchmarking studies (Section 3.3.5), whereas others are predicting much further into the future, like a technology scenario (Section 4.3)
3. Type of industry – some industries may focus heavily on customer needs for innovations so would use methods that centre on the needs of the customer

It can be difficult finding definitions for the methods that exist for collecting technical information. This dissertation could serve as a useful reference point for TAs who wish to find out about a number of different methods.

3.3.1 Publication Searching

Libraries offer access to publications (Section 3.2.1), such as books and journals. There are public libraries open to the general public and usually make their books available for borrowing. University libraries exist principally to provide support for the teaching, learning and research conducted at that institute [49]. University libraries are more likely to offer a greater number of books related to technical information if technology is one of the University's specialisms. Universities can allow external users to borrow books and will typically charge a fee for this privilege, for example a one off registration fee of £25 and an annual subscription of £15. Heavy restrictions can be placed on what can be borrowed. For hardcopy material the restrictions can be on the number of books that can be borrowed and also the type of book, for example no borrowing of short term loan books. There is also the high possibility that an external user will not be able to make use of the electronic resources, such as electronic journals. Many libraries are phasing out hardcopy journals and instead increasing their electronic journal resources, therefore many it harder for an external user to utilise journals as a source of information. When searching electronic databases for journal papers a short abstract of each paper is returned for the relevant

papers [15]. Therefore, the usefulness of each paper can be quickly determined before spending time reading it in full. The contents or introduction of a book can be used in much the same way but usually each book needs to be sought and read individually taking more time. Some library catalogue searches will provide an author biography, summary and contents of the book in the search results (Figure 1).

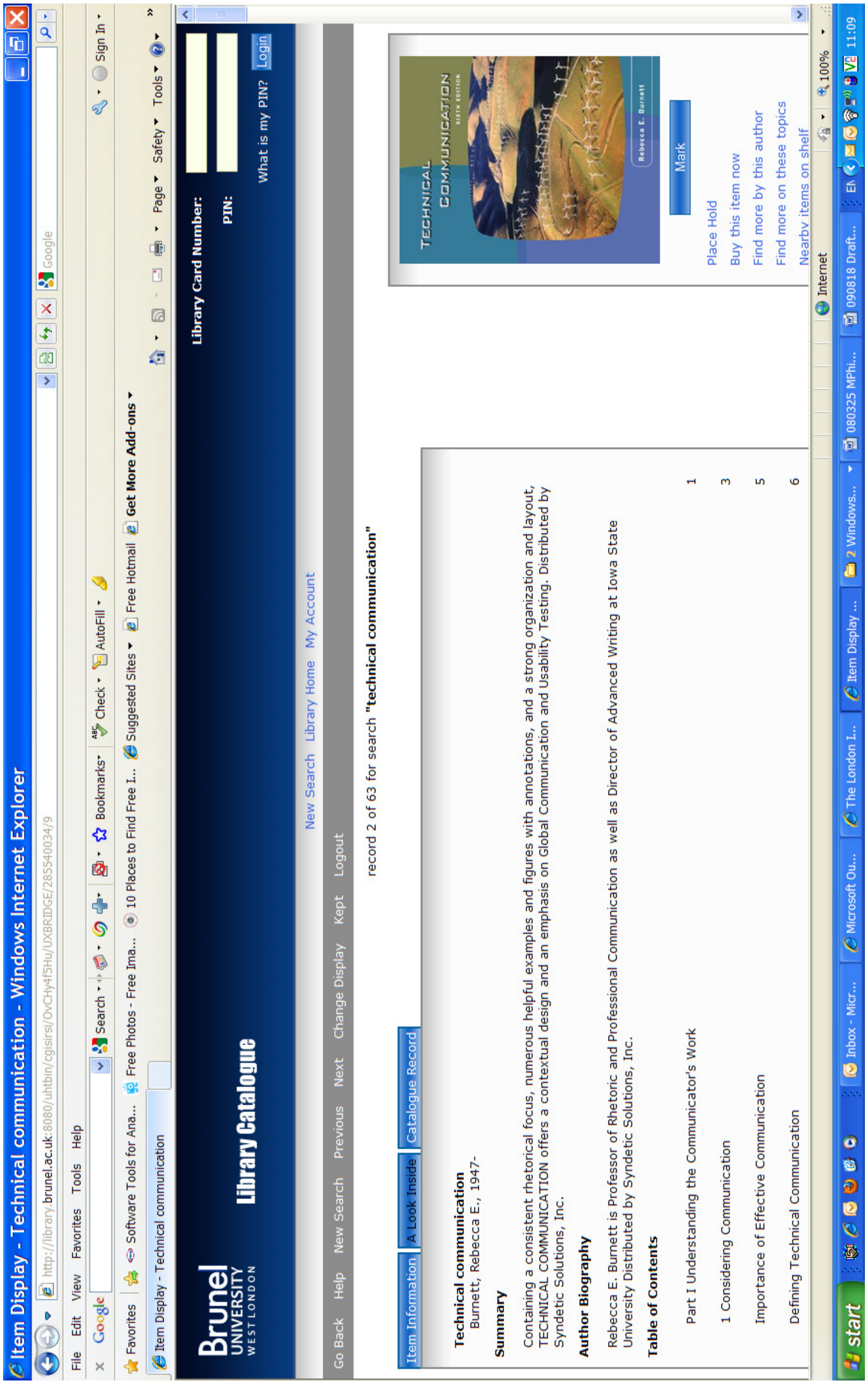

Figure 1: Screenshot to show summary, author biography and table of contents information on books returned with search results.

An average subscription, for both hardcopy and electronic, to a journal is £1000 (2004) and some can cost up to £15,000 annually [50]. Therefore, if access cannot be granted to a library's electronic resources many journals maybe inaccessible and the sources of information limited. On the other hand access to sources, such as journals, could change. The internet was revolutionary in giving people easier access to information. A publishing group called the Public Library of Science (PLoS) [51] is trying to change the way e-journals are accessed by distributing its journals free of charge. At the moment its coverage of science topics is very limited. Although consultants (Section 3.2.4) can be deemed as expensive they can also offer access to information from journals. For example, Pera's [52] Business Intelligence team has access to over 1,700 global databases at a cost of several hundred thousand pounds per year [53].

3.3.2 Publication Frequency Analysis

Essentially **Publication frequency analysis** is the study of the frequency that the name of a technology appears in publications. The more times that the name of a technology appears in or as a publication the more likely it is to be significant, hence information is collected from publications (Section 3.2.1) to help decide what technologies ought to be researched further and disseminated. Bibliometrics [54] – the measurement of texts and information – can help identify the authors, journals and institutions most cited. Hence, not only identifying the popular technologies written about but also the authors and institutions et cetera is a further source of information. Software, such as VantagePoint [55] can be used to aid in analysing text. The cost of such software is approximately £4,500 for a single seat/user license.

3.3.3 Patent Searching

The search mechanisms for sourcing information from relevant patents (Section 3.2.2) can be simple to use. Databases can be used, such as Espacenet [56] (developed by the European Patent Office), to perform searches by keywords or for persons or organisations (see Figure 2). A huge number of results for patents

can be generated. For the keyword ‘injection moulding’ over 16,000 results were returned. It could be a time consuming task searching through the huge number of applications for those that are of interest. The search functions of a browser can be used to search the text of reports found, which makes it quicker and easier to find relevant parts of the report. There is a wealth of information available through patent databases but they do not necessarily have all items of data for all patents [57]. For example the patent report may not have the full text or images.

The UK Intellectual Office offers four expert search services [58]. Prices for these types of searches can range from about £580 to £6000, depending on the type of search and technical complexity of the idea being looked at. Although this could be deemed expensive a full and accurate report is produced as a culmination of work of 200 science-graduate patent examiners. If a company did not have the equivalent of 200 people to perform a search then it would take much more time.

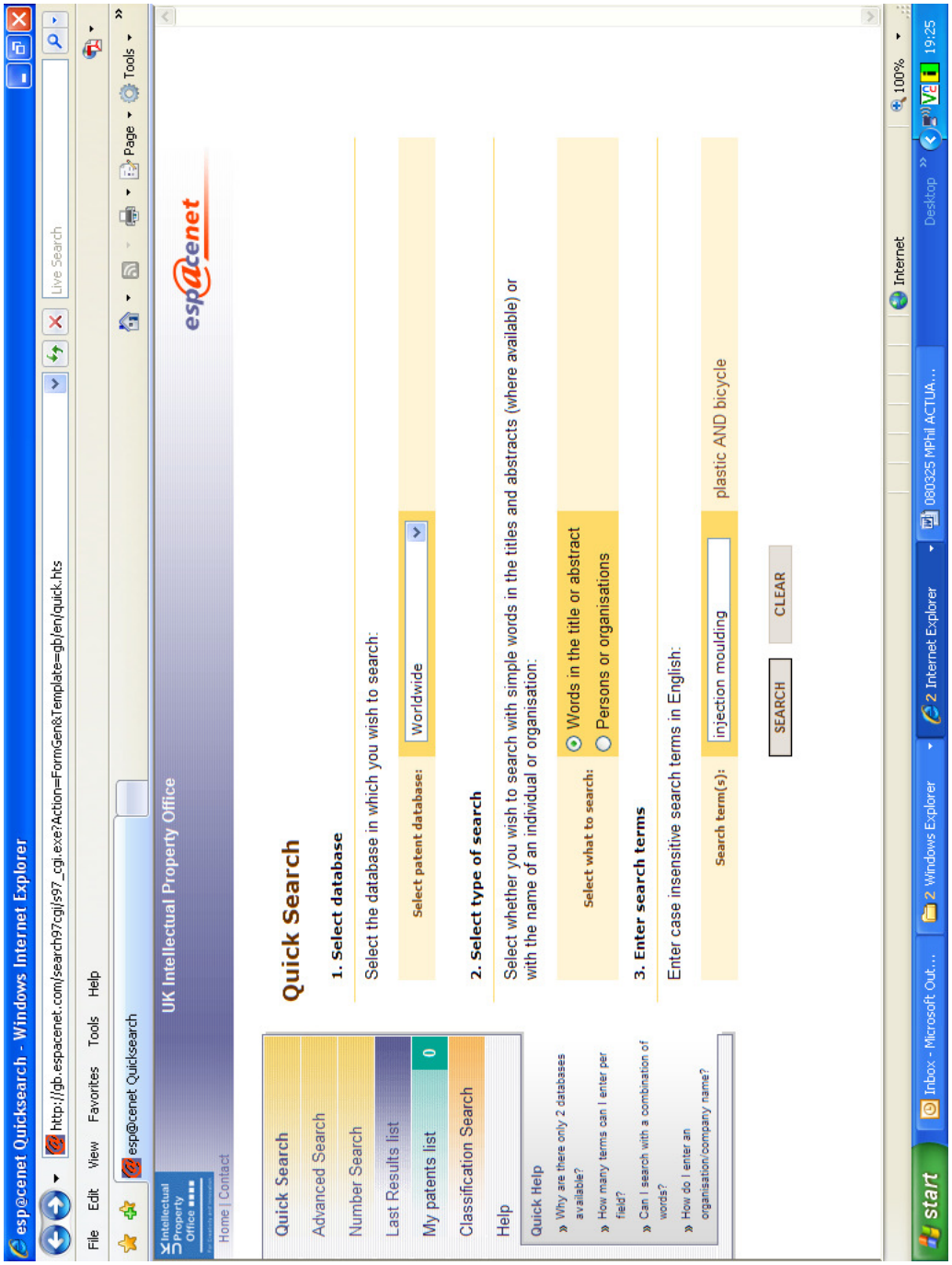

Figure 2: Screenshot of how the patent database Espacenet can be searched using keywords

3.3.4 Patent Frequency Analysis

Patent frequency analysis is similar to the publication frequency analysis (Section 3.3.2) in that it looks at the frequency a technology appears in patent reports. The use of this method is particularly useful when no historical data, relating to the emerging technology, is available [54]. Because filing a patent is expensive an organisation or individual that files one must be optimistic in its success. Therefore, if the frequency of patents for a technology increases it is a good indication that it will be an emerging technology. Many patents do not become commercially successful, although there are advances that follow-on. Just like publication frequency analysis patent frequency analysis can be time consuming as there is a vast amount of patents to search through. Software that already exists, such as Patent Insight Pro [59], goes some way towards reducing this disadvantage, though it can be expensive. Such software can cost in the region of £22,000 [60].

3.3.5 Benchmarking Studies

Benchmarking studies [61] are evaluations performed on a number of companies or organisations that a company determines as competition. The technical service(s) or product(s) will be compared, usually comparing like with like. Sources that can be an input to this method are publications (Section 3.2.1), especially company literature, product fairs and exhibitions (Section 3.2.6), and the internet (Section 3.2.8). Sometimes this involves studying best practice or world class standards in order to make comparisons [62]. One benefit of employing this method is it aids in understanding the present, though it does not give predictions nor is it likely information on future developments can be found.

3.3.6 Experience Curves

An **experience curve** will show the relation between a product's unit cost and its cumulative production volume [63]. This is often presented in a graphical form

plotting the unit cost against a log-log scale of the cumulative volume. It essentially will illustrate an exponential trend where increased experience in producing a product will lead to reduced costs in producing it. For instance the more often a worker repeats a task the better they should become at it. A disadvantage is that the effect of other factors, such as economies of scale, is not usually considered. Sources of information can be from personal observations within an organisation of cost and volume of production, external experts and publications, such as journals, that describe experience curves in relevant industries. The reduced costs can in part be attributed to reduced time spent in iterations for the production [64]. In a technological context it means that new technologies may become cost competitive with conventional technologies when the use of it has increased. This information is potentially useful for companies as they can decide when to take advantage of a technology in order to increase their competitiveness. Obtaining information for producing experience curves could be very difficult and time consuming. It should also be noted that the trend described has historically occurred for a large number of technologies, not necessarily all.

3.3.7 Expert Panels

Expert panels are groups of diverse experts especially put together [68] to discuss a subject [67], for instance evaluating a new technology. The group often is made up of independent specialists who are recognised as experts within their field – a field that is relevant to the purpose of the expert panel [68]. The purpose of such a panel is to evaluate a programme or for technology forecasting [67]. For example, expert panels are sometimes used by the European Commission to select projects for funding (Section 3.3.7). For the task of collecting information expert panels can be employed to determine what technologies information should be collected on, hence preventing time spent on the wrong technologies. Furthermore, an expert panel could be used to source the technical information or even provide it themselves.

The steps for using this method are:

1. Create list of experts whose fields are relevant to that of the programme
2. Select and get permission to involve those selected
3. The experts conduct their investigation and discussions on the programme that has been assigned to them. This can include examination of documents relevant to the programme and visits by the experts to those concerned with the programme
4. The panel produces a report that provides conclusions and recommendations, based upon the consensus of the majority. Secondary sources can be detailed within reports [69], which provides further sources of information for the recipient to explore themselves

Advantages of this method include its speed [67] – it can be completed within a few months [68]. Its costs, relative to other techniques, are lower, however, this can be affected by whether the experts are remunerated or not and also on the size of the panel. Reduced costs make this method suitable for small organisations. Typically the size of the group would be between six and 12 experts. The credibility for results of expert panels is good as it draws upon the various views of many people who are usually considered experts within their fields. The method is considered versatile and has been successfully used where other methods would be unsuccessful – especially when the subject is complex. On the other hand, if the questions posed to a panel are too broad the reliability may suffer due to less likelihood of a majority consensus being found. It is particularly useful when other technology intelligence gathering methods provide inputs into the panel.

Like a committee it uses a consensus method to provide results [67]. If just the consensus is reported the comments of the minority may be missed, which could be important to consider. Therefore, the comments of the minority should be communicated. If strong personalities exist within the group this can sway the voting of the group when trying to reach a consensus [66]. The Halo or Horns effect is where the respect, or disrespect, for a person can influence the group. If a person with a Halo or Horns is part of the expert panel this could have negative effects on the reliability of the conclusions reached. Meredith *et al* [66] also

describe other similar disadvantages of methods that involve open discussion amongst groups, such as the bandwagon effect where people feel pressure to go with the majority. Individuals within a group may feel pressurised to make their decisions more quickly than what they are comfortable with normally so that they do not delay the group. Lemos *et al* [67] suggests more disadvantages associated with open discussion methods, such as group fatigue can create an unreliable consensus and some members fear that if they change their mind they may offend, hence the right technologies to collect information on may not be correctly identified.

3.3.8 Utilising Information Technology to Assist Collection

Many of the aforementioned technology collection methods can be assisted by using the internet. The way the internet is used as a tool can greatly affect its usefulness as an information gathering method. Within academia there is an awareness that the use of search engines, such as Google [70], far outweighs the use of other electronic information services (EIS) [71]. If a researcher solely uses search engines, rather than other search options, then there is a high chance that they will miss high quality resources and that the resources found are not trusted [72]. The problem of the overreliance on search engines is reflected in the fact that it was addressed in a House of Commons report [71]. Other search options include the use of **resource discovery networks** (RDNs), for example Intute [73] and TechXtra [74] (both are relevant to science, engineering and technology).

RDN hubs are a free online service that provides access to databases and specially selected web resources for education and research [73]. These resources can be searched by using keywords, similar to the way a search engine is used, but RDN hubs can offer more multifaceted ways of searching [71]. The RDN TechXtra recommends that, if the user is associated with a university, then they should use the university Library cross-searching service before using a RDN [75]. A university library will have information relevant to its specialism's and hence may be more appropriate to a researchers needs. RDNs declare that they

return better quality material in comparison to search engines because all their material has been evaluated and selected by a network of subject specialists [73]. Some also access cross-subject resources, which can promote the cross fertilisation of technology. Still, search engines like Google have tried to resolve the aforementioned problem by launching search engines that specifically search against just the academic material [75], such as Google Scholar [76]. A benefit of using Google Scholar is it gives access to invisible content, for example papers from journals that require subscriptions and would not normally be found using a search engine [75]. Although papers are found the full text content may not be available. A further disadvantage is that, unlike most RDNs, all subject areas are covered, hence there is a greater likelihood of getting irrelevant information [77].

Past research based on university students has shown that a sizeable majority of users of search engines would not look at search results past the first few pages – between 1997 and 2001 the number of users that only looked at the first page rose from 28.6 percent to 50.5 percent [71]. Some of the research even stated that only the first few hits were looked at. It should be noted that in order to not miss potentially useful information users should look beyond the first few hits, however, this can be more time consuming. It has been suggested that expert users of search engines, who use more complex queries, return results of better relevance than non-expert users. This reiterates the importance of training staff on how to use the internet, and other information gathering methods, effectively. The RDNs offer free of charge tutorials, that are specific to a subject area, on how to effectively use web resources for finding good quality material [72].

Tacit knowledge is a possible source of information on technology (Section 3.2.12). Informal discussion networks are a method for encouraging knowledge sharing [18], and hence supporting the exchange of tacit knowledge. They can be monitored in order to collect information from them. IT can be utilised to create and support informal discussion networks by means of an online community. An online community is a group of people, who come together for a shared purpose online, and who are governed by norms and policies of that community [78]. This again can be a method to collect tacit information.

The process of creating an online community can take many different forms, two are mentioned here. An organisations intranet – a private network using software [79] – can provide a discussion forum for its staff [11]. Setting up a discussion forum in this way could be costly. Consideration needs to be given to the computer resources required of the TA and of its members so that there is enough computer capacity to support an online community. Northrop Grumman [80], a US aerospace and defence company, demonstrated its worth as over 80% of its engineers used such a system to share knowledge [11]. The other method is to use freely available services on offer for participating in or creating online discussion groups, such as Google Groups [81]. With a free service there are likely to be fewer options for customising it to the needs of the user, which is reflected in the cost. There may also be reluctance to people discussing information on technology, which might be deemed sensitive information, on a publicly available site such as Google Groups with the worry that access might be gained by people outside of the intended group.

A big advantage of this method is that unique information can be obtained from the minds of those that participate it would mainly be considered first-hand – external primary – information. Caution should be taken as some participants may be communicating second-hand knowledge and their interpretation of what they heard may be incorrect or bias. It would be difficult to distinguish what information was first-hand and second-hand, the first being the more credible [15].

A disadvantage of using online communities to encourage the migration of information on technology is that it can be notoriously difficult to encourage people to participate and to maintain active participation [78]. Using good software can help increase the success of an online community; however, even the most state-of-the-art software cannot ensure success. In support of this it is believed that the key to producing innovation lays not so much in technological systems, but in human resources management, knowledge management systems and leadership [11]. This is discussed further in Section 3.3.10.

As part of the information gathering method a TA would have to monitor the information being shared amongst the community, which could be time consuming. Through monitoring the TA would also be expected to moderate messages written by its members as irrelevant ones could be off-putting to users, although enhanced software can automatically filter out unwanted messages [78]. There is a risk of bias associated with the source (people) for this method as opinions of the individuals are likely to be present, hence potentially affecting the credibility of the sources [15]. Sometimes conflicts or social dilemmas could occur [78]. For example, an individual may try to benefit from group work without making a fair contribution. Some individuals may frequently request information from others, but will not answer questions posed to him/her. It would be the role of the TA to endeavour to support both individuals and the community and to protect each from exploitation.

3.3.9 Technology Intelligence Specialist

A means of improving the competence of technology related information collected is for an organisation to employ one or more Technology Intelligence Specialists (TIS) [18]. A TIS is a specialist that has an in-depth understanding of the needs of their organisation. They should therefore be better at pre-empting what technologies their organisation need. Additionally they will be familiar with methods for collecting information on technology, and hence put them to better use. Some methods should not be used in isolation [67] and a TIS could help coordinate the combined use of them. Also a TIS should better be able to assess the credibility of sources of information [15] as they will be more aware of the four main elements that need to be considered: authorship; timeliness; purpose; content (Section 3.2).

The risk associated with employing a TIS is of information overload where more information is gathered than can be sensibly used by the organisation. The sole delegation of information gathering to a TIS has been seen to create information distortion [18]. Falsified or inaccurate information may be provided to a TIS if the other staff feel unmotivated that they are not included in plans for collecting

information or if a TIS is seen as using information in unforeseeable ways among top management.

3.3.10 Management of Personnel

An organisation can employ many different methods to promote technical information collection. This can range from enforcing different organisational structures that make use of a variety of information sources, to methods for tapping into tacit knowledge. To get the best return on resources invested in collecting and utilising information on technology the leadership of an organisation must 'buy into' and support such activities [11] and the aspirations of the staff must be aligned with that of the organisation [78].

Section 3.2.7 (co-operation and collaborations) has already shown how different organisational structures can affect the sharing of knowledge with the case of the Japanese 'organisational' model and the British 'professional' model. Many other organisational structures can be implemented that affect the way in which information is collected. For instance, structural coordination [18] attributes tasks for specific departments. For example, a technology intelligence unit would be used to track competitors, universities and start-up companies or networks of external experts can be established. In the previous section the detrimental effect of only using specific departments, or people, for specific tasks is seen.

Methods that can be drawn on to encourage the movement of knowledge, particularly that, which is tacit, into something that is more easily collected and recorded include [11]:

1. Rewarding staff – staff are rewarded for sharing information. The amount of reward is likely to affect the success of this method
2. Job rotation – employees can transfer information from their last role/department to their new role/department through personal observations made (Section 3.2.11). This method is good for promoting informal communication. This may not be possible as staff may not have the skills to

perform other roles and much disruption may be caused in each of the departments involved

3. Informal discussion networks – this is a group of people that come together to discuss related topics, akin to an online community whose advantages and disadvantages are talked about in Section 3.3.7
4. Supplementary travel expenses – staff are given extra expenses to fund their attendance of fairs and exhibitions (Section 3.2.6) or conferences (Section 3.2.5) where information can be collected by talking to staff of other companies present
5. Professional development programmes – programmes that look at training staff can increase an employee's knowledge and hence increase their efficiency to collect and interpret technical information. The advantage of this method is that employees are often keen to partake in training as it adds value to them as an employee

3.4 Concluding Remarks

There are *many* sources of technical innovation that can be used to obtain technical information. A source can be classified as either a primary or secondary source. Table 2 highlights the advantages and disadvantages of each. The credentials of a source must be taken into consideration by looking at authorship, timeliness, purpose and content. The process of assessing credibility is likely to become more time consuming due to the rapid growth in volume of data. Making use of 'poor' sources would result in poor information being disseminated, ultimately resulting in the provision of a poor technology intelligence service. The types of sources used can be dependent on the industry. Those sources seen to be predominantly used in industry, as identified by Lichtenthaler's research, and that were deemed relevant to a TA were presented. Advantages and disadvantages of each source were examined.

There are also *many* technology monitoring methods that can be used to gather information from *many* sources, and they can also aid in interpretation of information gathered. A TA must be able to interpret information properly in

order to add value. Some methods can be costly to use and a TAs budget will determine which ones cannot be afforded. However, the methods available can change dramatically over time. For example the Public Library of Science (PLoS) aims to make e-journals available free of charge. Some technology intelligence methods do not need pre-requisite knowledge whereas others do, such as experience curves and technology scenarios. Therefore the quality of staff employed by a TA can affect whether certain methods can be utilised or not. The employment of a Technology Intelligence Specialist (TIS) can help counteract this and ensure that the most relevant methods are used that make the best use of a TA's resource. There is no point gathering technical information unless suitable methods for effectively disseminating it are in place. These are explored in the next chapter.

4 Technical Information Dissemination: Methods

4.1 Introduction

The previous chapters examined sources of information and methods for collecting information. This Chapter identifies methods by which the information can be made available to users. Dissemination methods were identified within Chapter 3, as many of the sources are the result of dissemination, such as publications. Some of the advantages or disadvantages of using sources echo the advantages and disadvantages of the dissemination methods. There is a multitude of different methods available to disseminate information but only those appropriate to a TA are discussed. Widely available scientific information cannot become an input in the innovative activities of a company until they undertake their own research [32]. Internal research lets a company absorb, evaluate and utilise the information outside its own boundaries. Using the most appropriate dissemination methods should make it easier for a company to absorb and hence utilise information.

The frequency of communication to members is an important point to consider. A common criticism of Trade Associations has been they send out too much information and do not send out the right information at the right time [82]. No matter what dissemination method is used the frequency of communication must be considered to prevent annoying a member. To avoid annoyance and to increase the chances information is absorbed it is imperative that it goes to the right person.

A TA should have basic information about its members. The specific interests and details of the recipient of each member should be known [82] so that the pertinent technologies, in view of the recipient, can be disseminated [83].

4.2 Hardcopy Dissemination

Hardcopy dissemination can take the form of correspondence, books, industry newsletters, journals and papers, manuals, reports and much more. Producing something like a book in collaboration with others can generate benefits and disadvantages [15]. For example, working independently gives freedom to do what you want. Working collaboratively can bring in expert knowledge but collation of information can be more time consuming.

4.2.1 Journals and Papers

Disseminating information on technology in a peer-reviewed journal and conference proceedings has the advantage that it is largely seen as a credible source because of the peer-review process [15]. It should be noted that definitions for journals state that the journal must be "peer-reviewed or edited" whereas others do not [84]. For this dissertation journals will be considered as peer-reviewed.

If a TA were to disseminate information through this method time, subject and format constraints would be inflicted onto it. There would be deadlines for sending in the written paper which may not fit in with the TAs timelines. Also, the review process can take a long-time, which could be too long to keep the information relevant for members. The subject areas for the journals will be predetermined and there may not be a journal representing the subject area that the TA wishes to disseminate. There will be strict guidelines for the format of the paper that might take time to adhere to – the formatting process – and might not suite the format it deems as best for its members. Most importantly, disseminating information in this way gives a TA no control of its distribution, and hence they may not be able to freely distribute it to its members, thus not addressing the aim of this dissertation. Members could be given the reference of where to find the paper(s) but a member is likely not to be paying the cost of subscription to journals. This could change in the future with the efforts of

groups, such as the Public Library of Science [51] (Section 3.3.1), to try and make access free to journals.

4.2.2 Books

Books are another way of disseminating information, but suffer from many of the same disadvantages as journals. If producing an entire book the demand on resources would be very high in comparison to other hardcopy dissemination methods. For any written form of technical information disseminated it must be written to a good standard and therefore a person with good authoring skills would be needed. In Chapter 3 it was revealed poor spelling and grammar could be used to verify the credibility of a source of information [15].

4.2.3 Industry Newsletters

The trade press and industry newsletters also have constraints on time, subject and format. The constraints are usually less stringent than for journals as the magazine editor will edit the text and style. The trade press contain publications that can cover almost every business or sector [14] so the likelihood of finding one appropriate for disseminating information is high. A newsletter can be created and distributed by post or handed out by the originating organisation, which would have the advantage that constraints such as time, subject and format could be controlled by the organisation rather than being imposed by another. However, the trade press may have more state-of-the-art tools for creating online newsletters in comparison to an organisation that produces their own newsletters.

The National Research Council Canada (NRC) [85], a Canadian Government agency that represents twenty research and development institutes and programmes, trialled a hardcopy technical newsletter for its SME members. The recipients were limited on time, due to their work schedules, to read a newsletter. Therefore it was made easily readable, by its bullet point format, and description was kept to a minimum [83]. The lack of time was especially significant as its target audience comprised of company presidents or vice-presidents, as the chief

decision makers in SMEs. This is an exemplar of how the audience constraints can affect the method chosen for disseminating information.

Decisions would have to be made by a TA about the level of the technical and intellectual content of a newsletter and whether it was at an appropriate level for the recipients [15]. For the NRC example it was identified that those involved in gathering information had to have a clear understanding of the needs of the receptor industry. Additionally, the importance of knowing the technical and financial capacity of the recipients was key; ensuring pertinent technologies were disseminated [83]. This is where the employment of a Technology Intelligence Specialist (Section 3.3.9) would be beneficial.

4.3 Visual Forms

Visuals, for example diagrams and graphs, can be incorporated into dissemination mediums to add appeal and to help understanding. Visuals have been proven to help readers learn. Readers who were given documents containing visuals learnt 36% more than those given just text [15]. A disadvantage is that the use of some visualisations could be unethical as the visualisation could mislead if presented in the wrong way.

An example of a visual form is an emerging software that aims to aid understanding of text. The Visual Communication Lab [86], part of IBM's Collaborative User Experience research groups (CUE) [87], started a project in 2004 to encourage sharing and conservation around visualisations that help understanding. For example '**Tag Clouds**' [88] create a visualisation of word frequencies within text with the most frequent words being represented by larger text (Figure 3). Two different bodies of text can be compared.

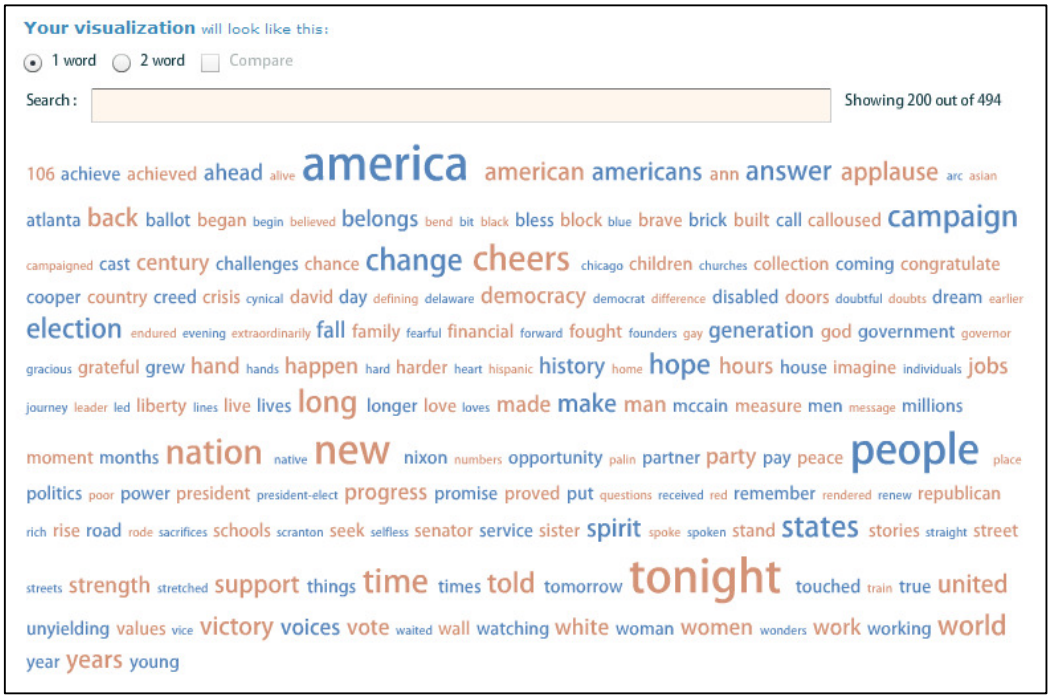

Figure 3: Tag Cloud for Obama's presidential victory speech [90]

Access to the visualisation tools offered by the Visual Communication Lab is free of charge if registered with IBM (registration is free of charge). However, in the Use Agreement [89] the user gives IBM all intellectual property rights (including copyright) to information that is provided by the user – a technology constraint of this dissemination method. A TA may not wish to make technical information it has sought available outside of its membership. Furthermore, the user agrees not to submit anyone else's copyright material without written permission. External sources of technical information could not be analysed without prior permission, which may not be granted and would be time consuming.

A method for communicating a technologies impact on an organisation without having to dwell on the technical details, hence saving resources spent, is **Technology Scenarios**. A technology scenario is a forecast that estimates the impacts on products, production processes and services etc on a "what-if" basis [65]. For example, what would happen to a digital radio product line if the current broadcasting method was changed? Some, such as Meredith *et al*, think that the generality is a disadvantage of the method [66]. It also assists in identifying the threats and opportunities for the organisation [67]. It does not take

into consideration that preceding occurrences will determine the outcome of a product or service and that human intervention can change the future, therefore it is considered an optimistic tool.

A Technology Scenario uses qualitative research and can extrapolate the results into quantitative information [154], hence providing a metric that can be benchmarked. Metrics can be used to show the effect a certain scenario would have on a product line or service [65]. If the right metrics are used then they can be useful as indicators. Their accuracy within technology forecasting may not be very good; however Betz [65] recommends some useful metrics: financial measures of return on research; projected value of R&D project portfolios; market shares of products or potential products; product development process time. These make up some of the information inputs that should be collected to create a technology scenario, obtained through sources like publications (Section 3.2.1), the internet (Section 3.2.8), tacit knowledge (Section 3.2.12) of those within the company(s) within the relevant industry(s) and consultants (Section 3.2.4). Betz strongly advocates that it is "the new ideas for technology that is far more important to technology strategy than metrics of past contributions of technology".

The number of people involved in creating and analysing the scenario can affect its perceived value. If only a few are involved in its creation it may be too biased to their opinions [66]. If many people are involved it could become expensive. Lemos *et al* [67] believes it is necessary to hire consultants to help use this method effectively.

Technology Roadmapping is another visual tool for technology planning and coordination [153]. It displays the interaction between products and technology over time, taking into account both short-term and long-term aspects [157]. It is one of the most popular tools used for supporting innovation and strategy at a company, industry and national level [98]. One of the main reasons that Technology Roadmapping is used is that the number of technologies per product (TPP) is increasing [18], therefore, making them more complicated [153]. Technology Roadmapping can be used to help identify product needs, identify

alternative technologies to meet the needs, and develop project plans to make sure the right technologies will be available when required.

4.4 Electronic Communication

Information Technology (IT), especially using the internet, encompasses many different sources and methods for collecting information (Chapter 3). In addition to this it also offers a number of different methods for disseminating information including online newsletters, journals and websites.

4.4.1 Online Newsletters

Newsletters can be sent out electronically via email. These are often referred to as e-newsletters or online newsletters, which have the same functionality as a hardcopy newsletter but take advantage of the medium, email.

There has been a rapid increase in their use for the same reason email has increased in popularity over printed (hardcopy) correspondence. There has been mention of the success of online newsletter usage within the commercial sector. However, it is difficult to find any empirical evidence to prove that there has been an increase in the use of online newsletters. Eid *et al* support this comment and state that most research in this area has been descriptive or theoretical/speculative [91]. A study on the uptake of online newsletter usage by Members of Parliament (MPs) [92] in the UK provides an indication that the popularity of their use is growing. The study revealed that in the space of a year, between 2003 and 2004, the number of MPs offering an online newsletter service doubled. This is particularly interesting as in the past MPs uptake and use of other internet tools, such as websites, has been poor. Therefore, one could presuppose that they would be slower than other groups to utilise such a tool.

There can be many benefits for using online newsletters over hardcopy newsletters [92]:

- Recipients can usually be reached directly without going through a 'gatekeeper'. For example, a hardcopy sent through the post may be read by a secretary or PA before an intended person in senior management. The secretary or PA may decide it is not needed by their superior and discard it
- They are cost effective, in comparison to hardcopy newsletters, which require printing and posting
- They are fairly easy to produce, even for technophobes. Once a mailing list is complete an online newsletter can be sent by a single click of a computer mouse button

An example of a successful online newsletter is from the National Association of Realtors (NAR) [93], which is the biggest association in the world with 1.3 million members. Its online newsletter was received electronically by almost 680,000 of its members, over half of its total membership [94]. This example demonstrates how audience constraints can affect the way in which information is disseminated. Members of NAR are themselves constrained by the lack of time (just like the recipients of the NRC hardcopy newsletter) meaning they would not necessarily read information from their association. It was thought that members would more likely read a newsletter if it would help them personally – the 'what's-in-it-for-me' syndrome. This was achieved by giving tips on how they could improve their performance in the workplace.

As the online newsletter was a dissemination method controlled by the association they had few constraints on the format. They could label the articles with interesting and self-explanatory headings such as 'coaching' and 'ask the expert' so that they would be compelling for the reader [94]. Each article was summarised so that a titbit of information that showed the value of the article to entice the member to read on. The coaching articles were written using a variety of consultants to write non-opinionated articles on two topics. To ensure time constraints would not prevent the completion of coaching articles the authors' names were not given so that different consultants could write the articles if their fellow consultants were unavailable.

4.4.2 The Internet

The internet provides a place to distribute publications that would have traditionally have been sent out in print. It has the advantages that the time to distributing information is quicker than for hardcopy and usually less expensive [15].

Online communities have previously been shown as a mechanism for collecting information but they can enable the dissemination of information to members of that community. The information disseminated will emanate from the TA members as well as the TA staff themselves. Consequently the users of the community suffer the constraints of this method, such as deciding what is appropriate for the audience, rather than the TA. Although the TA should mediate information exchanged [18]. Online communities are dynamic and constantly changing [78] which would make it more difficult for a TA to support such a method.

A website can be used to make information on technologies available. An example is the Technology Watch (TW PRIME) website [95]. It has the aim of informing PRIME (PRoducts with Interdependent Mechanical and Electronic parts) manufacturers of technical developments enabling them to remain informed [96]. Access to technical information is granted via their website [97], in exchange for the user information submitted during registration. If a user chooses not to register, then only publications that have already been available to registered users for three months can be accessed. Government reports [3] about TAs have advocated providing the ability for ordering publications, that is technical publications, and booking events online. Including links to useful information sources on a TA's website can enhance the value of that website.

The subject matter of information to be generated for inclusion on the TW PRIME website is determined with technology road mapping, which is a tool for supporting innovation and strategy at a company, industry and national level [98]. Articles and papers relevant to the subject matter determined are then

written, edited and published on the website. Articles are written by PERA [52], a technical consultancy, and others are commissioned [96].

Technology constraints can impact on the practicality of a website as a dissemination method. There is the need for a member of staff within the TA to have the capability and training to maintain it [15].Visitors to the websites of TAs would become disinterested if updates were rare [3]. Furthermore, hosting a website and keeping it up-to-date could be expensive for a TA. It is the tradition of the internet that users intend to find information free of charge, which would make it difficult for a TA to request payment for information provided via its website.

4.5 Oral Communication

Face-to-face meetings, seminars, workshops, conferences and exhibitions are all methods of oral dissemination [14]. It is believed that meetings are more likely to draw attention to the information being disseminated than written information and leads to a better common understanding, which is discussed in more detail in Section 4.6.

An oral communication method is a conference. A conference is a prearranged meeting for consultation or exchange of information and discussion [99]. Exchange of information is what a TA needs to nurture within its members so that they can learn from each other. A UK government report on TAs [3] found that those TAs that ran big exhibitions or conferences were looked upon with envious eyes by other TAs as they had a good case to prove their worth. TAs that ran conferences would reduce their *weakness* of not being able to prove the value of subscriptions if members attended a conference free of charge or at a discounted rate. Furthermore, the intensity of use of scientific conferences as an information source in the pharmaceuticals, electronics and auto/machinery industries is high [18]. The inference is that it would be a popular source that TA members would use. However, the source of this information was from a survey

of multinational companies. This would not necessarily represent the 'average' sized member of a TA, who is typically a small company.

A disadvantage of face-to-face meetings and conferences is the amount of time they take, both for the attendee and organiser [14]. There is a high possibility that an oral presentation is impeded, which is sometimes referred to as 'noise' [15]. For instance, the communicator themselves, such as a speaker at a conference, may be biased or their interpretation of information may be disagreeable. Information presented came sometimes be inflammatory and the audience may disturb the presentation if they strongly oppose. This may be less the case for technical information; however the audience may disagree with the credibility of empirical data, for example.

4.6 Phases of Technology Dissemination

Some methods of disseminating information can be deemed as 'poor' and others as 'good'. Lichtenthaler [18] says that poor communication methods are where information is not exchanged it the best way which is likely to lead to the author and recipient(s) not seeing things in dissimilar ways – a state of heterogeneity. For example, dissemination by email could be deemed a poor dissemination method – in terms of reducing heterogeneity amongst a group – in comparison to a telephone conversation. This is because email communication is staggered – a recipient may read an email several days or so after it has been sent – whereas telephone communication is instant if the recipient of the call answers. Secondly there is less chance of impromptu remarks being made that may lead to other, informative, conversations. An email can be drafted and amended before sending whereas once something has said on the telephone it cannot be taken back. Thirdly emails, such as online newsletters, are considered by some as 'poor' disseminations methods and that it can lead to sloppy communication with information being sent out at the last moment that is not cohesive [82].

Figure 5 illustrates how a balance of poor and good communication methods can be used to ensure that heterogeneity is maintained within an acceptable level –

not above the ‘point of inefficiency’. Up to point one shows a phase of conveyance where information is being disseminated to a group of people. The line to this point is increasing in value on the *y-axis*, which indicates the diversity of ways the group are interpreting the information being conveyed is increasing from the intended interpreted (frame of reference). At point one a planned meeting occurs which is considered a good communication method. It helps the group realise what the true interpretation of the conveyed inform should be and the heterogeneity reduces as they come to a common understanding, which is referred to as a convergence phase.

At point two the heterogeneity has exceeded the point of inefficiency and this requires an unplanned face-to-face meeting to bring about a phase of convergence.

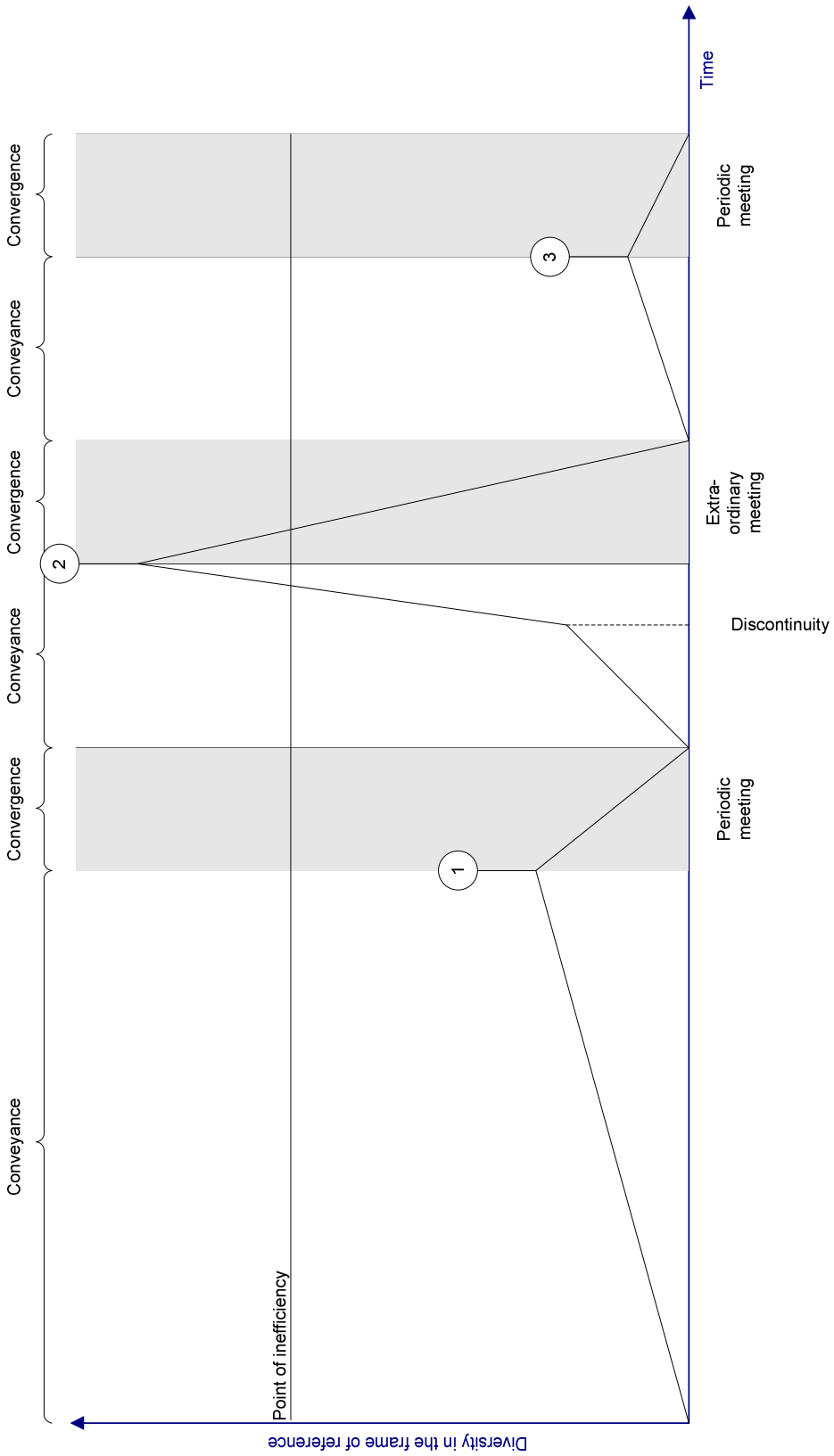

Figure 4: Illustration to show the phases of technology dissemination [18].

4.7 Concluding Remark

The main groups of methods identified for disseminating technology intelligence information were hardcopy, visual forms, electronic communication and oral. The advantages and constraints for each dissemination method were given. This would enable a TA to decide which methods were best for its members and utilised its resources and capabilities best.

The **time** from gathering information to disseminating it is an important consideration as a TA does not want to be seen to be promoting an obsolete technology. Journals and papers would normally take longer to publish information than an online newsletter generated by the TA itself. However, **credibility** of a journal and paper would be higher than for an online newsletter produced by a TA. The **quality of staff** that a TA has can influence the dissemination method used. To have a chance of a paper being accepted by a reputable journal the author would have to have good writing skills a good understanding of their subject area.

Furthermore, the **ease of extracting information** from material disseminated by a TA is a significant consideration. The NRC case study pointed towards the use of bullet points. Visual forms can certainly aid understanding and these methods are currently being developed and should be looked at in the future. The case study also highlighted that the **type of recipient** determines the dissemination method used.

The **frequency** that information is sent out can affect the success of dissemination – if too much information is sent out it could annoy the recipient. The **point in time** that information is sent out is crucial as a new technology can become 'old news' very quickly. The dissemination method used dictate whether a TA has control over frequency or not. A TA is unlikely to have control over the timelines of a journal being published however it can have full control over its own newsletter. There will very effective dissemination methods that a TA wishes to use however the **cost** may be too high. No matter what dissemination

method is utilised a TA must make it clear the information satisfies the ‘what’s-in-it-for-me’ syndrome to entice the recipient to read, see or hear it.

5 Strategic Assessment and Prioritisation of Technology Foresight by Trade Associations

5.1 Introduction

When creating a strategy, objective six (Section 2.1), it is important to understand the internal and external influences that may affect the desired outcome. A Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis tool is used to identify the factors that are likely to affect a TA that wishes to provide technical information to its members. How a TA can conduct its own SWOT analysis is also given.

5.2 Analysing Resources and Capabilities

A SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis is a tool to assist forward planning by identifying the strengths, weaknesses, opportunities and threats posed by a situation [100]. It has been described as the commonest practical analyst tool used by consultants and executives [101].

Companies and organisations, such as TAs, do not exist in a vacuum. Instead they operate in a complex environment that can have much ambiguity. Understanding this environment is essential when an organisation puts together a strategy [102]. The current technological advancements have increased the need for strategic planning using tools like the SWOT analysis due to the increase in information exceeding the rate of increase of knowledge [100].

There are many reasons for the popularity of SWOT analysis. It is familiar to most and it is easily understandable by the user. Piercy *et al* sees SWOT analysis as a flexible tool that can incorporate other systems, such as market information systems, when necessary. It offers a structured way of looking at factors that are likely to affect an organisation's future and helps realise whether it has an ability

to exploit these factors in the future. It can take into consideration a mixture of factors that are quantitative and qualitative, familiar or unfamiliar and those that are known or half-known [101]. Information gathered by the information collection methods identified in Chapter 3 can be entered into a SWOT analysis to enable companies to utilise opportunities and to defend against threats [18].

Panagiotou [102] brings to light the deficiencies of the tool. The tool is rooted in vagueness, relies on an oversimplified process and has many limitations. At the tool's inception in the 1950s its simplistic analysis was deemed satisfactory, but today's organisations need to deal with more complex environments when formulating strategies. That said Panagiotou still considers SWOT analysis as a valuable tool because it gets people to consider important aspects of their environment and encourages them to organise their thoughts.

Many academics have tried to modify the SWOT analysis tool to try and counteract some of the deficiencies. For instance, modified models have included 'SOFT', where the F stands for 'fault'. Some have created new tools, like the TOWS matrix. This tries to link internal strengths and weaknesses to external opportunities and threats. Panagiotou believes that these 'new' tools are still limited. Since TAs can be considered different to a traditional company, in terms of its structure and income streams (Section 2.2), the SWOT analysis presented in this dissertation will differ slightly to the traditional presentation of a SWOT analysis in order to encapsulate some of these differences.

Panagiotou's own 'Telescopic Observations' strategic framework tries to bring a more systematic approach to environmental analysis. It categorises relevant business environment variables using the acronym 'TELESCOPIC OBSERVATIONS' (Figure 6).

T	= Technological advancements
E	= Economic considerations
L	= Legal and regulatory requirements
E	= Ecological and environmental issues
S	= Sociological trends
C	= Competition
O	= Organisational culture
P	= Portfolio analysis
I	= International issues
C	= Cost efficiencies and cost structures
O	= Organisational core competencies and capabilities
B	= Buyers
S	= Suppliers
E	= Electronic commerce
R	= Resources audit
V	= Value chain
A	= Alliances (including partnerships, networks and joint ventures)
T	= Total quality management
I	= Industry key factors for success
O	= Organisational structure
N	= New entrants
S	= Substitute products and services

Figure 6: Panagiotou's 'Telescopic Observations' strategic framework

When creating the SWOT analysis the categories of business environment variables presented in Figure 6 were taken into consideration. Those that were relevant were used. It is recommended that TAs conducting a SWOT analysis should do the same.

Piercy *et al* thinks that the use of the SWOT analysis tool has become "sloppy and unfocused" [101]. Reasons for this include the fact that the concept of the technique is so simple that many people try to use it without any 'real' knowledge of the technique and how it should be implemented. A few rules for using a SWOT have been proposed, which TAs should note:

1. **Focused SWOTs** – the area to be evaluated with SWOT needs to be defined carefully. In focusing on a specific area it will exclude non-relevant input that can lead to a vague SWOT analysis. It should not be too global in its scope. However, for the purpose of this dissertation the scope needs to be comprehensive in order for it to be relevant to many TAs, rather than the one

2. **Shared visions** – *many* sources ought to be involved in the pooling of ideas for the SWOT analysis. By working together it can help bring a team to agreement and can 'flush out' the disagreements

3. **Customer orientation** – when identifying the strengths and weaknesses the only resources or capabilities that are recognised are those that would be known and valued by the customer. This can be a difficult rule to implement as people can find it difficult to distinguish between what they think is important and what customers think is important. In many instances people will claim that the same thing can be both a strength and a weakness. Piercy feels that this means they have not gone far enough in their statement. For example, it may be stated that a strength is "we are an old-established Trade Association", which can be a strength and a weakness. This characteristic must be broken down into the aspects that make it, Table 4.

Table 5: Breaking down SWOT characteristics into the aspects that make

"An old established Trade Association"	
Strength	***Weakness***
Trustworthy	Inflexible
Experienced	Old-fashioned
Long established links with government	No innovation

Strengths and weaknesses included in the SWOT analysis should only be those recognised by the customer. Sometimes the person conducting the SWOT analysis will identify strengths and weaknesses that are not known by the customer. These are often too important to leave out so they should be presented beside the SWOT analysis diagram. As mentioned in Section 2.2 TAs have difficulty in proving their value to members. Thus, all strengths and weaknesses that the executive of the TA believes it has will be included in the SWOT analysis diagram.

4. **Environmental analysis** – a mistake often made is potential strategies are put down as opportunities, which is wrong in the eyes of Piercy *et al*. The opportunities and threats exist only in the outside world, whereas a strategy is created in-house to make the most of the SWOTs. For example, reducing member subscription costs, to increase the number of members, is not an opportunity; it is a strategy that could be adopted.

The process of the SWOT analysis can generate new ideas. These need to be captured, even if they do not fit into the format of the SWOT, so a separate box should be used. All of the above guidelines help structure the SWOT analysis. The SWOT should be updated when new SWOTs come to light; in order to see how it is likely to affect the strategy of an organisation [101].

A SWOT analysis has been included in this dissertation to bring together the SWOTs that have been uncovered in the previous chapters and through the research conducted. There is a mixture of factors that differ in their characteristics, for example some are quantitative and others qualitative. For that

reason it fits in with the recommendation of Piercy *et al* for using a SWOT analysis.

Many sources were used as an input to the SWOT analysis: TA staff; TA members; literature survey on TAs, and information gathering and dissemination; consultation with academics in the field of engineering. The results are shown in four tables labelled strengths, weaknesses, opportunities and weaknesses (Tables 5-8 respectively). In creation of the SWOT analysis the SWOTs were firstly written onto post-it notes and organised into the quadrants of the SWOT analysis. A group was used to create a 'shared vision' and to determine the relative importance of each SWOT. The later helped to focus the thoughts of the researcher and would enable a TA to address the highest priority SWOTs first. The post-it notes were moved between the quadrants until the group had agreed upon where it should stay. It is highly recommended that TAs do the same when creating their analysis.

Table 6: Strengths of TAs who are considering creating a technical service for members

Variable	***Reference number****	***Strengths***	*Description*
Economic / environmental considerations	11	*Value of technical information*	Technical advice was ranked as the second most demanded service by members. A technical service would fulfil such a demand
Membership	5	*Size of membership*	More members result in more income that can be used for the technical service. Also, there will be many members as sources of information. Greater economies of scale come from a larger size
	6	*Supply chain*	If the entire supply chain is in membership then the different tiers could supply technical information that would be useful to the others

Variable	***Reference number****	***Strengths***	*Description*
Organisational structure	2	*Flexible*	There are no hard and fast rules for what a TA should be. Modern TAs are quick to change. A TA should be able to adapt quickly to suit the needs of a technical service
	3	*Staff*	Quality of TA staff has been raised. Better staff ought to lead to a better service
	4	*Graduates*	The number of graduates employed by TAs has increased. 'New blood' can bring new ideas for developing a technical service. Young graduates are usually energetic so are likely to progress quickly
	7	*Coherent voice*	Rationalisation of TAs has led to a more coherent voice. Organisations, such as government, are more likely to pay attention to the views of TAs on technology
	12	*Industry knowledge*	Established TAs know their industry. This will help a TA decide what technologies are appropriate and where they can be sourced
Political	10	*Established links with government et cetera*	Some TAs have had links with government since the 1880s. These contacts can be useful in finding funding for technical projects and are useful for keeping up-to-date with what technologies are promoted by government and other organisations
Resources	8	*Economies of scale*	TAs can benefit from economies of scale due to their many members. Therefore, outside technical related services could be obtained at a cheaper rate

Variable	*Reference number**	*Strengths*	*Description*
	9	*More economical*	Rationalisation of TAs through reducing the number of them has resulted in more economical use of resources so that TAs can survive. A technical service run in a frugal way should increase its chances of succeeding and being cost effective
Societal	1	*Trustworthy*	A TA is able to collect sensitive data from companies to provide industry perspectives. Companies should feel more at ease in sharing information or working with a TA as they are often considered impartial

*Corresponding to the SWOT diagram in Figure 7

Table 7: Weaknesses of TAs who are considering creating a technical service for members

Variable	*Reference number**	*Weaknesses*	*Description*
Communication	15	*Contact management systems*	Lack of expertise to effectively utilise contact management systems. An effectively used system would help organise contacts for gathering and disseminating information
	16	*Unnecessary correspondence*	Typically too much information is sent out and the right information is not sent out at the right time. If the same occurs for technical information members would become disinterested
Parameters	17	*Value of subscription*	It is difficult for a TA to prove the value of members subscriptions, especially for intangibles
	18	*Mechanism for feedback*	Usually unable to get adequate feedback from members, for example low response rates to

Variable	*Reference number**	*Weaknesses*	*Description*
			questionnaires. Feedback is needed to improve services and to prove the value of a service to members and the TA board
	21	*Intangible benefits*	Not easy to show the 'worth' of intangible benefits using parameters
Resources	13	*Subscription rates*	TAs in the past have been reluctant to increase subscription rates. In order to provide a quality technical service revenue may need to come from increased subscriptions
	14	*Technological knowledge*	A TA cannot be expected to have enough staff to be 'experts' in all technological fields of its members
	19	*Trade Association resources*	Many TAs do not have the resources they need to be effective. Industry is not prepared to provide the funds. There may not be enough resources to have extensive personal contact with members, which is a pre-requisite to successful transfer of tacit knowledge
Technological advancements	20	*Website*	Some TAs have not yet fully embraced the benefits of having a good website. An out-of-date website could result in less hits reducing the chances of members seeing information on the technical services

*Corresponding to the SWOT diagram in Figure 7

Table 8: Opportunities for TAs who are considering creating a technical service for members

Variable	*Reference number**	*Opportunities*	*Description*

Variable	*Reference number**	*Opportunities*	*Description*
Alliances (including partnerships, networks and joint ventures)	28	*Collaborations*	Collaborations can increase the resources available to gather technical information
	29	*'Star scientists'*	Through participation in government projects access to 'star scientists' can be gained, who could provide a good quality source
	30	*Contacts*	Further contacts with government (both UK and European), other TAs and interest groups could provide leads for new technology ideas
	31	*Trade Association mergers*	Mergers with other TAs would mean that resources could be shared, resulting in better efficiency. Access to more members would increase the *many* sources of information
Competition	32	*Member competition*	Some companies, especially large ones, come into membership to keep an eye on their competition
Economic / environmental considerations	23	*Fear of recession*	Fears over the UK economy going into a recession can create a need for companies to offer 'more' through increasing their technical competencies
	24	*Escalating research and development cost*	Increased costs of research and development may make companies more open to receiving research and development information from outside its organisation
	25	*Shorter technology life cycle*	Shorter technology life cycles suggest that the cost of research and development will increase as more effort will be needed to keep up-to-date. This may lead to companies to use more sources for information rather than from in-house
Information gathering	34	*Technology intelligence methods*	There are a multitude of methods available for gathering information that a TA could use

Variable	*Reference number**	*Opportunities*	*Description*
	35	*Many sources*	Sources include members, external expert networks, and internal informants. *Many* sources should imply that there is lots of information out there. A TA could be selective in the source of information so that the 'best' information is sought. The risk of information 'drying up' is lessened
	36	*Migratory knowledge*	Migratory knowledge can be easily turned into a physical format. Less effort would be needed by a TA to create this type of information into something useful
Members	22	*'Going native'*	The 'going native' attitude of UK subsidiaries of multinational companies means that they are keen to do more to compete against other subsidiaries
Organisational structure	33	*Informal contact*	Informal contact is a pre-requisite to formal co-operation. A TA should embrace informal contact to assist in creating formal co-operation for technical projects
Resources	26	*Funding*	Funding can be used to address any deficiency in resources for the technical service capability. For example government and venture capital funds can be possible areas of funding
	27	*Case studies*	Case studies are available that can promote the benefits of how technical information/services can be of benefit to the members
Technological advancements	37	*New communication media*	New formats for communication, such as online conferencing, can lead to more efficient and effective communication of technical information. If the quality of communication is high then a member is more likely to use it well

Variable	*Reference number**	*Opportunities*	*Description*
	38	*New monitoring systems*	New software can make it easier to gather technical information, such as website monitoring tools
	39	*Data storage*	Information storage is becoming smarter. Systems can make it more accessible through a search engine

*Corresponding to the SWOT diagram in Figure 7

Table 9: Threats to TAs who are considering creating a technical service for members

Variable	*Reference number**	*Threats*	*Description*
Alliances (including partnerships, networks and joint ventures)	48	*Member company mergers*	Mergers between companies can result in sectors being made up of fewer companies, which can result is less income for TAs. Hence, less resources available for a technical service capability. There would be fewer members to make up part of the *many* sources for technical information. Larger companies present other threats for TAs (see below)
Competition	40	*Large member companies*	Generally large companies that are dominant in their sector are not interested in the work of their appropriate TA. Additionally they can have direct links with government and hence could influence what areas of technology should be funded
	41	*Other Trade Associations*	TAs could offer technical services that are in competition with each other. Secondly, new TAs that occur because of a single current issue are more likely to be 'flavour of the month'
	42	*Opinion*	Ineffective TAs that are kept

Variable	*Reference number**	*Threats*	*Description*
			afloat may give the TA industry a bad name
	43	*Foreign member companies*	Foreign companies that may be in membership could use information that is meant for UK companies only
	44	*Movers and shakers*	Companies that are seen as the 'movers and shakers' typically see TAs as slow moving and consensus seeking so may not support TAs setting up technical service capabilities
Communication	64	*Communication media*	'Poor' communication media can lead to sloppy communication and a high state of heterogeneity can occur. This could lead to a TA becoming out of touch with technologies that members need
Information gathering	54	*Key member companies*	Key companies that are not in membership may have desirable information that a TA will not be able to have access to
	55	*Unexciting technology*	If exciting technical information cannot be found to disseminate then members may become despondent to technical information disseminated by a TA
	56	*Information distortion*	If the *many* sources of information are not motivated to contribute to the TA there could be a risk that any information sent in is inaccurate or distorted
	57	*Embedded information*	Information can be embedded in social reactions and is slow moving. This type of information will be difficult to obtain, but may be important

Variable	*Reference number**	*Threats*	*Description*
Organisational culture	58	*Lost relationships*	An important contact that provides technical information could leave their current post, which would remove the information sources. For example, established relationships with company Chief Executives can be lost as a result of the 'Four Years and You're Out' syndrome
	60	*Research ethos*	Technical information cannot become an input in the innovative activities of a member until they conduct their own research. A TA will be unable to control whether a members technology strategy is in line with its own
Organisational structure	65	*Inter-organisational co-operation by members*	Members may be inexperienced in managing inter-organisational co-operation
Parameters	49	*Deficient feedback*	Lack of feedback from members could lead to the technical service capability being developed into something that is not what members want
Political	53	*Government*	Negative government opinion on TAs could result in lack of help/funding. Also, government may not listen to TAs about technical issues. UK government powers moving from central state to regions, such as Regional Development Agencies, could make it more difficult for TAs to impact on government
Resources	45	*Volatile subscriptions*	Income from membership subscriptions can be volatile. A reduction of income from subscriptions could restrict what can be done for the technical service capability

Variable	*Reference number**	*Threats*	*Description*
	46	*Sources*	If a wrong type of source is used for the wrong sector this could lead to technical information being seen as inappropriate
	47	*Member resources*	There are a high number of small companies in membership of TAs. Smaller companies are less likely, than a larger company, to have financial 'slack' to afford extra services on top of their subscriptions. Furthermore, members may not have the appropriate equipment or resources to take advantage of new technologies disseminated. Industry may not be prepared to support their TA, either by not preparing funds or through Board Members not making a commitment
Societal	52	*Wrong networks*	A good technology cannot be taken advantage of unless the company is in the right network or community
	59	*Apprehension*	Employees of member companies may be apprehensive about sharing their knowledge in fear that their value will be reduced if they share their knowledge with other colleagues. Member companies will be reluctant to contribute information about critical technologies
	61	*Societal settings*	Points of friction can occur between people in companies that have different cultural backgrounds, this could impede technical collaborations. There is difficulty in encouraging reciprocity

Variable	*Reference number**	*Threats*	*Description*
Technological advancements	50	*Slow uptake*	There could be difficulty in getting members to use new technologies in communication. Slow uptake, by members, of the technologies disseminated could result in them missing out on the time when it offers them a competitive advantage
	51	*Internet*	The tradition of the internet is to obtain information free of charge. This could be a hindrance for TAs charging for technical services. Members may sought technical information from the internet rather than from their TA
	62	*Superseded technologies*	Lock-in on technologies that have been superseded could end up with a route being followed that does not bring members a competitive advantage
	63	*Ineffective systems*	Ineffective systems externally provided for gathering or disseminating information would waste resources

*Corresponding to the SWOT diagram in Figure 7

5.3 Prioritised use of Resources and Capabilities for Technology Foresight

Figure 7 is the SWOT analysis diagram that shows the strengths, weaknesses, opportunities and threats (from Tables 5-8) that may affect the desired outcome of providing technical information to UK TA member companies. This provides a quick reference to the SWOTs so that they can easily be taken into consideration when formulating strategies. Each SWOT is numbered, which refers to the number in column two of Tables 5-8, providing a description for each SWOT.

The SWOTs have been prioritised in each quadrant, showing the SWOTs with the highest relative importance at the top and the SWOT with the lowest relative importance at the bottom.

*Could exist as a weakness. It is dependent on the specific TA. Refer to Section 5.2 for elaboration.

M = Member; TA = Trade Association

Figure 7: SWOT analysis of TAs capability to run a technical service

5.4 Technology Foresight Approaches by Trade Associations

5.4.1 Value of a Strategy

A strategy can help induce an understanding of the need to use different information gathering and dissemination methods. It increases the chance of a TAs staff and its members approach being inline and hence a shared vision. The value of technical information can be threatened if there is no or a poor strategy to utilise the current assets of an organisation [11], that is to say a TAs *strengths*.

5.4.2 Strategy for a Technology Foresight Approach by Trade Associations

Taking into consideration the SWOT analysis a strategy is proposed for the provision of engineering technical information by a TA to its members. This was then implemented using a test-bed TA (Chapter 6), which makes particular reference to why certain processes were chosen to employ the proposed strategy, relating them to the strengths, weaknesses, opportunities and threats to establishing a technical service. The strategy and implementation was influenced by the resources and needs of the test-bed TA; however, the TA used was representative of a typical TA (Section 6.2). Lessons learned from implementation are then taken into consideration in creating a final, updated, strategy for other TAs to use (Chapter 7).

The three principal components that form the strategy are:

1. Utilising IT communication capabilities
2. Newsletters
3. Collaborations

Each one will be discussed in turn. An employee of the TA needs to be nominated to perform the role of Technology Intelligence Specialist (3.3.9) and will therefore oversee the implementation and functioning of the three principal components.

For the provision of technical information to TA members' to be successful the leader of the TA needs to fully support it. To ensure that the staff of the TA aspire to make the service a success techniques for managing and motivating personnel can be employed (Section 3.3.10), such as rewarding and training staff.

5.3.2.1 Utilising Information Technology Communication Capabilities

An online community, made up of the TA members, is to be set-up. Due to the impracticalities of using an intranet to set-up an online community (Section 3.3.8) this method should not be used. Instead freely available services, such as Google Groups, will be utilised. An online discussion forum will be set-up. The TA will monitor the messages posted in order to gather technical information from discussions and to moderate messages. A clear statement of the purpose of the forum – to discuss technical related matters – must be given in order to reduce the likelihood of irrelevant messages. Setting up pertinent topics at the beginning will provide an example of a suitable use. A controversial statement ought to be posted first of all so that it generates interest from within the membership.

Online meeting tools should be made use of for technical seminars and also to support collaborations. Access to state-of-the-art technology does not guarantee a successful online community [78]. For that reason the TA will need to ensure members' would have a need for the online community [103]. The stratagem is to initially support the use of online meetings with partners in collaborative projects and then promote the success of its use to the rest of the membership.

5.3.2.2 Newsletters

Hardcopy technical newsletters will be used to disseminate technical information to members once a month. The aim of these is to offer members a single source where they can scan for information on technical advances in their industries.

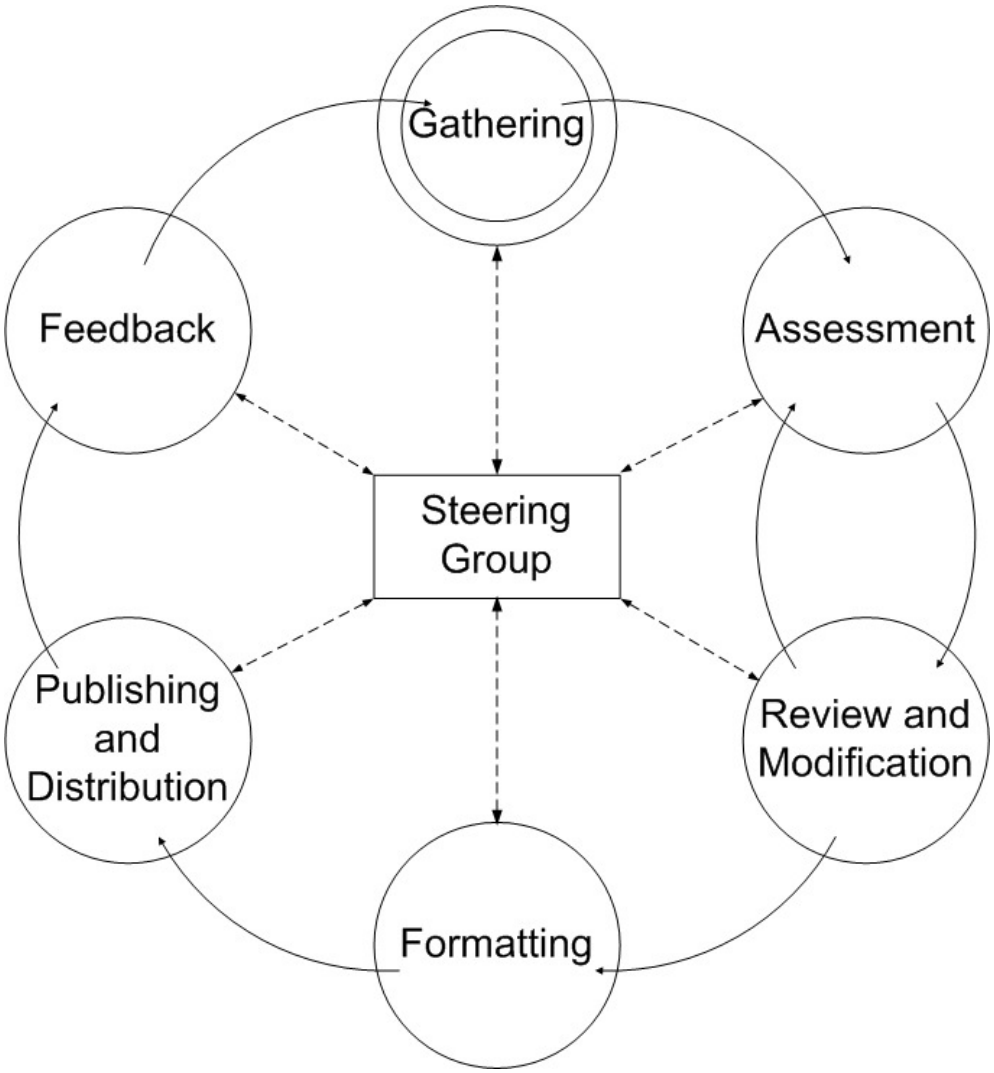

Figure 8: The screening process for technical dissemination.

Figure 8 shows the six stage process for producing the technical newsletter, which is loosely based upon the approach of TW PRIME. To begin with technical information will be gathered. Taking into consideration primary and secondary sources of information (Section 3.2) the following route, in order, should be taken by a TA when sourcing technical information:

1. External secondary sources
2. External primary sources

This follows the recommendation by West [14] but does not recommend using any internal sources. This is because a TA does not typically have a large number

of technical staff or publications to call upon within itself. A main reason for searching for secondary sources is that they are typically inexpensive. Also, external primary sources are more difficult to source information from, such as embedded tacit knowledge. It would be ideal to get as much tacit information as possible as it is by and large unique. On the other hand it is difficult to tap into and therefore a TA may not have the resources to spend on obtaining this type of technical information.

The choice of sources and methods for collecting information has been narrowed down in Section 3.2 and Section 3.3 respectively. As many of these as possible ought to be used.

The second stage of the process, assessment, is where the TIS assesses the articles that have been submitted and decides which ones will be included. When intending to utilise a source its credibility (Section 3.2) should be assessed according to the advice given by Burnett [15] and West [14]. The TIS will assess the credibility of each article as well. For TW PRIME all authors were legally bound to follow the house style and not to infringe copyrights or plagiarise [96]. To make certain that the TA does not infringe copyright nor other laws relating to publication of other people's information the TA has to ask for information sources to be provided, thus enabling the TA to assess the risk. Next the articles chosen will be reviewed in more detail and any necessary changes will be made by the TIS. Once changes have been made the article will be assessed once more.

The accepted and revised articles will then be put into the appropriate format that the newsletter will take. The articles will be of minimal length, approximately 150 words, taking into consideration the busy schedules of members. It will be printed in black and white, to save money, on two sides of A4 sized paper. Consequently space is limited and will help to reduce the possibility of 'information overload'. Contact details for the each author will be given at the end of their article providing a route for further information.

Subsequently the newsletter will be published and distributed. The newsletter will be sent out by post to the contacts that the TA has on its contact management

system. Understanding the type of recipient of the newsletter is imperative so that it can be aimed at the main group of reader. Different groups may have different technical and financial capacities and interests. For instance, senior management might have a better interest or capacity for the financial benefits of a technology than the technical, and vice versa for an engineer [83]. The target recipient group will be technical managers within member companies.

Members, including a steering group, will be invited to provide feedback, which will be used to improve future newsletters. This is to ensure that the newsletters will be "market pull" focused; therefore, only technologies that members necessitate will be included. It is important to consider **technologies vs. products** [161]. Technologies and products bring opposing perspectives in that technology drives excitement and creates new markets, "technology push", whereas the market should dictate the product and technology directions, "market pull".

5.3.2.3 Collaborations

To take advantage of the benefits of collaborations, as mentioned in Section 3.2.7, a TA should partake in collaborative research projects. It will have to endeavour to join collaborative projects where there is funding available, which has been identified as an opportunity for TAs.

Both national and international collaborations will be suitable. However, the inherent difficulties associated with cross-border collaborations need to be taken into consideration (Section 3.2.7) – there is a higher failure rate for these types of collaborations. The TA can apply some techniques to help make collaboration more successful. For example, creating an appreciation of each person's role within a collaboration through listening to their description of work. It is crucial that for coordination and communication purposes that information that stems from collaborations is put into a migratory form, such as a report, so that it is not difficult to extract.

Personal observations (Section 3.2.11) can be used to gather information from meetings and demonstrations that may be held for a collaborative project. If the TIS partakes in the collaborations he or she would be better equipped to explain the project and its results to members. This also needs to be put into a migratory form and should be supported by other reports that are an outcome of the project.

5.5 Concluding Remark

The TA resources and capabilities for technology foresight were analysed. A SWOT analysis tool was used to do this. The main reason for using this tool was because of its simplicity of use. However, to avoid sloppy and unfocused use of the tool, which had been highlighted by Piercy *et al*, techniques for using the tool were given. One way in that the SWOT was modified was by putting the SWOTs in priority order. This resulted in a prioritised use of resources and capabilities for technology foresight that successfully extracted 65 SWOTs from research that had been described in previous chapters of the dissertation.

The generic SWOT, Figure 6, was taken into consideration to create a strategy for a technology foresight approach by TAs. Three main components make up the strategy:

1. Utilising IT communication capabilities – freely available services will be used to set-up an online community.
2. Newsletters – a six-stage scanning process for technical dissemination is given.
3. Collaborations – it was recommended that the TA participates in collaborative research projects where funding is available. It was cautioned that there are inherent difficulties with cross-border collaborations.

Emphasis had been put on the importance of a Technology Intelligence Specialist (TIS) to oversee the implementation and functioning of the technology foresight approach. Additionally, the TIS would better be able to assess the credibility of information sourced, which had been recommended in past research by Burnett

and West. The following chapter (Chapter 6) provides the results of implementing the proposed strategy.

6 Investigation of Prioritised Technology Foresight Practises for Trade Associations

6.1 Introduction

In Chapter 5 a strategy was developed for a TA to provide engineering technical information to its members. The GTMA (Section 2.4) was selected as an appropriate TA against which to implement the strategy and determine its effectiveness. The GTMA was deemed an appropriate test-bed as it represented a typical TA due to the following main reasons:

- Considering it has been in existence since 1942 it has experienced the pressures, such as rationalisation (Section 2.2), that has been inflicted on TAs over the years.
- It offered a sizeable majority of the main services offered by TAs in general (Section 2.3).
- Typically TAs membership is made up mostly of small sized companies, less than 30 people. Ninety percent of the GTMA's membership is made up of small sized companies.

To be able to assess the implementation of the strategy feedback is required. Section 6.2 highlights difficulties associated with obtaining feedback and provides some techniques that can assist in getting feedback.

This subsequent section then describes how the three principal components of the strategy were implemented and provides the results from feedback gained:

1. Utilising IT communication capabilities (Section 6.3) – a discussion on the freely available online meeting and discussion tools implemented is given.
2. Newsletters (Section 6.4) – as per the strategy hardcopy newsletters were implemented. Acting on feedback from a questionnaire the newsletters are then sent out as an online newsletter. The more automated less obtrusive parameters used to obtain feedback from the online newsletters is then discussed.

3. Collaborations (Section 6.5) – action research, based upon the test-beds experience win five international research projects, provides recommendations on how a TA can work better in collaborations.

The implementation and results of an additional component, conferences (Section 6.6), is also given. The results presented are from a questionnaire administered at a technology conference held by the test-bed TA.

The main findings from the results are then given in Section 6.7 along with their relation to previous research and how the research in this dissertation has contributed to the research.

6.2 Methods for Obtaining Feedback from Trade Association Members

In order to assess the proposed strategy feedback must be obtained. Gathering feedback needs to be a continuous process, which leads to an updated strategy, due to the ever changing needs of members and the dynamic nature of gathering and dissemination methods. Boleat [106], a specialist TA consultant, highlights the difficulty of getting feedback particularly from TA members; it is described by him as "horribly difficult". In his former role of Director General of the Association of British Insurers – the biggest UK TA – he said they would "get minimal feedback from members and what they [the Association of British Insurers] got back was rubbish" [107]. This is supported by Bartholomew *et al* [108] who states that obtaining a sufficient response rate remains a key challenge.

Response rates are typically higher when trust exists between the organisation administering the questionnaire and recipient. The SWOT analysis (Figure 7) shows that trust between a TA and its members is a strength; hence it utilised to increase response rates.

Low sample sizes for feedback can lead to unrepresentative results that can be affected by bias, that is to say a biased result would affect the results less in a larger sample than a small sample [109]. The Trade Association Forum [110] and the DTI both promote the use of membership surveys. For that reason it was important that the GTMA implemented parameters and methods to gain feedback, which other TAs could easily apply. On the other hand Phaal [111], Senior Research Associate at the Institute for Manufacturing, University of Cambridge, warned that 'searching' for statistics could negatively narrow the scope of creating a technical service capability for TAs. It is best to go with someone's 'gut instinct' as to whether a technical service is valuable or not. Surveys can be used to get an insight into 'gut instinct'. Boleat supports this by saying "often the best way of getting feedback is literally talking to members" [107].

Written questionnaires can be considered a better way than talking to get feedback as recordable (migratory) data is produced. Questionnaires can be administered orally by an interview. Written questionnaires are more likely to result in uninfluenced responses than oral questionnaires as there is no interviewer that can affect the recipient's responses. Recipients are also more likely to be more honest with their answers when compared to an oral interview and inaccuracy of recording responses is eliminated. Questionnaires were the main method employed to obtain feedback from the members of the TA with which the strategy was implemented. They have been a popular method of data collection in small business research [108]. Possible reasons for this are that other methodologies, like field research, demand more time from the recipient. Small companies, which represent a majority of TA members, generally have less time and money than large companies to deal with research.

In preparing a questionnaire thought was given to the questions and their wording. To retain the recipients interest the number of questions was limited and a range of question and answer types were selected appropriately [112]. Structure also influences the effectiveness of a questionnaire; the sequence of questions has to take a logical approach which makes it easier for a respondent to work through it. If a respondent answers questions in a random order the

responses are not 'developed' by the sequence, therefore, they are effectively answering a different questionnaire [113]. Peterson [112] also provides helpful information on structuring questionnaires.

Questionnaires can take hardcopy or electronic format. The former is often referred to as a mail survey. Jobber *et al* [114] and Drummond *et al* [109] believe that postal surveys are a cost-effective research tool, although cost advantage is reduced if a low sample size is obtained. Email surveys or those conducted via the internet can be used. Benefits over hardcopy include cost – no postage or stationary required – and the ability to track and define mailings is better than postal surveys [92]. Disadvantages include the need for recipients to be computer literate and there is the possibility of the recipient not receiving the questionnaire if it is screened out by a SPAM detection system (Section 6.4.2). Further benefits of hardcopy and electronic questionnaires are that the respondent can complete it in their own time.

Techniques, developed from industrial case studies, can be applied to increase response rates:

1. Using a suitable database [92]
2. Endorsement of questionnaires [108]
3. Prior notification by telephone [114]
4. Prepaid monetary incentive [114]
5. Stamps on hardcopy questionnaire return envelopes [114]
6. Anonymity [114]

A questionnaire can be endorsed by another relevant organisation. For example, a questionnaire on teaching practises maybe endorsed by the National Union of Teachers, which would show approval by a relevant credible organisation that the questionnaire is suitable and worthwhile. It has been shown that endorsement of a questionnaire resulted in a recipient being 1.4 times more likely to respond to a questionnaire than one that was not endorsed [108]. This could be used advantageously by a TA if it were to gain endorsement by reputable organisations, for instance universities. According to Jobber *et al* [114] an

organisation is expected to reciprocate the value added by an endorsement so that the equilibrium is kept between the two parties.

6.3 Utilising IT Communication Capabilities

A Knowledge Transfer Network (KTN) is a national network, within the UK, in a specific field of technology or business application [115]. A network can consist of many organisations, businesses, universities, research and technology organisations and other intermediaries. A variety of activities and initiatives are provided to facilitate the exchange of knowledge and increase innovation amongst the community.

As stipulated by the strategy the GTMA has made use of a freely available service for creating an online community. These were offered through the Electronics-Enabled Products KTN (EEP KTN) [97]. The KTN presented an opportunity for GTMA members to become a trial micro-community within their KTN. The EEP KTN was chosen because it was able and willing to support the GTMA in creating its micro-community. Stokes and Palmer [96] highlighted that "innovation amongst our [*their*] audience members might be much improved if we were to make a concerted effort to recognise one another and record and then communicate among ourselves the knowledge we have accumulated to date". The GTMA has pursued this path by encouraging this in the members' 'micro-community'.

The first group to be registered on the KTN was the UK consortium members of a European collective research project [116], T-ForM [117] (Appendix 5). Before registration the GTMA obtained permission from each member, as their details would be shared with the KTN administrator. Initial engagement of members was face-to-face at a meeting so that benefits could be conveyed so that a state of heterogeneity could be achieved (Section 4.6). A key issue for some online community designers is encouraging empathy and trust within an online community [78]. This already existed as a strength for TAs (Figure 7).

As suggested by the strategy a need for using the online community was created. The first group selected for registration, T-ForM members, were contracted to work together on a project, which should have encouraged participation in the online community. This group was then to be used as an example group to aid introduction of other groups by showing what they could have, hence, creating a demand.

Sufficient feedback from the T-ForM group on the use of the online software was not obtained. For future feedback approaches particular attention ought to be given to feedback regarding the three key factors that De Souza *et al* [78] stated that the success of an online community depends upon: social; software functionality; usability.

Online facilities, offered through the KTN, ensured that the GTMA did not need to invest in advanced IT but simultaneously ensured that members had access to the latest internet developments including document sharing, web meetings and other remote working activities. This counteracted the TA weakness of limited IT equipment and knowledge.

Interwise [118] is an online conferencing system, with the capability for users to share documents and communicate via the PC. Online meetings can be recorded allowing those absent to playback the meeting at their convenience. A number of successful online technical meetings have been held by the GTMA, none of which were formally assessed by participants. It is vital that feedback is obtained so that it can be gauged whether the facility is of value to members.

Online discussion boards were also offered through the KTN. The GTMA encouraged members to use such a tool, offered through the KTN, to discuss technical issues. As identified in the strategy irrelevant messages can sometimes be posted onto a discussion forum if it is not moderated. This can be overcome by enhancing the software to filter out these messages or by adding structure to the community, including moderators or norms with clear statements about the purpose of the message board [78]. There was no control over enhancing the

KTN software. However, the GTMA issued clear statements about the purpose of the online discussion boards.

In line with the strategy it was intended that a controversial statement would be posted first all of to generate a response from members. This was to focus on work the GTMA and author of this dissertation had completed on 'the real cost of tool, die and mould manufacture'. A copy of this paper can be found in Appendix 1. Due to time restraints the GTMA was unable to use the forum with its members.

6.4 Assessment of Trade Association Newsletters

The two types of newsletter created by the GTMA are described in Section 6.4.1 and Section 6.4.2. The first type was hardcopy and was implemented in line with the strategy. The second, which was a progression from the first, took an online format. This led to a revised strategy for newsletters. The feedback from the recipients of the newsletters is treated separately for each so that the chronological order that each was developed in is reflected. This is especially important as the results of the first hardcopy type instigated the creation of the next.

6.4.1 Hardcopy Newsletter

The newsletters created for the GTMA were entitled 'Technical Briefings' (TBs). The first (Appendix 2) was created using the six-stage process given in the strategy (Figure 7). The articles covered a mixture of technologies including laser sintering; graphite selection; Electric Discharge Machining (EDM); High Speed Milling (HSM); acoustic emission; on-machine verification.

For the gathering stage rather than utilising a majority of the sources and gathering methods the main sources used were the GTMA's *many* members – taking advantage of the *opportunity* (SWOT 35) shown in the SWOT analysis (Figure 7). This was mainly because time was not available to spend on

employing the different collecting methods to extract information from *many* sources.

The size of a TAs membership (SWOT 5) would be considered a *strength* here as more members reduce the *threat* of lack of sources. Further to this, using members would give members an opportunity to promote their products/services to other members, who could be potential customers. This is likely to be seen as promotion that can be assigned a value that can be seen as a tangible benefit of membership, hence addressing the *weaknesses* of 'value of subscription' (SWOT 17) and 'intangible benefits' (SWOT 21).

The assessment stage was adhered to and was completed by a TA employee performing the role of a TIS. However, due to time constraints, credibility was not assessed in the way recommended by Burnett [15] and West [14]. As the strategy suggested the GTMA requested that authors provided information on sources that they had used. This was never provided, mainly because the information sourced internally from within the company providing it. For that reason a non-liability statement was given at the end of each TB. Changes required for an article were completed by the TIS.

The format was exactly as set in the strategy. It was distributed by post to all GTMA members, of which there were approximately 300. The principal targets were company managers, who were typically the initial recipients of GTMA information. Ideally the recipients should have also of been technical managers. It was not possible to differentiate between the types of manager from the data held by GTMA. This highlighted the generic *weakness* of TAs of 'contact management systems' (Figure 7).

The experience from producing the first issue was used to improve the subsequent issue. A steering group could not be put together to facilitate suggestions for improvements as not enough members could be convinced to participate.

Further information, in the first issue, was accessible using direct links to the source of information. In the successive issue these links were not provided and instead members were encouraged to contact GTMA for supplementary information. This made it possible to monitor the demand for supplementary information. The second issue was produced in colour and included figures, hence making it more visually more appealing (Appendix 3).

6.4.1.1 Questionnaire

A questionnaire (see Appendix 2) was incorporated into the first TB, which had been sent to 300 member companies. In addition to obtaining basic contact information about the respondent two questions were asked. One asked for the respondent's view on the format of the TB and the other about what they would like featured in future issues. No responses were received. This was indicative that 'mechanism for feedback' is a *weakness* for TAs that wish to run a technical service (Figure 7). Without feedback the GTMA would not be able to determine what members wanted. Jobber *et al* showed that giving an incentive increased response rates (Section 6.2). An incentive had been used in the first TB to encourage completion, which was to enter participants into a prize draw to win having an article on their company featured in the next issue. The zero return rate of the questionnaire indicated that this incentive was not enough to encourage a good response rate. For that reason a personal incentive, shop vouchers, was exploited to encourage completion of the questionnaire in the second issue. Online survey software, QuestionPro [119], was used to create the questionnaire. A copy of the questionnaire is contained in Appendix 10. A hyperlink to the website that hosted the questionnaire was given in the TB. The survey software automatically collated the results so that time did not have to be spent by the TA on this task.

The **sample size** for the second issue of the TB questionnaire was 11 companies. The questionnaire had been sent with the second issue of the TB that had been sent to 300 companies. Therefore, the **return rate** was 3.7%.

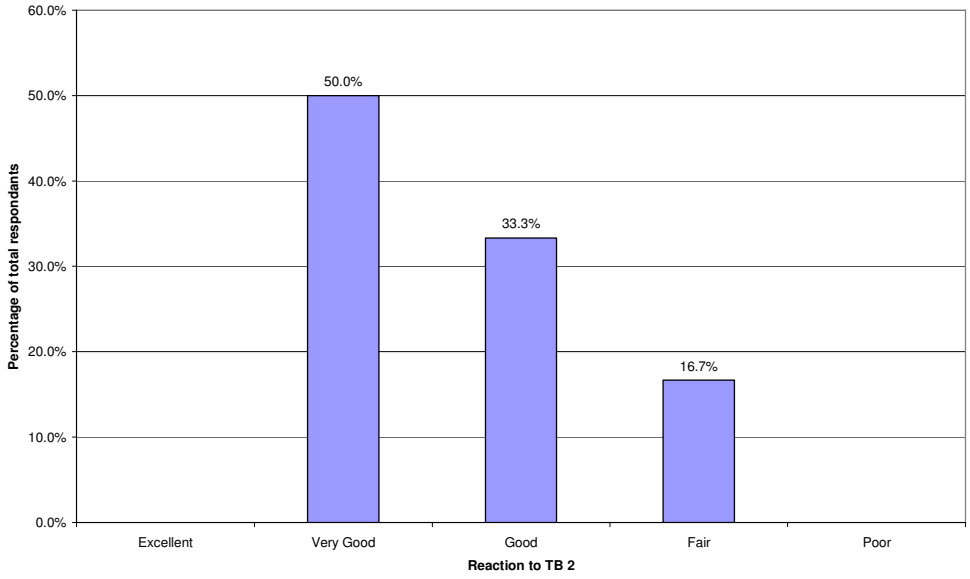

Figure 9: Column chart to show the reaction of members to the second Technical Briefing

There was a significant improvement in the number of companies that completed the second questionnaire. The results showed that all recipients had a favourable reaction to the TB (Figure 9). Half of those thought it was 'very good'. Approximately one third thought that the TB was 'good'. No one considered it as 'excellent' (the highest possible score) or as being 'poor' (the lowest possible score).

Table 10: Comments on what GTMA members liked the most about the second Technical Briefing

What do you like most about the Technical Briefing?
1. Imparts knowledge in areas of previous little known involvement
2. Targeting to specialist technologists
3. This one is not applicable to us
4. Not sure if there is anything
5. As I have only received a couple of briefings it is too early to comment
6. Brief and punchy
7. To the point and quick to read
8. Short and to the point
9. A source of information on new developments

Table 10 shows the free text comments given in relation to what members liked most about the second TB. Members predominantly commented that they liked the TB because it was 'brief and punchy'. Several respondents felt that they had not seen enough TBs to have decided what they liked best. Comment 3, about the TB being inapplicable, was unexpected. There could be a number of assumptions made as to why the respondent thought it was inapplicable. For example, the technologies covered might not have been directly relevant. Alternatively, the respondent may have joined the GTMA to sell to fellow members; hence, they might deem learning of new technologies irrelevant. Comments 1 and 9 signified that the TB's main aim of disseminating new technical information had been met.

Only one comment was given about what members least liked, which was that there were not enough industry related examples of the technology presented in the TB. Elucidation of this comment was sought from the member that had made it. The member indicated that where possible, each article that covers a new technology should be supported by a case study that mentions both the positives and negatives. As the comment was made by just one member other members were briefly consulted. Support was given to the idea, with most saying that mainly positive case studies would increase their confidence in using technologies. The idea was implemented into the successive TB. The GTMA stipulated that case studies should be based upon its members. This would increase the number of members who gained promotion through the TB.

Rather than just find out if members thought the TB was good or not it was important to find out what specific elements they liked or disliked, such as the usefulness, technical quality of articles, layout and article length. The perspectives that members had on these are given in Figure 10 to Figure 13. A majority of recipients thought that the usefulness of the TB was 'good' (46%), 28% thought it 'fair' and 18% saw it as 'poor'. Only 9% considered the usefulness to be 'very good' and no one chose 'excellent'.

All respondents perceived the technical quality of the articles to be good or very good, with good receiving the highest percentage of 60%.

Again all respondents thought that the layout of the second TB was ‘good’ or better. A significant majority, 70%, rated the layout as ‘good’, followed by ‘very good’ and ‘excellent’, with 20% and 10% percent respectively.

Almost all of the respondents, 91%, judged the length of the TB articles (approximately 150 words) as being the suitable length, reinforcing that the strategy was acceptable. Only the remaining 9% believed that articles should be shorter. No one wanted the articles to be longer.

Previous research had shown that keeping description in a technical newsletter would fit in with the busy schedules of management. It was unexpected that the remainder thought that the articles should be shorter. Making them any shorter would make the task of conveying the technical information very hard. Experience in producing the TB highlighted that companies themselves found it difficult not to exceed the word limit when submitting an article.

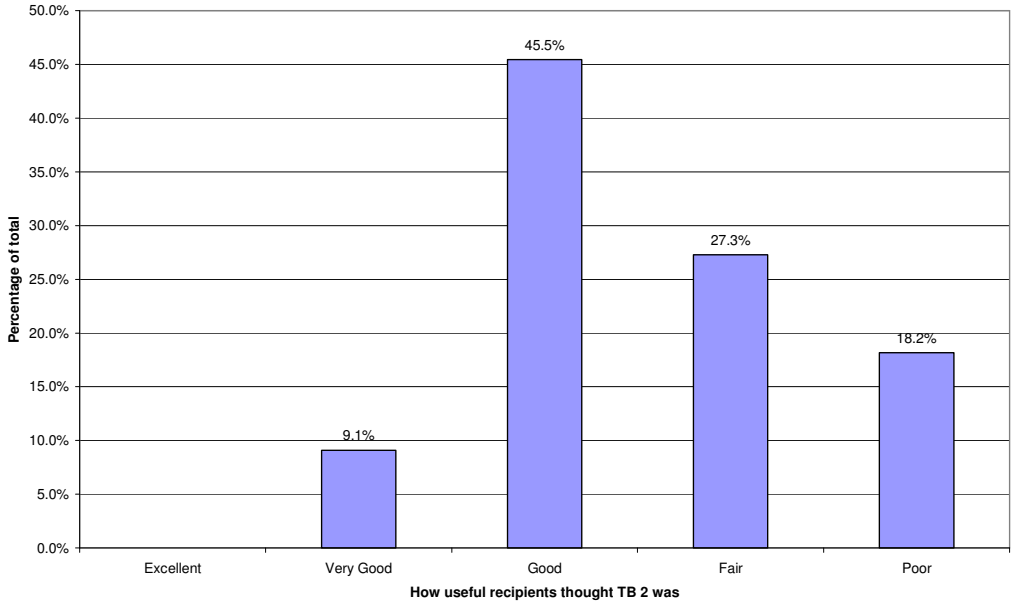

Figure 10: Column chart to show how useful members thought the second Technical Briefing was

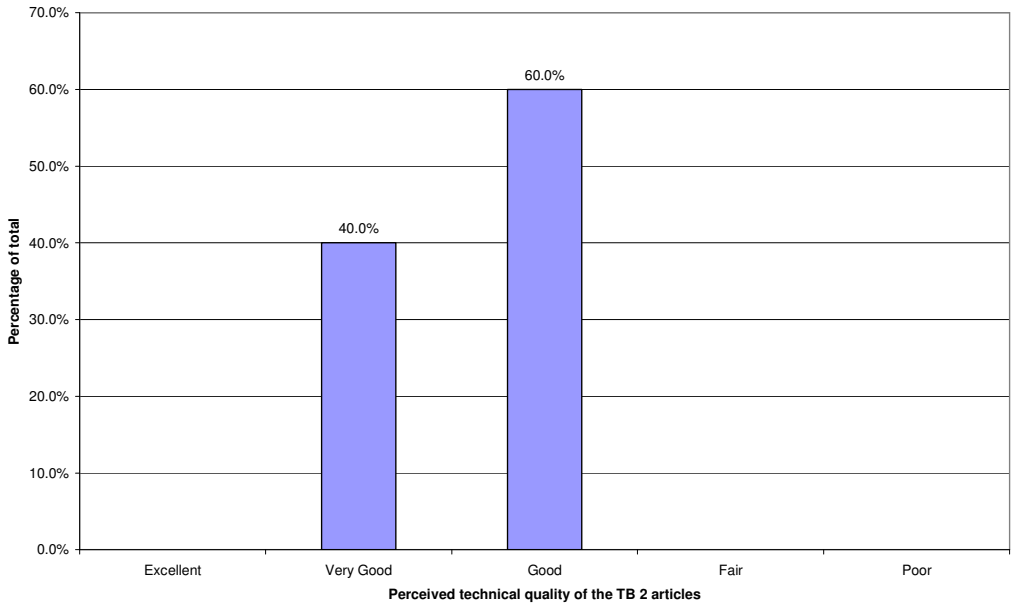

Figure 11: Column chart to show how members perceived the technical quality of the second Technical Briefing articles

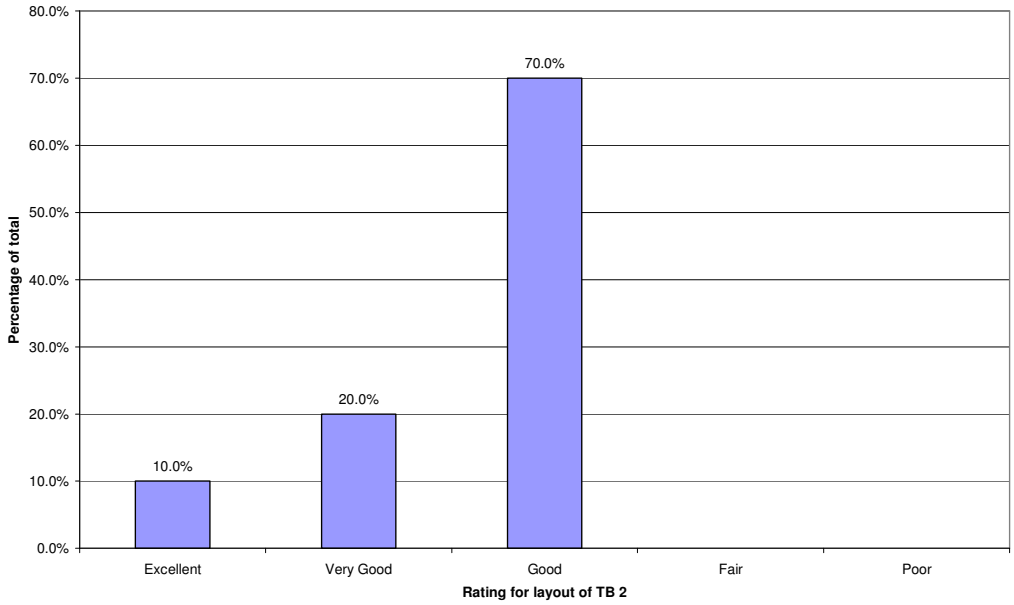

Figure 12: Column chart to show what members thought of the layout of the second Technical Briefing

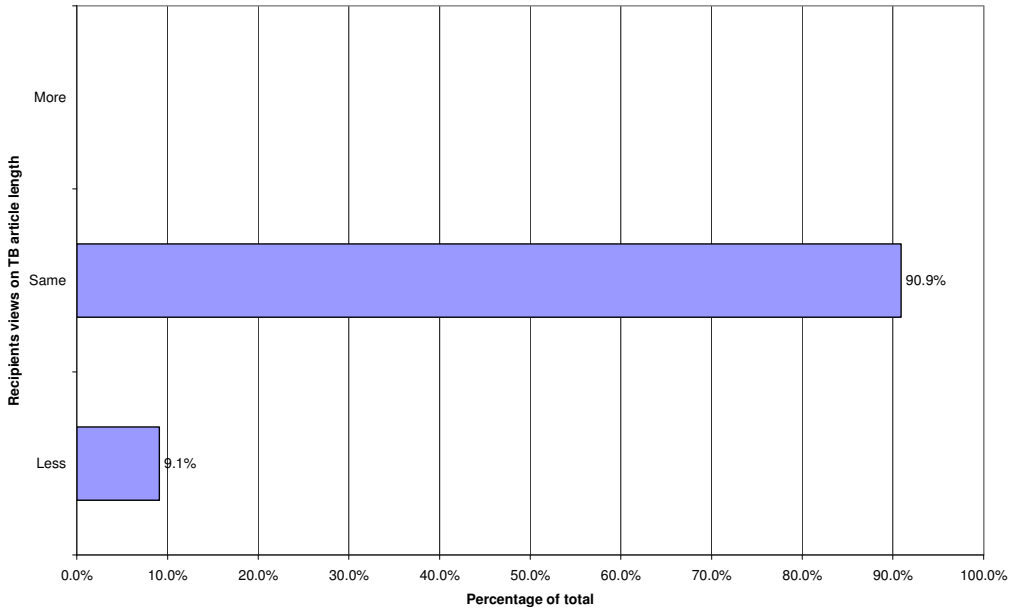

Figure 13: Bar chart to show whether the recipients of the second Technical Briefing thought the article length should be less than, equal to or more than the length of articles in that issue (approximately 150 words)

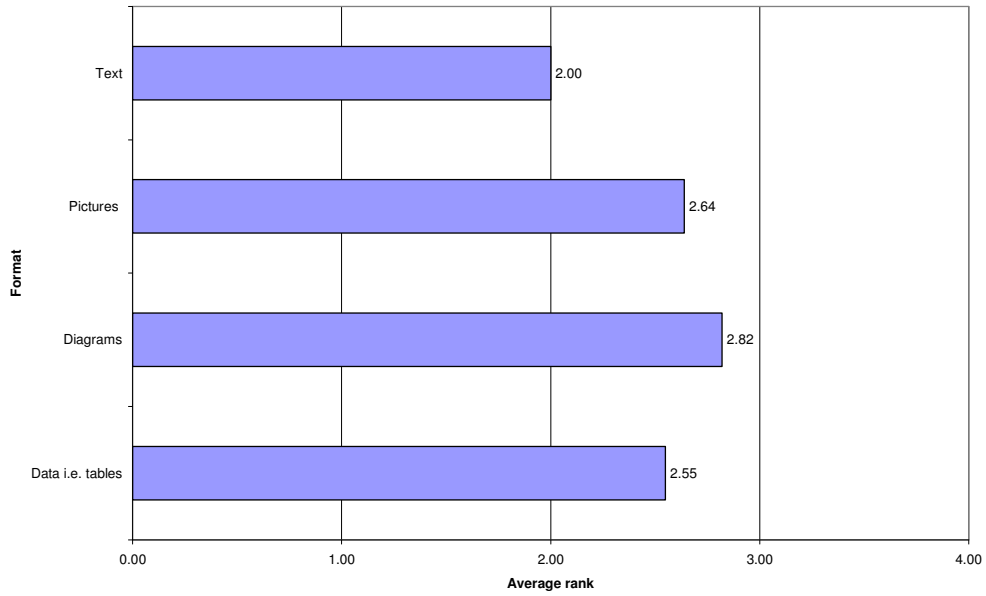

Figure 14: Bar chart to show the recipients average ranking of formats for how technical information is presented

Continuing on the theme of the layout those questioned were asked to rank the formats of how technical information is presented. Four options were given: data; diagrams; pictures; text. Recipients were asked to place a '1' next to their most preferred format, a '2' next to the format of next preference and so forth until all items were ranked. It is perceivable from Figure 14 that 'text' achieved the lowest average rank, which makes it the most preferred format. The next preferred format was 'data (i.e. tables)', closely followed by 'pictures' and 'diagrams' in that order. There was no noteworthy preference as all formats were in the same, second rank, range.

It was expected that pictures and diagrams would have been more popular as it can be considered that they would increase the attractiveness of the TB. On reflection though, the text is likely to be most needed as without it the meaning or significance of a picture, diagram or data table may not be clear. The results do not have any major implications for practise as a combination of the four formats should be used. Previous research had stated that usability attributes of something used online can affect its success [78]. Its typography or style of an online application, for instance, can affect how welcoming it comes across and hence what its perceived ease of use is. By including diagrams and pictures it can

help clarify something. Considering the length of TB articles is only about 150 words pictures and diagrams could aid in portraying technical ideas in fewer words, hence making it easier to meet the guidelines.

The format of the text itself can be different, for example bullet points can be used or the length of the sentences can differ. Future work could include using indicators, such as the Gunning Fog Index [120], to calculate the readability for the articles. The Fog Index score is meant to relate to the number of years of schooling needed to comprehend a piece of writing. Professional prose should never exceed a score of 18 otherwise the text can be deemed too complicated to easily read. A suitable score could be determined for the TB and then subsequent issues can be checked to see if they meet the Gunning Fog Index. This would be dependant upon who is identified as the main reader of the TB – a Technical Director is likely to be able to read text with a higher score than an apprentice.

The average reading rate for the main recipients of the TB could be found and each article could be tested to see if its Fog Index score is suitable. However, it should be noted that such indicators are rough indicators and do not take into consideration the nature of the audience, for example their knowledge base of a subject.

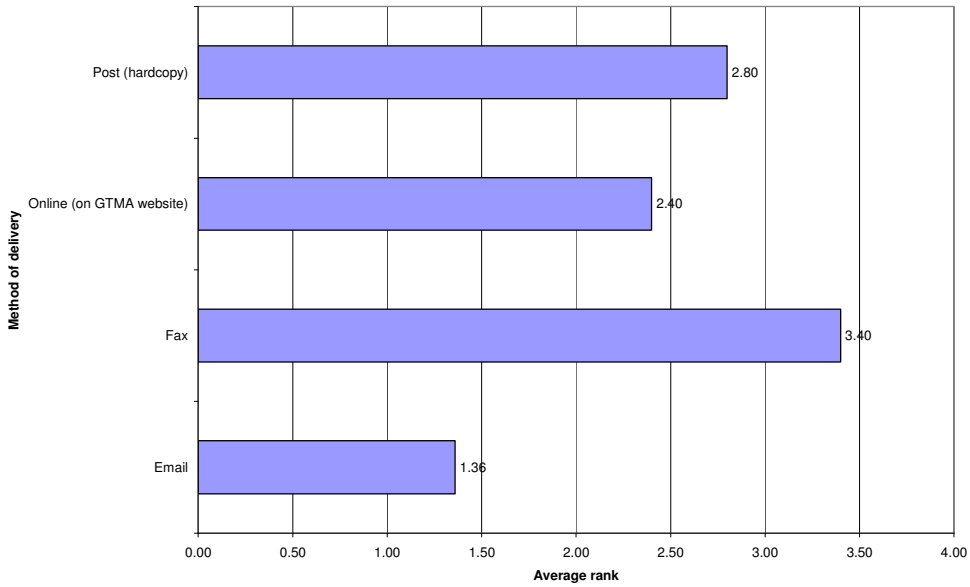

Figure 15: Bar chart to show the recipients' average ranking of delivery formats for the Technical Briefings

The format of delivery for a technical newsletter can affect the number of people that read it. Figure 15 clearly illustrates that 'email' is the preferable format for the TB, with an average ranking of 1.36. The least favourable format was 'fax', which only received an average ranking of 3.4. 'Online' and 'post' were both in the range of the average rank of two, with scores of 2.4 and 2.8 correspondingly. The results support previous literature that has stated there has been an increase in the popularity of email and e-newsletters.

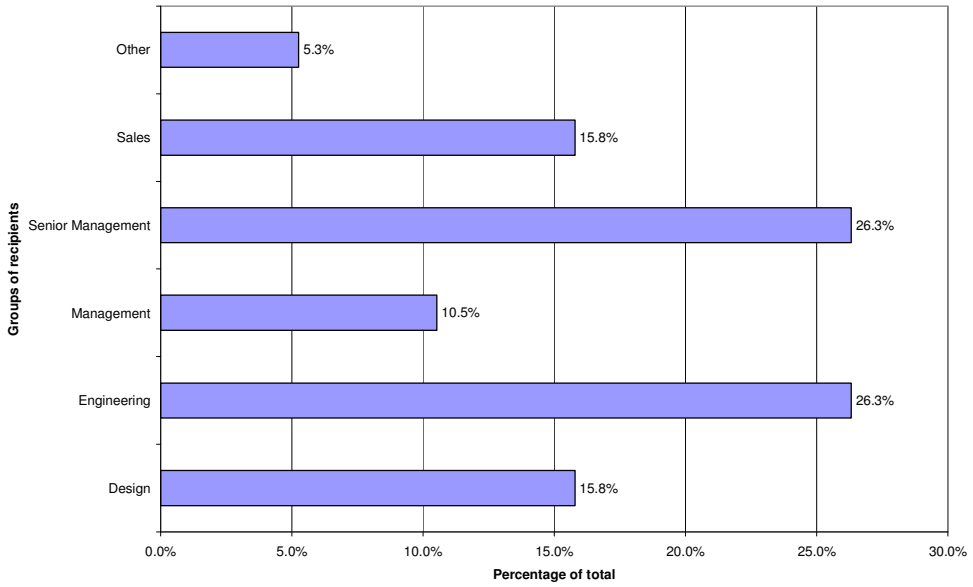

Figure 16: Bar chart to show the groups of people the recipients of the questionnaire expected would be the greatest users of the Technical Briefing

The question was posed about which groups of people within the member company the recipient expected to be the greatest user of the TB. Six options were available to the recipient: design; engineering; management; senior management; sales; other. More than one option could be selected. The groups identified as being the greatest users were 'senior management' and 'engineering', both receiving 26% of the choices made (Figure 16). The terminology used in the questionnaire did the match that of the strategy, particularly with reference to 'technical managers'. This made it difficult to show whether the results supported the strategy.

It would be in the interest for a TA to make sure that a TB reaches senior management. Not only would it satisfy the desires of the respondents to the questionnaire, but it would provide evidence to senior management of a company that a TA is providing this service, thus show that it contributes to the value of their subscription. Previous research had suggested that some workers were apprehensive about sharing their knowledge [11]. Therefore, if the TB is sent directly to senior management, as well as engineers and technical managers, there would not be the risk that it would not be seen by them.

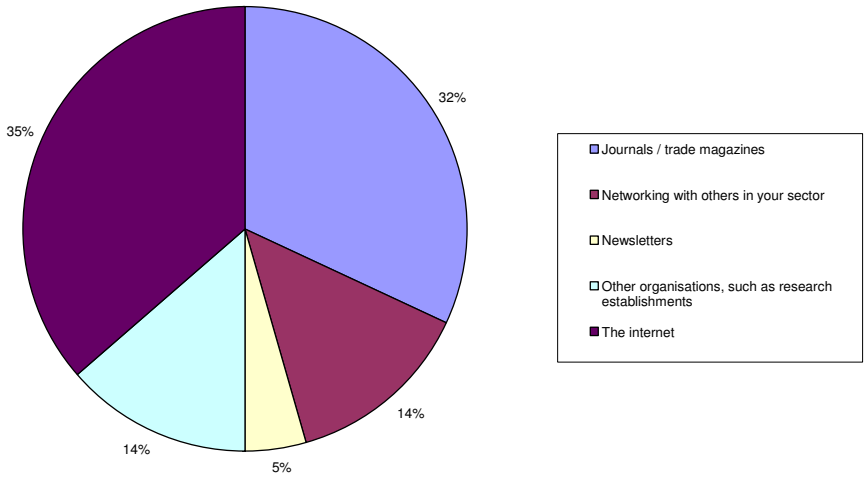

Figure 17: Pie chart to show where recipients of the Technical briefing currently get their best new technical information from

Competition – a *threat* – to the TBs would come from other mediums that provide technical information appropriate to the members' industry, therefore, recipients were asked about where they typically obtain their best new technical information. Respondents were allowed to pick more than one category. The results are presented in Figure 17. 'The internet' was the most popular current source of information with over one third choosing it. In Section 4.1 it had already been highlighted that the internet can be seen as a *threat* to TAs as it allows members easier access to information that had previously been sought through a TA.

'Journals and trade magazines' accounted for almost one third of the sources that members use, which made it the second most popular choice. Joint third, each with 14%, was 'other organisations' and 'networking with others'. Newsletters only accounted for 5% of sources used. The option of 'other' received no response.

The result that newsletters were one of the least popular sources of information, in the first instance was a surprise and did not seem to bode well for the TB. More thought into this removed some of this trepidation. The question had not

specified what type of newsletter. A newsletter from a TA, which is likely to be considered impartial and trustworthy, may be more readily received than one from a company who is promoting the availability of their own products or services.

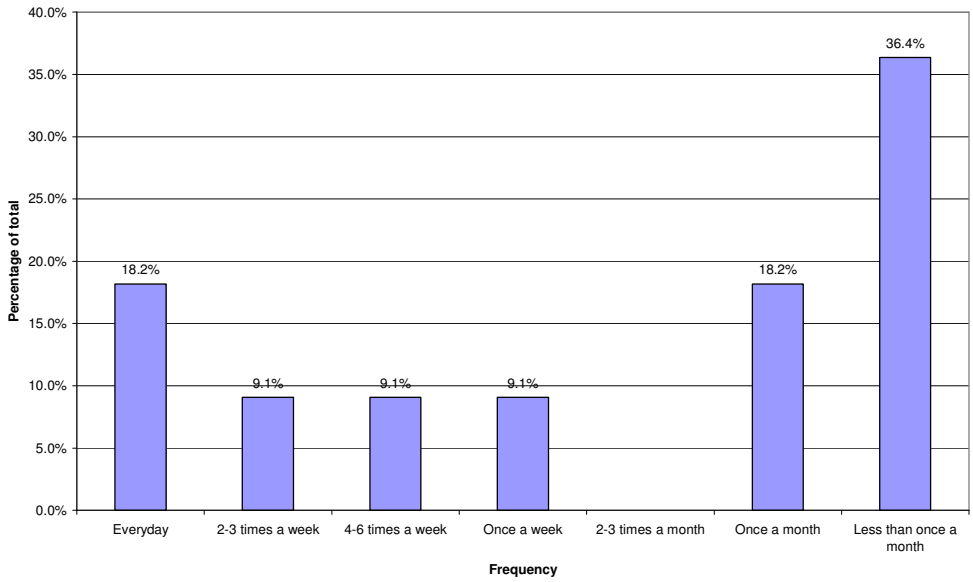

Figure 18: Column chart to show the typical frequency recipients look for technical information

How often members searched for new technical information would be useful to know in order to decide upon an appropriate frequency for the TB. Figure 18 shows that predominantly members search for new technical information less than once a month. This would insinuate that the strategy for sending out a TB once a month was appropriate, although sending it out less often would still be acceptable.

The main purpose of the questionnaire was to obtain information that would help improve upcoming issues. Only two improvements were suggested:

1. Make the TB less sales like – one recipient commented that the TB "seemed to be a series of advertisements, except for the heat treatment [article]"
2. Highlight the main headings a little more and specify relevant sector where appropriate

Further to this the recipients were asked what type of technical information they would like to see in future TBs. Half those that responded thought that they could not comment as they had not seen enough issues or they did not have the time to answer. The more relevant answers suggested “anything regarding the various users of tool steels” and “how to be more competitive [lean manufacturing techniques etc.]”. The first comment was given by a tool steel company, who would obviously have a vested interest in learning more about the various users of tool steels.

Even though feedback was obtained it could still be deemed as deficient, therefore a *threat*. Further consideration for obtaining feedback was given in the implementation of the future issues of the TB. Taking into account the results of the questionnaire it was obvious that email would be the preferred format of the TB. Successive TBs took on the format of an online newsletter, which is discussed in Section 6.4.2. Including industry related examples were selected as a necessary inclusion in future issues in order to induce confidence in the technologies presented. The concept of offering bite-size chunks of information proved popular and so the length of articles remained the same.

6.4.2 Revision to the Strategy for the Newsletter

A third TB (Appendix 4) implemented the improvements that were suggested from the results of the questionnaire associated with the second (hardcopy) issue.

6.4.2.1 Online Newsletter

Through using an online format the cost saving in postage when compared to the hardcopy was approximately £108[1] in postage and £62 in consumables, which was an immediate benefit. This supports other authors in this area of research who have stated that online newsletters are cost effective in comparison to hardcopy ones.

An Email Service Provider (ESP) is the common name given to a company that send bulk email/newsletters on behalf of customers. An ESP, GraphicMail [121], was chosen by GTMA to send out its online newsletters as it was the most cost effective. There are others, for example JangoMail [122] and Mailing Manager [123]. GraphicMail would cost £8.80[2] per send for the GTMA, a saving of approximately 85% when compared to hardcopy. This meant TA *strength* of being 'more economical' was built-in (Figure 7).

The SWOT analysis in Figure 7 identified 'resources' as a *weakness* for TAs. For that reason it is likely that a TA could not afford to bring in a computer programmer to write the HTML code that produces online newsletters. Fortunately many ESP's use systems that mean you do not have to be a computer programmer. The GTMA used a system that used a 'What You See Is What You Get' (WYSIWYG) editor. A WYSIWYG is a HTML (Hypertext Markup Language) editor that lets you work with pictures, fonts and colours instead of working with the direct code.

[1] At 36 pence per first class stamp
[2] Based upon a 17.5% VAT rate

For the GTMA formatting the TB was quicker for hardcopy than the electronic version, since the WYSIWYG editor was a new tool for the GTMA to use. This may not be the case for all TAs as their staff may already be familiar with such an editor. The general increase in the professionalism of a TAs staff and their higher intake of young and energetic graduates that are willing to learn is a *strength* that should more easily allow TAs to introduce and use new tools and ways of working.

SPAM is an unsolicited email message. There are laws in place that regulates commercial email, such as the CAN-SPAM Act [124]. It is extremely important that a TA sending out online newsletters should adhere to the appropriate laws. It could be very resource heavy making sure all the laws is upheld. Opportunely many ESPs will ensure that their systems meet them. For example, the ESP employed by the GTMA would automatically provide an unsubscribe link. This allows a subscriber to the TBs to no longer receive information from the GTMA. This will counteract a TA *weakness* of sending unnecessary correspondence.

The software used to send out the TB electronically would generate statistics automatically such as open rates - the number of subscribers who have opened up the email in a recordable way [121]. These statistics could be used instead of questionnaires to avert over saturation which can create 'research fatigue' [109]. Hyperlinks – an element on a webpage which you click on to jump to another location [125] – to the GTMA and member websites were included in the electronic version, which would encourage traffic onto these websites. Hyperlinks used by recipients could be tracked so that demand for supplementary information could be monitored.

The Defence Diversification Agency [126] (DDA) existed up to April 2007 as a Government initiative to promote the cross fertilisation of technology between the defence sector and the rest of UK industry. Schemes prior to the DDA had failed given that they were "technology push". The DDA was "market pull" focused*;* therefore, only technologies that companies necessitate are disseminated [127]. Hence, by tracking the use of hyperlinks a TA could build up a better idea of what members wanted and therefore be more market pull.

6.4.2.2 Revision to Process for Producing Newsletters

The strategy and process steps for producing the TB were revised, Figure 19. The first step is deciding upon a theme. Giving each TB a theme allows the GTMA to request articles from a smaller number of companies, which is less time consuming – helping build upon the TA *strength* of being more economical. However, this meant that the TB was more 'technology push' rather than 'technology pull' as it would pick just concentrate on one technological area and run with it. A TA could miss out on gathering and disseminating information on many technologies that are necessitated if they just concentrate on particular themes for each issue.

Furthermore, member companies of GTMA cover many different industry sectors, which sometimes do not have any commonalities. Therefore, if a theme related to plastics is chosen, such as 'Polymer Training and Funding', this would more than likely not be of interest to the press tool section, who are typically not going to be concerned about plastics. On the other hand the cross fertilisation of technology can only be achieved if companies are willing to look into places that they would not normally look into.

Lichtenthaler had shown that the intensity of use of technology intelligence methods for gathering technical information depended on the type of industry. A theme is likely to focus a TB issue on less or even one industry type. Using fewer technology intelligence methods may well reduce the time spent applying them.

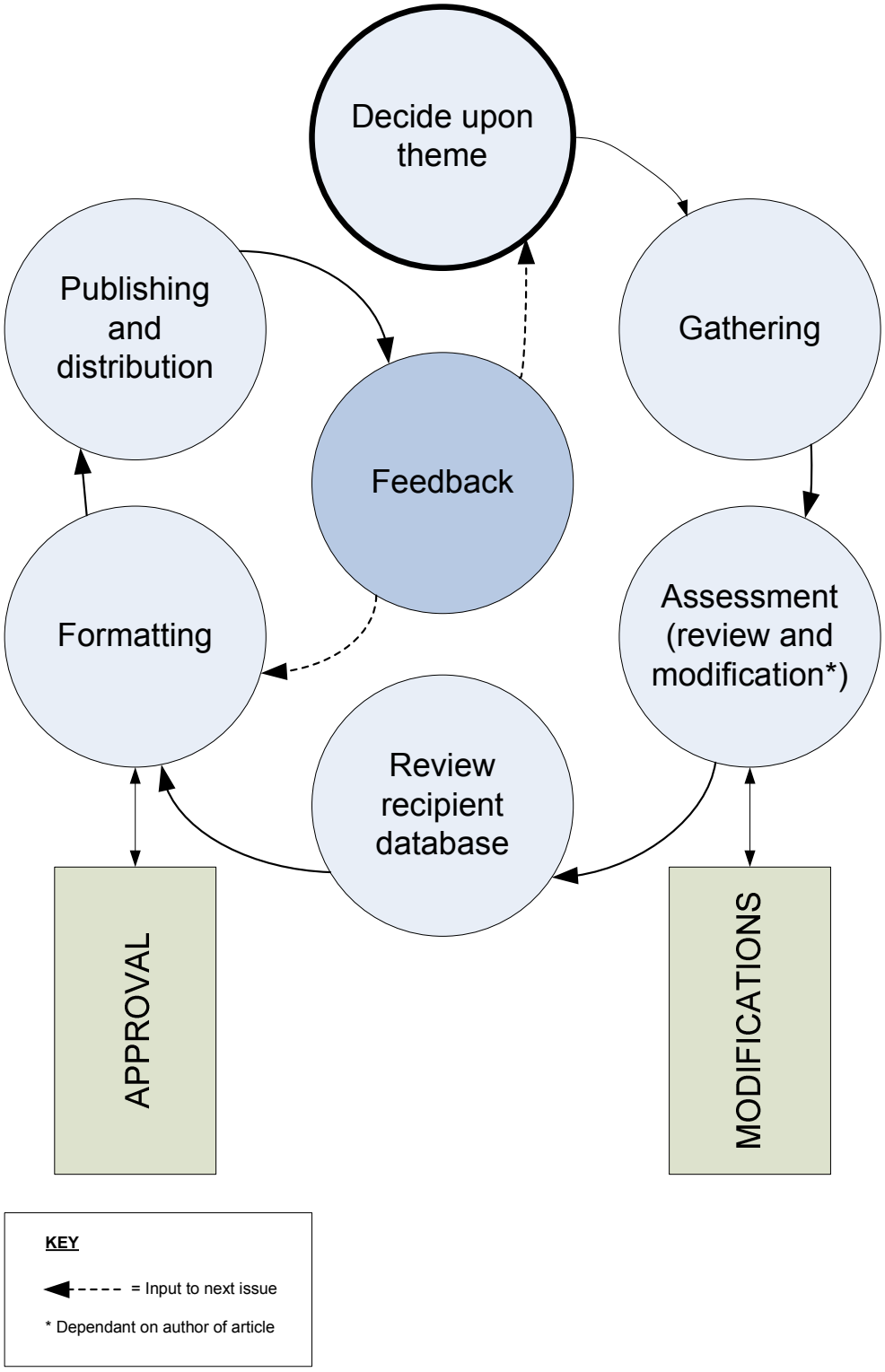

Figure 19: Revision of the screening process for technical dissemination.

In practise, for the gathering stage, the only sources of information used were the *many* TA members, university contacts and collaborations. There were not the resources available to spend time using other sources. On the other hand the tools that can be used to gather information in a more automated way are being further developed. For example text-mining tools can be used to help quickly navigate through large volumes of text to see relationships and patterns [55]. A recommendation for further research would be to trial the use of a text mining tool to see how useful, for a TA and its members, the information derived from its use is. The usefulness could depend on the type of industry the TA represents, just like Lichtenthaler showed how different industries had preferences for using different technology intelligence methods.

A lot of members that submitted information to the TB were keen to promote their products or services to their fellow members. Members who were given the occasion to promote their products or services in the TB can assign a value to this as promotion would normally cost money. A value of their TA subscription would be realised, hence addressing a *weakness* typically faced by TAs (Figure 6).

In the revision the person supplying the article is responsible for making any modifications that are required after the assessment. The main modifications required were shortening the length of articles, removing sales wording and increasing the technical content. Commonly it seemed although the author had not read the brief instructions on what was required of an article. For example, the instructions given stipulated that articles should be between 150 and 250 words in length. Some articles were submitted that were over 1000 words. It would be pointed out to the author that the word limit had been exceeded.

Making the authors modify their article reduced the resources required by the GTMA to produce a TB. In practise the author would rely on the TA to modify their article. This would be time consuming for the TA and there was a risk that the technical integrity of the article would be lost because the TA would not understand the technology as well as the author who had written it. Approval

from the author of an article was now sought, especially if the GTMA had made the modifications. This made certain the technical integrity was kept.

An additional step of 'review recipient database' required the GTMA to add any new members or new contacts for current members to the TB distribution list, addressing the TA *weakness* of ineffective use of contact management systems. It was important that the TB was distributed as widely as possible. This process became much easier when using the Email Service Provider (ESP) as it would automatically adjust the database to reflect who had unsubscribed. This lessened the *weakness* of a TAs archetypal lack of resources. It also reduced the likelihood of sending unnecessary correspondence.

Over half the participants of the TB questionnaire, that accompanied the second issue, expected the biggest group of readers would be Senior Management and Engineering staff. For this reason members are continuously invited to submit email addresses of those staff, in their organisation, they wanted to receive the TB. This helped address the *weakness* of TAs ineffectively using contact management systems (Figure 7).

A questionnaire similar to that used for the hardcopy TBs was used for the electronic TBs. Access to this was provided via a link in the newsletter. There were too few responses for the results to be useable, hence hardcopy TBs could not be directly compared to online TBs. This demonstrated that the *threat* of deficient feedback was in existence.

A difference between the questionnaire that was utilised for the second hardcopy TB, which received an acceptable response rate, and the electronic TBs was that the latter did not include an incentive for recipients to complete them. Prior research (Section 6.2) had shown that an incentive, for example a monetary one, had increased response rates by a significant amount. The lack of response to the electronic TB questionnaires, which offered no incentive, supports the previous research. In practise this emphasises that monetary type incentives should be incorporated into important questionnaires conducted by TAs.

Another probable reason for the disparity in responses is that those that had already answered a questionnaire were not motivated to answer a second similar one as it could be boring. If there is a strong case for fatigue of questionnaires existing it could have serious ramifications for TAs and obtaining feedback, especially considering TA members are often asked to complete frequent questionnaires in areas other than technology. Perhaps prior research may even offer advice on how to work around this.

6.4.2.3 Results for Online Newsletters

The statistics that are automatically generated by the ESP system were used as a mechanism of obtaining feedback. Statistics were gathered from three online TBs. These covered the themes 'laser for tool repair' (Appendix 4), 'polymer training and funding' (Appendix 6), and 'automation and technical standards' (Appendix 7), respectively.

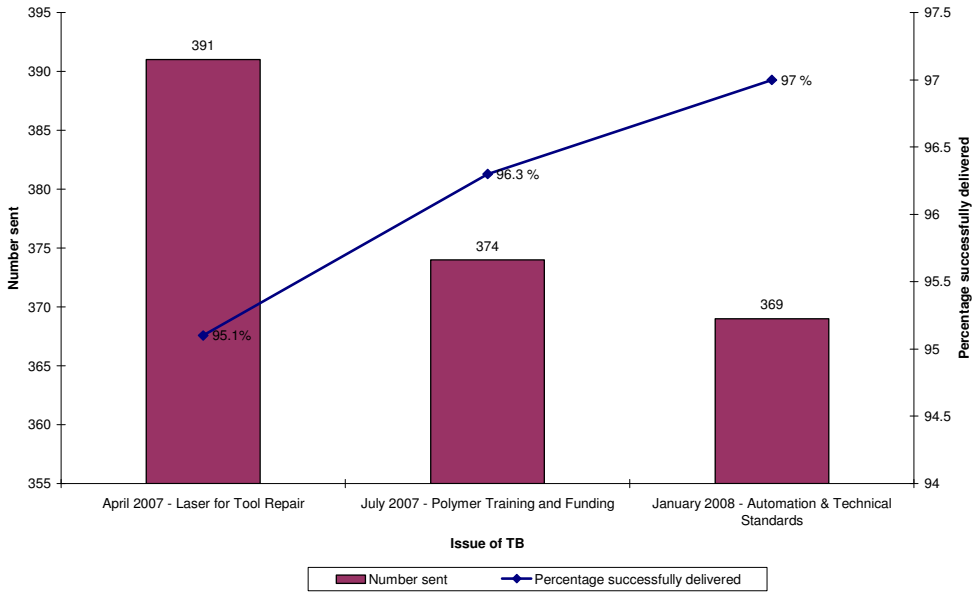

Figure 20: Line - column graph on two axes to show the number of online Technical Briefings sent and the percentage successfully delivered

On average the online TBs were delivered to 378 email addresses. Figure 20 shows the percentage of online TBs that were successfully delivered increased each time a new TB was issued, 1.9% over the duration. As this increases the

number sent decreases by 22 email addresses, which is attributed to the system removing email addresses that did not receive the newsletter successfully. The ESP system provides more detailed information as to why emails are not delivered, such as whether they have been rejected as SPAM.

Knowing this information did not prove that useful for a TA as over 60% of the TBs were undelivered due to unknown reasons. Still, the number of failed deliveries due to SPAM was given. For a TA this should be the most important reason that they should keep an eye on as it can be affected by their actions. If the number of undeliverable emails due to SPAM goes beyond a certain unacceptable threshold – that is decided upon by the TA – then the design and content of a TB would have to be changed to make it less likely register as SPAM.

Another statistic related to online newsletters is the open rate. This infers that the recipient has an interest in the content of the newsletter. This should be a percentage of emails successfully delivered and is not the same as the number sent.

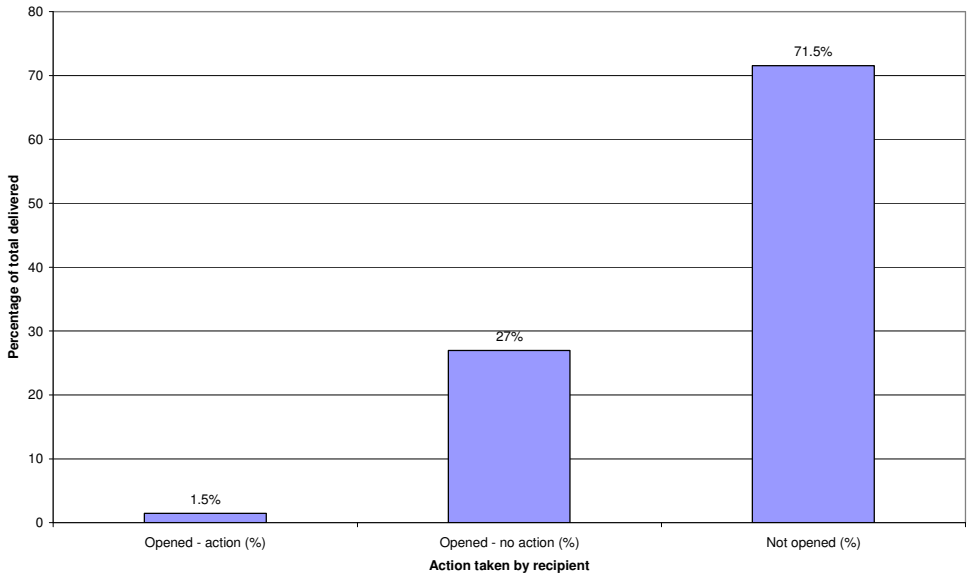

Figure 21: Column graph to show the combined open rates for the online Technical Briefings

The average open rate for all online TBs as a combined percentage is 28.5%, shown in Figure 21. The biggest association in the world, NAR, could expect a 29% open rate for its newsletters, which it considered a success (Section 4.2.3). In light of this GTMA's open rates can be deemed a success reinforces an online newsletter was the right way to distribute the TB. A significant majority of the online TBs were not opened (71.5%). Figure 21 shows two columns for open rate. The first (opened – action) refers to TBs that have been opened and an actions has been completed, such as clicking on a link or unsubscribing to the newsletter. The second (opened – no action) refers to emails that have been opened but no action taken. The smallest number of recipients opened and completed an action related to the email. 27% of recipients opened the email.

The different types of action taken for an online newsletter that can be tracked include who have unsubscribed, clicked on a hyperlink, forwarded the newsletter to a friend or submitted a complaint to the ESP. Only a small number of actions were performed, hence an analysis of this would provide little insight.

As with most email statistics the open rate is not an accurate figure. This is because an open rate cannot be recorded in the following circumstances:

- When a recipient opens a plain-text version and does not click on a link
- If a recipient is using an image blocker, which is a default setting of Microsoft Outlook, and does not click on any links
- If someone views their emails offline

As a consequence it is likely that the 'true' open rate will be higher than that given in Figure 21. A well maintained database of recipients should achieve higher open rates. This gives grounds for spending effort in addressing a TAs *weakness* in effectively using contact management systems.

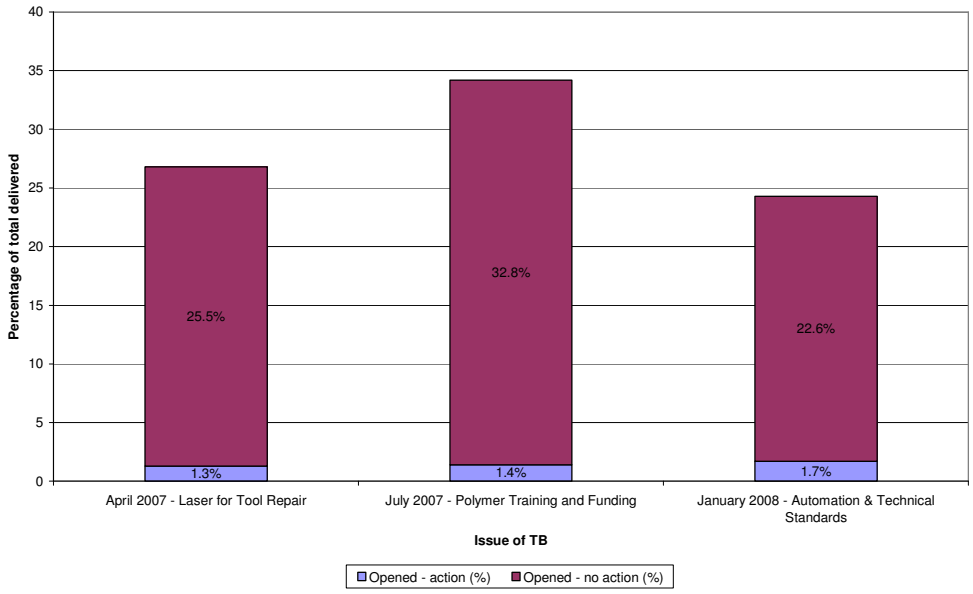

Figure 22: Stacked column chart to show the open rates, and type, for each online Technical Briefing issued

Open rates for each online TB issued are given in Figure 22. The 'Polymer Training and Funding' TB achieved the highest open rate of 32.8%. This exceeds the 29% open rate of NAR. The remaining two TB issues attained lower open rates of 25.5% and 22.6%. There was a 10.2% difference between the greatest and lowest open rates. As the GTMA membership consisted of 300 members the variation between the most and least popular is 12% of the membership. There was not a significant difference in open rate with an action between the TBs, only 0.4%.

The 'what's-in-it-for-me' syndrome (Section 4.2.3) could expound why the 'Polymer Training and Funding' TB achieved the greatest open rate. 'Funding' may have been the eye-catching word that suggested members could get a lead in getting a monetary benefit. Further work could be done to see what effect would occur if the wording of the same newsletter was changed. Half the issues sent out could contain a hint there is something that satisfies the 'what's-in-it-for-me' syndrome and the other could have a title that doesn't (the control). Commercially this may not be practical as a TA is unlikely to want to risk missing out on reaching members.

The articles in the Polymer Training and Funding TB were not necessarily providing technical information, but instead they were making members aware of a route that could increase their staff technical knowledge levels. Discounts and funding for training were offered to members, which could be assigned a value to their membership.

6.5 Assessment of Trade Association Collaborative Projects

Co-operations are a predominant source of technical information as identified in Section 3.2 and hence were part of the strategy for provision of engineering and technical information to TA members. The GTMA (Section 6.2) has experience in co-operating with companies and knowledge generating organisations through the European Community (EC) framework programmes for technological development. Action research is used to develop generic recommendations for how a TA can better co-operate. The author of this dissertation was responsible for running European Union (EU) funded projects for the GTMA. It can be argued that someone with hands on experience could be considered better equipped to explain a subject than someone who has just observed or read about it.

It is believed that studies on collaborative research are in the early stages of development [31] and the following should help progress study, especially by looking from the perspective of TAs, whereas research classically focuses on industry-university interactions. A TA perspective is important as it can be seen as an independent intermediary for the traditionally academic work by universities and the more commercial emphasis placed by industry.

Reports on dissemination that stemmed from the project were used to draw upon suggestions for improving partaking in EU projects, for example recommendations for increasing the number of companies that are involved. Consultation with other project members, especially other TAs, was used. Also, a short questionnaire was conducted to understand why companies got involved

and what their aspirations were from involvement. The risk of researcher bias was offset by seeking the approval of thoughts from the CEO of GTMA.

6.5.1 European Union Funded Projects

The projects that GTMA participated in were under The Sixth Framework Programme (FP6) [128]. The strategy had warned of the inherent difficulties of cross-border collaborations; however the GTMA did not have any national projects to participate in. One of the routes for SMEs and TAs to participate in a FP6 project is through 'an SME Association or Grouping'. This is where an SME association, such as a TA, becomes a participant on behalf of their members. This provides good *opportunities* for TAs as a majority of them have 50% of SMEs in membership (Section 2.2). Collective research projects are undertaken by research institutions on behalf of industrial associations or groupings. The EC's aim is to increase the knowledge base of sizeable communities of SMEs in order to increase their competitiveness, which is aligned with the desires of TAs. There is however a concern that the research community will develop proposals that is of interest to them rather than the SME community [129].

All the projects that GTMA participated in were three years long. The length of the projects could increase the *threat* of the developed technology being seen as unexciting (*threat* '55') as by the time results are delivered it is seen as not new. A draft report from EAMA [130] – a federation representing, at a European level, the mechanical, electrical, electronic and metals articles industries – stated industry had lost interest in European research programmes due to the long-term scientific approach [129].

The budget for projects is between €1.5 million and €4 million. Under FP6 up to 50% of eligible costs of the project could be funded [131]. TAs can claim not only their time but also the time of SMEs that participate as a National SME (Section 6.5.1). The time claimed from a National SME is referred to as an in-kind contribution. An SME would not receive money for this nor would they pay money for the privilege of being involved in a project. Throughout the extent of

the project much bureaucratic processes are enforced onto the participants, such as completion of timesheets and audits to claim their time and the in-kind time. Already limited TA resources – a *weakness* – would need to be assigned to these types of task. The level of unnecessary correspondence (*weakness* '16') is augmented by the need for TAs to send bureaucratic paperwork to its participating SMEs, which put SMEs off participation.

The average size of project that GTMA participated in was 21 partners; six TAs, five research partners and ten core SMEs. In the past collaborations in general were mainly *one-to-one* relationships [31]. The benefit of this was that communication was relatively simple. In the 1980s the more complex collaborations with *many* partners - involving not for profit organisations i.e. TAs as well - coined the term 'research and development consortia'. The FP6 projects are examples of 'research and development consortia'. While communication between larger groups of companies and organisations is more complex new technologies, such as online workspace tools, can help make communication easier. For a TA larger consortiums can add to the *many* sources that it can gather technical information from and enhances the *opportunities* that can be gained from contacts.

The roles of a TA within an SME Association or Grouping project are generally:

1. To manage the project and its outputs
2. Ensure appropriate exploitation of project results
3. Input into training activities performed
4. Recruitment of SMEs who are given non-public information on the project on a regular basis, are offered training and who can give their opinions on the progress and direction of the technologies developed within the project. These SMEs are referred to as 'National SMEs'
5. Dissemination of the project results

6.5.1.1 Project Proposals

Before a project is funded by the EU a proposal must be written for the intended partners of the project. Prior to the 1980s collaborations were often informal arrangements [31]. Just like the EU projects contractual agreements are now common place for collaborations, which can be time consuming to put in place. It is important that a TA understands the challenges submitting a proposal can present to help it decide if it is something it can and wishes to become involved with. Also, it was stipulated in the strategy that a TA should endeavour to join collaborative projects where there is funding available, hence the following provides an idea as to how easy or not this is.

Usually there are several stages for submitting a proposal and preparing a project contract. This can be a long process, perhaps lasting around eight months [132], and therefore requires TAs human resources with no guarantee of a positive outcome. Organisations may even charge to put together a project – some can charge in the region of £80,000 for writing a project proposal. This reinforces the disadvantage of consultants, as a source of information, in that they are usually unwilling to provide information unless they are paid for it [14]. Even though consultants may be deemed expensive the cost could be considered to pay off, as some consultancy based companies, such as Pera, boast that the organisations they support in proposals enjoy an 85% success rate in applying for Framework Programme funding [53]. This is much higher than the average success rate of 10% [133]. So far the GTMA has avoided paying such costs for putting together a proposal, and for a TA an increased number of contacts (*opportunity* '30') and relationships can improve the chance of working on a proposal submission without incurring any charges.

The example of the DDA (Section 6.4.2.1) had made known that 'technology push' schemes were likely to fail [134]. Pera, who are a big player in setting up collaborative projects, have also described that using a 'technology push' model had been a flaw in their past practises [133]. A major objective of the research for SME associations is for the projects to be driven by the SMEs [135], hence aiming to be market 'pull' rather than 'push'. This would help counteract the *threat* of unexciting technology. In practise it is collectively believed by some TAs that this has not been achieved [129].

A number of industry representatives believe that the success rates for proposals is low [129]. For the second call of the Research for SME Associations [136] funding from the EU – under the framework subsequent to FP6 – the number of proposals submitted was double that of the first [138]. This indicates that the competition will be fiercer and the success rate will become lower. As a lack of resources is a *weakness* for most TAs the decision to belong to a proposal should be given serious thought. Though, if a TA does not put effort into joining proposals the *opportunities* of participation would be missed. The more proposals submitted the better the chance of having one that is accepted. If all proposals that a TA were part of where accepted it could seriously consider which projects would be of most value to itself and membership.

The FP6 projects that GTMA participated in were:

- Emold [138].
- Flexform [139].
- Hipermoulding [140].
- KnowEDM [141].
- T-ForM [117].

A brief description of each project is provided in Appendix 5.

6.5.2 Dissemination of Information from Collaborations

There are two categories of SMEs that participate in the collective research projects. Core 'SMEs' are those that form part of the project consortium and they are funded to perform work within the project. 'National SMEs' do not belong to the consortium, nor do they perform work for the project, but instead they are there to receive information from the project through receiving reports, training (including handouts and online training) and attending national project meetings.

Technical information that comes from the projects is classified into different levels of dissemination. For example, some information may be confidential,

which allows the consortium and Core SMEs to receive it, whereas other information can be restricted, allowing the aforementioned plus National SMEs to receive it, and public, which allows access for anyone. Press releases are mainly used by TAs to distribute public information. Good relationships with the industry press are beneficial for this. Reports from the project are often restricted to the consortium and the National SMEs. Reports are sent by the TAs to the National SMEs. The more reports sent the better as time spent by the National SMEs reading the reports can contribute in-kind time. Reports and press releases are a form of migratory knowledge (*opportunity* '36') and therefore followed the recommendation of the strategy. When the TIS at the TA produced press releases their personal observations helped, hence supporting another recommendation of the strategy.

Further limitations on what could be disseminated were requested by the Core SMEs that belonged to the T-ForM project. They were not happy with the advertisement of figures being quoted as potential cost savings from the T-ForM results, for instance 'reduce thermoforming costs by 35 percent' [117]. There was a concern that their customers would see the saving that the Core SMEs maybe getting and would want the saving passed onto them. For T-ForM the consortium agreed that such figures should be dropped.

It has been said that collaboration with industry can restrict the free flow of information, which can go against the central ethics of some Universities [17]. Some believed that there is a reluctance of academics to share information with their fellow academics who were involved in industrial collaboration as they were concerned it would be used for commercial gain. The inclusion of scientific papers being disseminated from an EU project is important in encouraging the flow of information with the research community. This can be a motivating factor for academics to collaborate as industry experts can help turn research into a commercial product [17].

National meetings are held in each country where the National SMEs are invited to watch presentations about the project progress and to take part in discussions about the future steps of the project. These meetings can be good from the point

of view of a TA as it provides an opportunity to get feedback about the project, hence addressing the *threat* of deficient feedback (*threat* '49'), and can also aid in enticing out embedded information that is often in social reactions (*threat* '57'). From the standpoint of the GTMA it was difficult to encourage National SMEs to attend meetings, due to the limited resources of SMEs. Large Enterprises (LEs) – bigger than an SME in terms of employees (greater than 250) or turnover (greater than €50 million) – were invited to join the national meetings and even host some of them. The participation of LEs attracted more SMEs to come along in the hope that they could gain business from those that were higher up in the supply chain. A TA should make the most of its *strength* (*strength* '6') in linking up the supply chain. Embedded information could also flow between those companies within different tiers of the supply chain. Another attraction would be the opportunity to go on an interesting factory tour of the LEs – for T-ForM GTMA organised a tour of the facilities of JCB (makes loaders and excavators) [143] and Müller Dairy (producer of yogurt products) [144]. Both these national meetings were the best attended ones.

For the T-ForM project the GTMA created a forum for UK thermoformers, called the ThermoForum. This was to encourage National SMEs to attend project meetings by providing additional benefits and discussion topics. It was especially important for the thermoformers as GTMA had not traditionally represented this industry, therefore there was a lack of knowledge and support for it. Discussions at forum meetings enabled GTMA to learn more about their needs and how, as a TA, they could help them. This resulted in some new members and created a captive audience to sell membership to, which would increase the GTMA's size of membership (*strength* '5'). It was hoped that a forum would cultivate a sense of sharing and would allow other perhaps more exciting technologies beside that of the projects to be discussed.

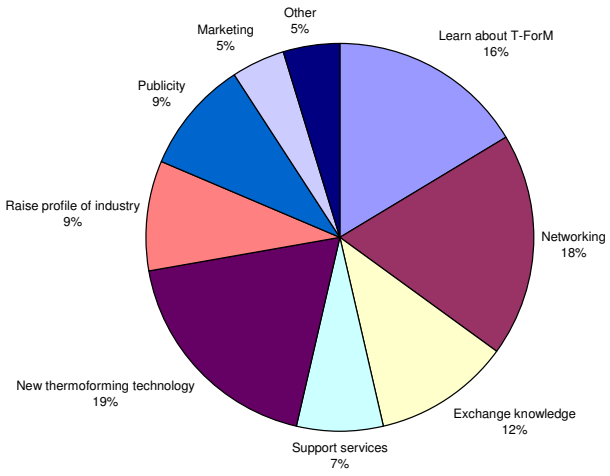

Figure 23: Pie chart to show the motives for joining the Thermoforum

No parameters were employed to monitor whether the introduction of a forum would serve the projects and the members well, but a questionnaire was completed to find out what motivated members to join such a forum. A copy of the questionnaire can be found in Appendix 11.

The **sample size** for the Thermoforum questionnaire was eight companies. Twenty-two companies had been given the questionnaire. Therefore the **return rate** was 36.4%.

The results are presented in Figure 23. The three main reasons why companies had joined the forum were to 'learn about T-ForM', for 'networking' and to find out about 'new thermoforming technology' – the most popular choice. Upon reflection of the options offered to the recipients for their motives 'learn about T-ForM' could also fall into the category of 'new thermoforming technology', which it is. However, the results show that ever so slightly more would like to learn about other technologies than T-ForM. This implies that for EU project meetings it would be beneficial to offer information on other technologies in addition to the ones that stem from the EU project being presented.

The fourth most chosen option, 'exchange knowledge' could even support learning about new thermoforming technology, although the choice does not offer differentiation between business and technical knowledge. Any option specifically related to business and monetary benefits as motivation for participation [17] had been omitted by the question. For similar future questionnaires this should also be taken into consideration.

It was no surprise that networking featured as a popular motivation for joining such a forum. 'Marketing' and 'other' were the least chosen options, although 'publicity' and 'marketing' could be deemed very similar and perhaps should have been a combined option.

6.5.3 Benefits of Collaborations for Members of a Trade Association

Economic benefits motivate companies to participate in collaborative projects [17], especially those that are government funded. For the Core SMEs the escalating research and development costs (*opportunity* '24') can be offset by funding given for EC collaborative projects. More money will be available for a member companies to employ resources to work on the projects, hence reducing the *threat* ('47') that a member would not have sufficient resources to take advantage of new technologies.

Chang [32] states that companies or organisations that already participate in government funded projects are more likely to be invited as partners for future ones (*opportunity* '26'). This can boost a TAs *strength* of established links with government. For a case in point an EC Officer attended an Emold project meeting to present the funding opportunities under FP7. This introduced the organisations and companies involved in the project to potential future funding.

Funding received by a Core SME who is a member of a TA can help reduce TA *weaknesses*. Funding, a tangible benefit (*weakness* '21') received by a member company is highly likely to be much higher than their TA subscription; therefore,

the cost of the subscription has been recuperated (*weakness* '17'). For a TA the service provided to members of informing them of EC project results could provide some justification for increasing subscriptions in the future (*weakness* '13').

'Products' are expected to be delivered by the projects. For T-ForM products included design guidelines to assist design for thermoformed parts and a new T-ForM software module for predictive thermoform mould design. These are tangible and can help address the *weakness* (*weakness* '21') of TAs mainly offering intangible benefits. In reality the UK National SMEs did not show much of an interest in using the T-ForM software module. This was for the reason that it was only usable if they owned particular CAD/CAM (Computer Aided Design/Computer Aided Manufacturing) software, TopSolid [145]. TopSolid is not a popular software package amongst UK thermoformers and for a National SME to buy it for the sake of using T-ForM would incur an expense of about €19,000 for the perpetual license [146], and would also have to pay to train its staff to use the new CAD/CAM package. In effect this meant that the product was not available to the UK National SMEs as a tangible product from the project.

The draft report from EAMA highlighted that interest in European project had been lost due to the lack of results that turn into truly tangible results for SMEs [129]. This detracts from the benefit of project participation diminishing the *weakness* (*weakness* '21') of intangible benefits.

Collaborations can thwart the *threat* of member resources – not having appropriate equipment to complete research needed. Research partners are likely to have equipment that a SME would not have. For instance, in the T-ForM project the Universität Stuttgart [147], in conjunction with other consortium partners, had to develop a new test and equipment for measuring the heat transfer and conductivity within sheet materials used for thermoforming [148]. The test results would have increased the Core and National SMEs knowledge on material properties.

6.5.4 Financial Expectations of European Commission Collaborations

In view of GTMA's participation in projects it should be cautioned that the financial expectations may not be fulfilled. Firstly, the budgets for its projects were based upon a set hourly rate that would be assigned to time spent on the project, both for GTMA and the in-kind contribution it would claim for its National SMEs. At a significant point into the projects it was realised that the 'real' costs had to be used for an hourly rate rather than the set hourly rate assumed from the onset. This had a negative impact because the GTMA's 'real' hourly rate for staff was almost less than half, and for many of the National SMEs their rate was less too. Consequently to get the monetary contribution expected GTMA would have to do almost double the planned hours, yet another drain on its resources and a further exacerbation of a TA *weakness*.

Secondly, the exchange rates can adversely or negatively affect payments to a project partner and especially for a UK one, as GTMA found out. For example, if the hourly rate for a project partner was £30, its value on the 31st December 2007 would be €40.90 compared to €31.50 on 31st December 2008. If 100 hours work was to be claimed using these two rates there would be a €940 difference, almost a 25% variation. The possible occurrence of changes in exchange rates would be impossible to predict.

Thirdly, a TA that participates in a FP6 collective research project aims to realize some of its hours contributed to the project from the in-kind hours from the National SMEs that participate in the projects. GTMA found that the number of National SMEs that partook in each project varied. For the T-ForM project there were 27 National SMEs while Flexform only had two. It is obvious to say that the in-kind contribution from T-ForM would be much higher if each SME contributed approximately the same hours in each project. There would be a difficulty in estimating how many National SMEs a TA could recruit for a project but a TA could utilise its *strength* of knowing its industry (*strength* '12') to make an educated guess as to what the interest would be.

Fourthly, it is important to note that the funding and in-kind contribution claimed by project partners has an impact on the funding for all partners. A UK TA could meet the hours and in-kind contribution expected of it but if other partners were to underperform this could negatively affect the final contribution of funding it receives from the EC. Furthermore the TA partners are last to be paid from the funding that the project finally receives, therefore, if the funding is less than anticipated the TAs would get less. Informal contact (*opportunity* '33') could help a TA get a feel for if it would feel confident working with particular organisations. Its *many* contacts (*opportunity* '30') could also enlighten a TA about the performance of organisations it intends to collaborate with. An SMEs possible apprehension (*threat* '59') about the performance of collaborative partners could be reduced by a TA. Since a TA that is active in collaborations is likely to have a familiarity with potential partners it is best placed to judge whether they would be good partners or not. Seen as a trustworthy (*strength* '1') organisation a SME should have confidence in its TAs choice of projects and partners.

A realisation was gained into how demanding the EU projects could be on human resources of the TA. As an example the Flexform project required GTMA to contribute 21.75 man months to the project over its three year duration [149]. That would be over seven months of an employee's time each year devoted to the one project. The employee that participated in the projects was chiefly responsible for three, which would equate to all of their time, and more, spent on the projects each year. Therefore, the importance of claiming in-kind contribution from national SMEs was key so that time could be spent by TA employees on all three projects in addition to other technical information collecting and dissemination activities.

6.5.5 Future Study of Collaborations

There are indicators that can be used to study the success of research, such as bibliometric data and peer review [17]. The scope of this dissertation does not cover how successful the research and dissemination activities employed for the

projects that GTMA partook in were. Investigation into the success of EC funded collective research projects in increasing the EU industry competitive edge could be a future project. Instead its own experiences and perceived benefits were drawn upon to offer firmer background information for a UK TA that is considering a similar collaboration. The archetypal SWOTs of a UK TA were taken into consideration. Further more detailed work, with a greater emphasis on empirical study, ought to be completed in the future to analyse the best methods for dissemination and exploitation, which a TA would normally be involved in or take charge of.

6.6 Assessment of Trade Association Conferences

A conference is a prearranged meeting for consultation or exchange of information and discussion. Exchange of information is what a TA needs to nurture within its members so that they can learn from each other. This was not in the original strategy but was later required as a method to disseminate information on the European projects of which the GTMA was a collaborative partner. Further justification for the use of conferences is also given.

Macdonald [3] found that TAs that ran big conferences had a good case to prove their worth as a TA due to the benefits a member would gain from a conference. TAs that ran conferences would reduce their *weakness* of not being able to prove the value of subscriptions if members attended a conference free of charge or at a discounted rate.

It is important that a TA and its members share a common idea on what technologies should be researched and disseminated; otherwise there will be a disinterest in each other's work. Past research has shown a state of heterogeneity can occur when 'poor' media, such as telephone or email, is used to communicate. To remove the risk of a state of heterogeneity becoming too great the GTMA held a conference to give attendees an idea about technologies that could be useful for the toolmaking and allied industries, including information that came from the European Community projects they were involved in. The

conference was entitled ‘Emerging Technologies 08’ (ET08). Another motive was that the National Meetings for the European projects (Appendix 5) that GTMA had were resource heavy and therefore augmenting the lack of resource *weakness* that a typical TA may suffer. A conference would allow all five projects to be presented with the need to organise only one event rather than five. Additionally, it was expected to increase the *many* sources of information that could be used in creating the TBs (Section 6.4), as more contacts would be gained.

Another raison d'être for organising a conference is it would provide networking opportunities for those that attend. It would allow a TA to take advantage of the *opportunity* of ‘informal contact’ as the pre-requisite to formal co-operation.

Organising an event like the Emerging Technologies 08 involved many tasks. Having an organised approach would increase the potential of success and reduce resources being spent unnecessarily, hence lessening a TA *weakness* of lack of resources. A technique called a ‘Product Breakdown Structure (PBS)’ [150] was used by GTMA. A PBS is a hierarchical structure that breaks a product down into its sub-products. It allows a planner to identify what other products are needed to create the final product and what work needs to be completed.

A PBS can be used as an input to producing a Gantt chart. A Gantt chart is a diagram of a plan’s activities against a time background, showing the start and end dates and the resources required. This is important to make sure activities are done on time so that an activity, such as a conference, is completed successfully. If a TA were to fail in its organisation of a conference it would likely lower the opinion – a *threat* – that the attendees would hold of that TA, if not others. The timescale GTMA used for organising ET08, approximately two months, was tight. It is recommended that three months or more should be given for a day conference aiming at twelve speakers and about 80 delegates.

The conference was held at the premises of a member company as it was economical. The same company sponsored the event. This was beneficial to the

host as potential customers (the delegates) came through their doors and they were featured in press releases promoting the conference.

Rather than have a central theme it was decided that many different technologies would be presented, which was in keeping with the many different areas covered by GTMA European projects. It would also promote the cross fertilisation of technology between industry sectors. It was anticipated that by presenting many different technologies it would open up the scope for the type of person that might attend. This would increase networking opportunities.

The presentations given are shown in the agenda for the day, which is presented in Appendix 8. The 'bite-size' chunks of information theme of the TBs were followed. Presentations were limited to fifteen minutes in length. The rationale behind this was:

- More presentations could be presented aiding cross fertilisation of information
- Due to the variety of topics covered it meant that an attendee would not have to listen to a topic that was of no interest for too long. In the first instance it would also increase the chances of attracting attendees
- A bigger number of members could benefit from giving a presentation

A few exceptions were made for this rule. The speaker from the sponsoring company and any presenter travelling from abroad was given half an hour as a 'thanks' for the extra effort.

The quality of presentation would reflect on the quality of the association. For this reason presenters were requested to provide their presentations two weeks before the event so they could be checked and changes made if appropriate. Guidelines on how to create a suitable presentation were given to the speakers. Much of the guidelines were generic and can be used by a TA wishing to hold a similar event. The guidelines covered items related to formatting of PowerPoint presentation slides and advice on how to make a good presentation. Most importantly the guidelines emphasised that presentations must not be sales pitches – just like the articles in the TBs could not be.

Even though guidelines were given some presentations still incorporated a sales pitch. This reinforced the remark in Section 3.2.4 that a denunciation of external experts is that the sales pitch would often accompany provision of information. This indicates that the company's presentation would be bias towards their own products and or services, which could affect the credibility of the source. This said the members that gave presentations and those that hosted Hot Desks put in a lot of effort to do well on the day. This opposes the credence that members do not usually put in as much effort as what they should do [3]. On the other hand the twenty or so members that took part represent only a small proportion of the total membership. It is supposed that these members had the prime motive to sell their services or products on the day, which would satisfy the 'what's-in-it-for-me' syndrome [94].

Non-members were invited to attend as well as members. The grounds for this were:

- Inviting non-members was likely to increase the attendance figures and hence increase the networking possibilities
- It provided an opportunity to speak to potential new members
- GTMA members could show those outside of membership, including their customers, that they were 'technologically advanced', which would help better the perception of their industry. Heseltine [3] recommended that TAs should improve the way in that their members industry is perceived
- It opened up the possibilities of members being able to talk to potential new customers, including some Original Equipment Manufacturers (OEMS)

No charge was made for attendance. The fact that typically a majority of TA members are small companies influenced this decision. Smaller companies are likely to have less money to spend on TA activities outside of their normal membership subscription. Members of a TA usually expect to be offered the delegate fee of a conference at a reduced cost or at no cost at all. Some TAs in the past has not done this and thus has reduced any potential value for their

members. Concentration on running a TA as a commercial business has gone too far to the extreme in some instances. Boleat warns that *"if an association seeks to become a commercial body it will become one but it will cease to be an adequate Trade Association"* [107].

Features of a conference ought to facilitate the exchange of information. It was believed that an important part of the event for attendees and speakers would be networking. One way of facilitating this was to offer members space for exhibiting their company and technologies during breaks. These areas were referred to as 'hot-desks'. Eleven hot-desks were made available free of charge to speakers and at a small cost (£50 plus VAT) for GTMA members. A booklet giving a description of companies that were hosting a hot-desk was produced so that attendees were aware of who was exhibiting. Another booklet was created giving succinct biographies of the speakers, which was done to show that speakers were proven experts in their fields, hence validating the quality of the source of information.

Most presentations could be classified as an external primary source. According to West's classifications [14], the detail of information was therefore high and unique information could be obtained, which is typically regarded as more valuable. This is especially so as the oral dissemination of information would deliver tacit information that is often embedded in people's minds [16] and hence not easy to disseminate using other methods like publications. Many sources of information were available in one place at the conference. Both external experts and university academics gave presentations and publications were available at the Hot Desks.

The name badges were seen as an opportunity to facilitate networking and the exchange of information. Information included on name badges was:

- Attendees name
- Company name
- Logo of European project if they belonged to one
- Hot-desk logo if their company was hosting one
- Speaker symbol if applicable
- Symbols to indicate what people were interested in and what they were experts in (explained below)

A symbol and colour coding system was employed to show who experts in specific technological areas were and who wanted to learn more. A person upon seeing a name badge could more easily perceive whether someone would be of interest to them. It would also act as an icebreaker as there would be a topic known that was relevant to the other person. It was encouraged that people whose colours matched and who had opposite symbols would be a 'perfect match' because one would possess knowledge that the other wanted. Name badges would also serve a purpose for the TA. After collection of the name badges, at the end of the event, they could be analysed to determine what technological area had the most experts and what technological area was most desirable for attendees to learn about.

6.6.1 Results

Approximately 80 people attended the ET08 conference. This was considered a feat by GTMA as in the past it has been hard to attract a similar size of audience. A variety of companies attended from small to the large Original Equipment Manufacturers (OEMs). Many tiers of the supply chain were represented, which was an intention for the conference. The trade press reported positively on the event (see Appendix 9); thus satisfying promotion of GTMA and its members in a positive light.

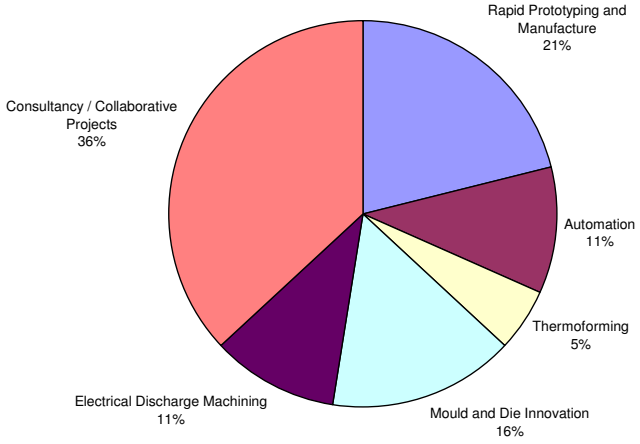

Figure 24: Pie chart to show the distribution of technologies that ET08 attendees claimed they were experts in

Of the 80 attendees 56 of them returned their name badges. Twenty-six of these had been used in the manner in which they were intended, as described previously. The return rate represented about 33% of those that attended. Figure 24 shows that the largest number of attendees claimed that they were experts in consultancy/collaborative projects (36%), followed by rapid prototyping and manufacture (21%). No one claimed to be an expert in cryogenic treatment or incremental die-less forming.

It was no surprise that most attendees claimed to be experts in consultancy/collaborative projects as many of the presentations were focused upon European funded projects. Chang's [32] proclamation that companies or organisations that already participate in collaborations are more likely to be involved in further collaborations can provide the allusion that these companies are likely to be on the lookout for future collaborations and consequently they would attend conference to build future relations.

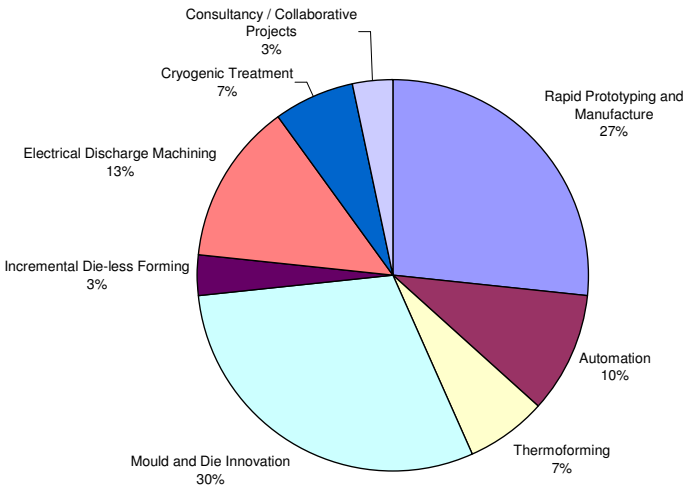

Figure 25: Pie chart to show the distribution of technologies that ET08 attendees wanted to learn more about

For those technologies that attendees wanted to learn more about (Figure 25) mould and die innovation was in the biggest demand, with almost a third of attendees interested in it. Rapid prototyping and manufacture closely trailed the popularity of mould and die innovation. All subject areas included in the colour coding scheme for badges had interest from attendees. The least popular ones, who both only appeared on three percent of badges, were incremental die-less forming and consultancy/collaborative projects.

The idea of the name badges had worked well to give the GTMA an idea of what technologies attendees wanted to learn more about. Upon reflection it was realised that those technologies highlighted as being of most interest would not encapsulate all technologies that could be considered by GTMA members. This was because the choices were restricted to the topics that presentations on the day covered. This was logical as the intention was to match needs with the sources available on the day, which took the form of external experts and university staff.

A questionnaire was given to all attendees of the ET08 event (Appendix 12). It took the basis of the template offered by the online survey provider that GTMA uses and points

from Section 6.2 were considered to improve upon this. This meant there was better use of the TAs resources. A lottery scratch card was offered to the first 20 people who completed the questionnaire as an incentive. Jobber *et al* [114] showed that the bigger the incentive the more likelihood the response rate will be higher. For a TA to offer a bigger incentive it would be an even bigger strain on resources that are possibly already strained. Hence, by offering a scratch card the incentive was massive, a chance to win £100,000, but the TA only needed to spend £20.

The incentive worked well seeing that the **sample size** for the conference questionnaire was 19 companies. Eighty companies had been given the questionnaire. Therefore the **return rate** was 23.8%.

All respondents stated that the conference fulfilled their reason for attending. A minority of those (16%) said that the conference partially met their expectation. More positively, the large majority (84%) affirmed that the event 'absolutely' met their expectations.

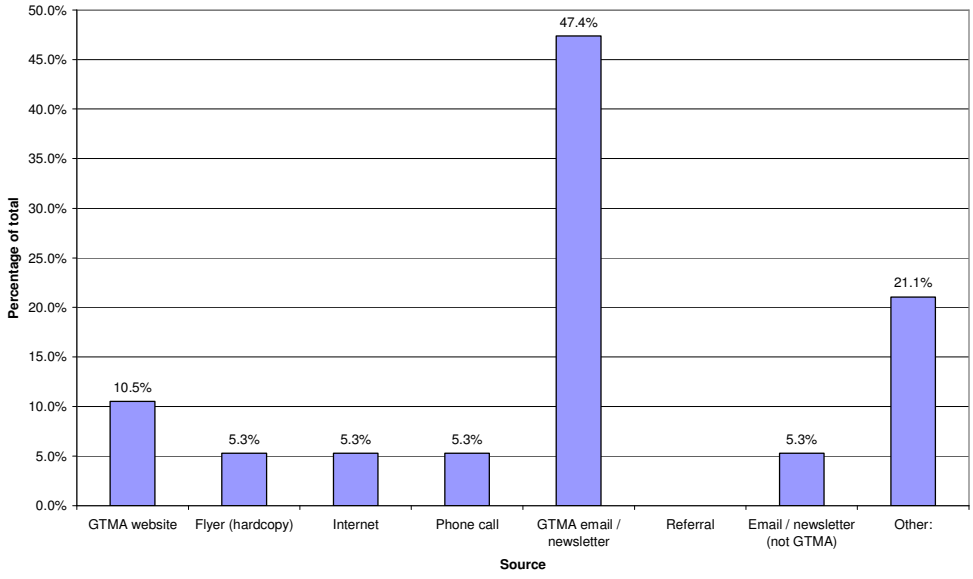

Figure 26: Column chart to show the source those attendees heard about Emerging Technologies 08 conference from

Figure 26 shows what methods were best in promoting ET08 to potential delegates. This is important for a TA to know so that in the future it uses the most effective method to get better efficiency from spending its resources. By far

the top method was GTMA email/newsletter, which included sending information via the TB route. This was followed by 'other' and then 'GTMA website'. The least useful method was 'referral', which no one had utilised. All other methods had equally been used by 5.3% of recipients.

It was anticipated that emails or newsletters emanating from organisations other than GTMA would have been the most effective. The event had been promoted through the trade press, which would have a much bigger audience than GTMA's correspondence. However, the trade press attract many stories from many companies presenting much more competition for GTMA's information to attract the attention of the reader.

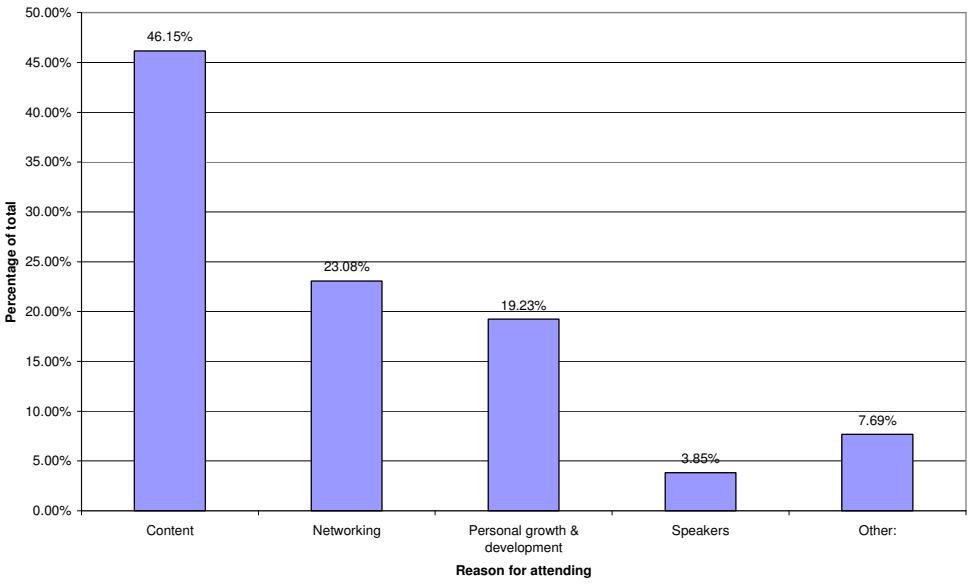

Figure 27: Column chart to show the reasons why delegates attended the Emerging Technologies 08 conference

If a TA understands delegates motives for attending a technical conference it can alter the way it conducts such events. TAs nowadays are generally flexible – a TA *strength* – and should be willing to alter its practises. Figure 27 shows that a sizeable majority of recipients considered the 'content' of the conference as their most important reason for attending (46%). This was followed by 'networking' and then 'personal growth and development'. The least popular reason for attendance was 'speakers'. For those that answered 'other' the reason given was to gain awareness of technologies.

The delegates saw networking as an important source and that there was expectation knowledge would be gained from conversation. Hence disparaging Hanrahan's [11] suggestion that using tacit knowledge as a source would be difficult as people would be apprehensive about sharing their knowledge. Then again, much information may be distorted due to the bias some members had in their presentation through promoting their own products and or services. This would advocate that credible, unbiased, tacit knowledge is difficult to obtain.

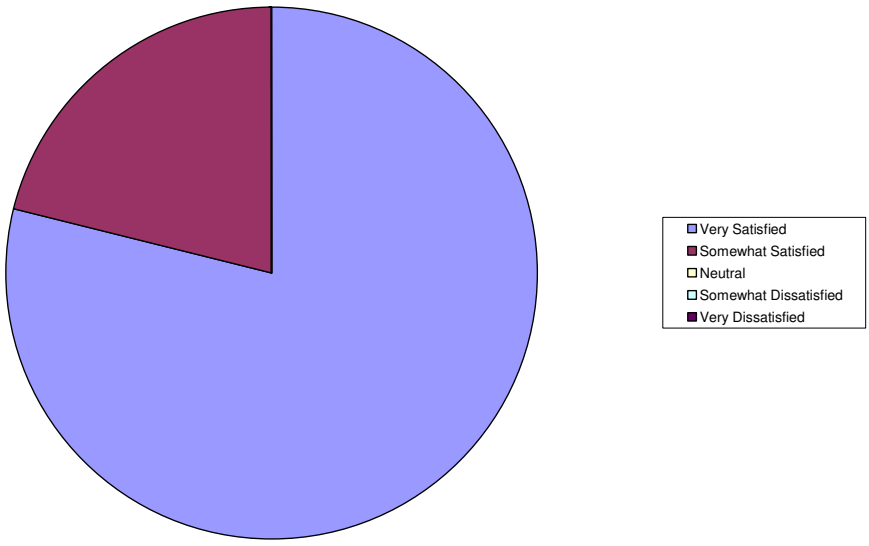

Figure 28: Pie chart to show how delegates rated their overall satisfaction with the content of the Emerging Technologies 08 conference

A huge majority (80%) of those asked were 'very satisfied' with the content of the conference, as can be seen in Figure 28. The remaining 20% expressed that they were 'somewhat satisfied'. No one had a neutral or negative judgment on the content.

The fact that a huge majority of respondents to the Emerging Technologies questionnaire were very satisfied with the contents of the conferences bodes well. It cannot be deduced what were the main factors that could have contributed to the good quality conference. There are numerous factors to consider like the

choice of speakers, the effort of the speakers or the guidelines given to help speakers et cetera. Further research into producing conferences may uncover this.

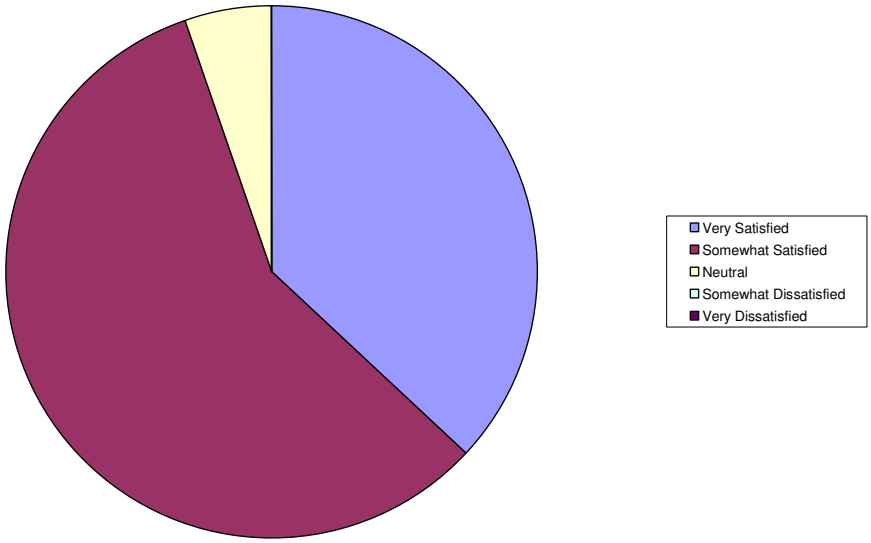

Figure 29: Pie chart to show the delegates rated their overall satisfaction with the networking opportunities at the Emerging Technologies 08 conference

Figure 29 illustrates that over half of the respondents to the questionnaire were 'somewhat satisfied' with the networking opportunities provided for them at ET08. The next biggest response was those that were 'very satisfied' (37%). Only one person was neutral in their opinion of the networking opportunities provided.

Table 11: Table to show the comments delegates made about what they thought was the most beneficial aspect of the technical conference

What was the most beneficial aspect of the conference?
1. The opportunity to see and hear how the various technologies have developed recently
2. Ability to have an overview of emerging technologies - length of presentations was perfect - especially with the ability to ask questions in the breaks
3. Opportunity to have number of speakers talking concisely about interesting projects
4. A lot of expertise in one room
5. Flexform was very interesting to me as it is a technology we could use. Also T-ForM as we manufacture vac-form tools for one customer but we do not have a lot of experience in that type of tooling
6. Picture it painted of the state of the art in commercially available manufacturing techniques
7. Networking
8. Finding out where Walt Disney's head was. No - really evolution was very good and interesting
9. Updating on EDM & metal sintering
10. Chatting
11. Information gathering
12. Learning about cooling channels in laser sintered components

An open-ended question was used as a catch-all to find out what aspects of the conference attendees felt was most beneficial, which is presented in

Table 11. Comment five makes reference to two of the European projects that GTMA participate in (Appendix 5). The eighth comment refers to one of the presentations given entitled 'Who's got Walt Disney's Head?', which was based on cryogenic treatment [151]. An article on this subject can be found in the second issue of the GTMA Technical Briefing, Appendix 3.

Largely responses indicated that the varied content of the presentations was the most beneficial aspect of the conference (comments one, two, three and four). Following this, with an equal number of comments, was networking (comments two, seven and ten) and an interest in specific technologies (comments five, nine and 12). The classification of the comments needs to be taken with caution as somebody's interpretation of the comments may be different to that meant by the person who wrote it. Nevertheless the analysis of

Table 11 corresponds with the results shown in Figure 27 if the variety and specific technologies presented are considered 'content', hence receiving a total of seven comments making it more significant than networking.

Table 12: Table to show the other topics or themes that would be of interest to them at a technical conference

What other topics or themes are of interest to you for a conference:
1. Hot runners
2. CAD/CAM developments
3. Selective laser melting issues such as: a. Surface quality improvement b. Tolerances c. Costs of typical inserts
4. Networking
5. Any better faster techniques in manufacturing of mould tools especially in Electro Discharge Machining
6. Rapid prototyping
7. Gas/water injection and blow moulding

It was important for the GTMA to use the questionnaire as an opportunity to find out what other topics or themes, other than those covered at the conference, delegates were interested in; hence, this question was posed. Seven out of the 19 recipients answered this (see Table 12). These will provide the initial ideas of topics to be covered at the next Emerging Technologies event.

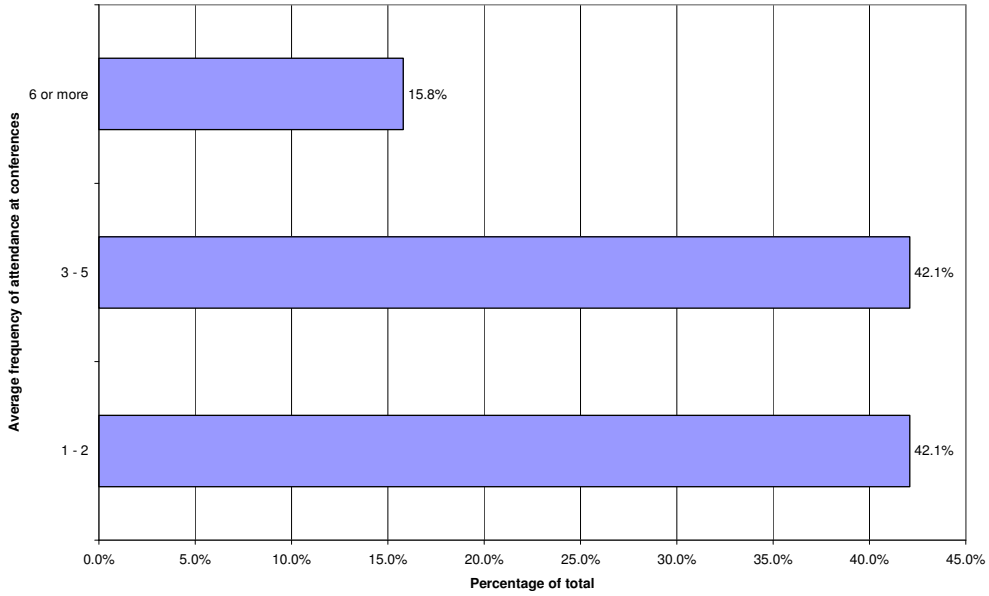

Figure 30: Bar chart to show the average number of external technical conferences/seminars that delegates stated they attend per year

Recipients of the questionnaire were asked to select one category, out of three, that best described their average attendance of technical conferences/seminars in a year. The results, Figure 30, showed that people are least likely to attend such a conference six or more times a year. The two other categories, once to twice a year and three to five times a year, were equally chosen (42% each). This exacerbates the threat of other TAs as competition to attract industry to oral dissemination methods like conferences or seminars would be high. Further work into the effect of charging and by how much for such events would help a TA attract the maximum number of delegates.

6.7 Concluding Remark

The three principal components from the strategy for a technology foresight approach by TAs (Chapter 5) were implemented using a test-bed TA:

1. Utilising IT communication capabilities.
2. Newsletters.
3. Collaborations.

Utilising IT communication capabilities did not achieve much success. In contradiction to previous research by Hanrahan, who said setting up online services was costly, freely available online services were utilised, such as online meeting tools and discussion boards. Even though access was free to members there was not much uptake. This supported De Souza's research that stated it was notoriously difficult to encourage and maintain participation in online communities.

As per the strategy hardcopy newsletters were used to disseminate technical information to TA members. Feedback through a questionnaire showed that all respondents had a favourable reaction to the hardcopy online newsletter. The short lengths of the articles were deemed by 91% of respondents as suitable, which was inline with previous research. The results of the questionnaire showed that the members preferred delivery format would be by email rather than hardcopy via the post. This led to a revision of the process for disseminating technical information, which included producing online newsletters.

The online newsletters proved to be successful in monetary terms as an 85% cost saving was realised in comparison to hardcopy newsletters. The Email Service Provider used to send out the online newsletters worked well as it needed no specialist computer skills from the user. Furthermore, it autonomously managed the recipient database and automatically generated statistics, such as open rates, that could be used as parameters to determine the success of newsletters sent. The average open rate of 28.5% was deemed a success when comparing it to the 29% open rate of the biggest association in the world, NAR.

Action research was employed to develop generic recommendations for how a TA could better work in collaborations. The threat of developed technology being seen as unexciting was shown to occur as a result of the long-term scientific approach of the EU projects that the test-bed TA participated in. Limitations on dissemination of EU project results were experienced, which coincided with Howells *et al* statement that collaboration with industry can restrict the free flow of information. Due to misinformation provided to the project consortium about budgetary information a drain was put on monetary

resources. This was because the TA received les money from the project than originally anticipated. Furthermore, the EU projects demanded a lot of time to be spent by a TA which took time away from other technology foresight activities. Something that proved to work well was encouraging the participation of LEs, in face-to-face national project meetings, in order to attract SMEs to the project. It also helped communication along the supply chain.

Current research by others on collaborations is in the early stages of development and mainly focus upon industry-university collaborations. The research in this dissertation has added to current research by focusing on university-trade association-industry collaborations.

Conferences were also implemented, which did not form part of the original strategy. It stemmed from the need to disseminate information on collaborative projects in an economical way, therefore creating a synergy between the different components of the strategy. The conference proved to be successful as 100% of respondents to a questionnaire about the conference said that their reason(s) for attending were fulfilled.

In order to effectively determine the success of a strategy implemented feedback needs to be obtained. Questionnaires got higher return rates when a personal incentive was used, hence satisfying the 'what's-in-it-for-me' syndrome, which supported previous research. Research fatigue of members should be avoided and one way this was achieved was by using an Email Service Provider, for online newsletters, that generated statistics automatically. Future work should include identifying further parameters that can be used, especially those that are unobtrusive.

7 Proposals Following Investigation into Prioritised Technology Foresight Practises for Trade Associations

7.1 Introduction

A revised strategy is given in this chapter that can be used as the foundation for a Trade Association that plans to provide technical information to its members. It aims to improve the strategy that was presented in Chapter 5. The format for the revised strategy has different headings which were deemed more suitable. It encapsulates the factors that are likely to influence the provision of a technical service (Chapter 5) and recommends an initial approach to setting it up – based upon the experiences of the test-bed Trade Association (Chapter 6).

7.2 Improvements to a Strategy for Technology Foresight by Trade Associations

7.2.1 The Need for Integration of Components

The provision of technical information includes utilising many sources of technical information, many processes that can be used to collect it and many methods to disseminate the information gathered. The test-bed showed how three main mechanisms were implemented – collaborations, conferences and technical briefings – to provide technical information to its members. It is important that the mechanisms are integrated as they can share the same sources and methods for collecting and disseminating information and that a synergism exists. This is shown in Figure 30 by the source and dissemination arrows between the three mechanisms. For example, the Emerging Technology conference (item '1') exploited the results from the European collaborative projects (item '2'). The collaborative projects benefited as the conference gave a suitable oral medium to disseminate its results through. Creating synergism amongst the methods employed by a TA is very important so that their archetypal lack of resources is

not further exacerbated. To realise this it is recommended that an individual within the TA is given the responsibility to coordinate the methods used to provide information.

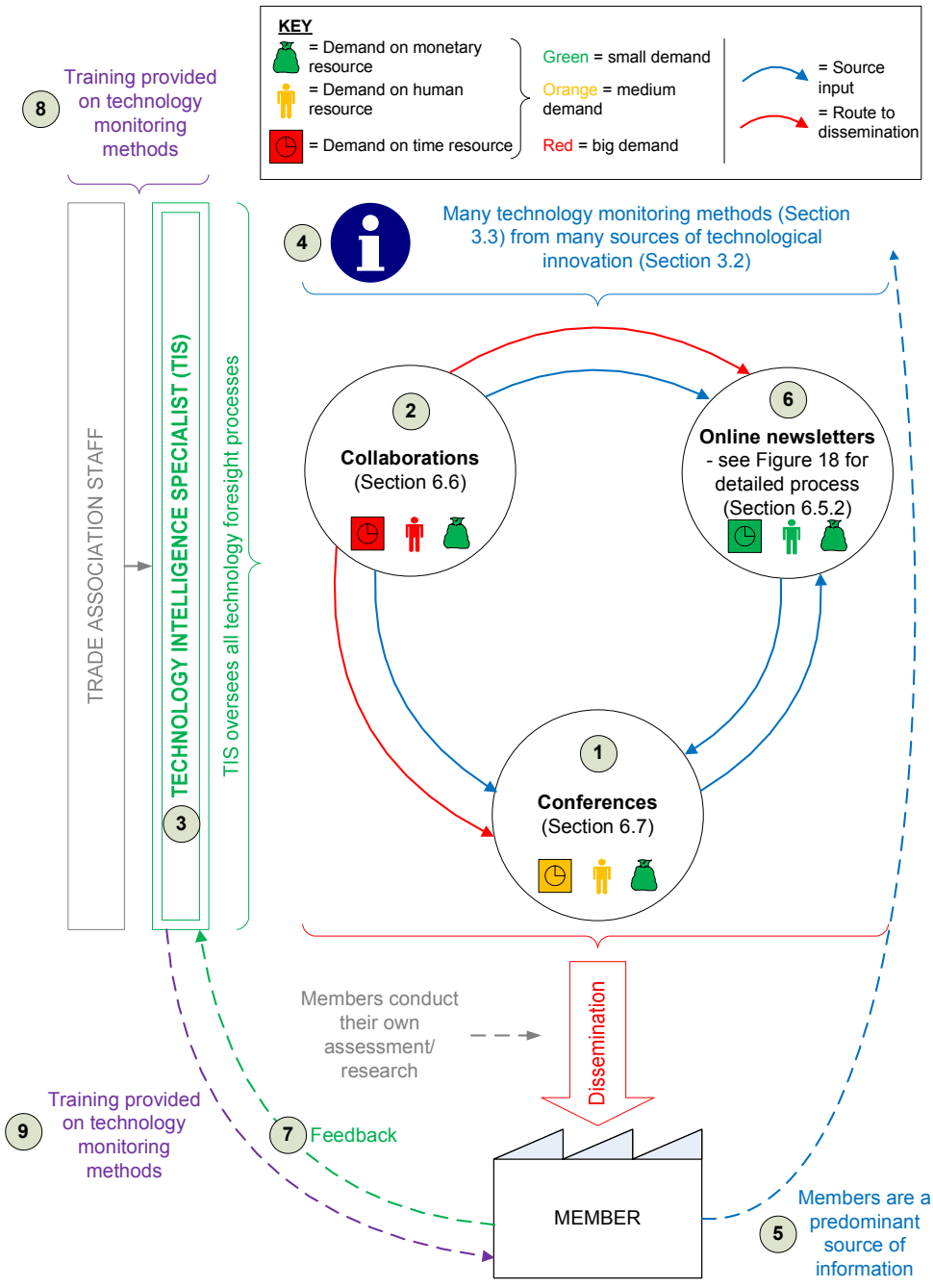

Figure 31: Trade Association process for providing technology intelligence to small and medium sized enterprises.

The individual within a TA that coordinates the technology intelligence processes is referred to as the Technology Intelligence Specialist (TIS) (item '3'). They are responsible for designing and maintaining the technology intelligence process and promoting it both internally and externally. In addition to this they are the scanner, analyst and disseminator and are expected to develop their knowledge on technology intelligence process. It is recommended that a TIS has a relevant technical degree qualification so that they can interpret information appropriately. They must show evidence of being a good communicator, especially with good writing skills and it is desirable that they are able to motivate the rest of the TA team to 'buy into' the value of providing technology intelligence. Previous research had shown that ancillary staff to the technology intelligence service may provide falsified in inaccurate information to a TIS if they feel unmotivated by not being included in technology intelligence activities.

For larger TAs there may be the resource to employ more than one TIS and the processes can then be split between them. For those TAs that find it difficult to find someone with the relevant competencies they may wish to utilise the expert knowledge of the Chief Executive Officer or staff with a technical background.

So that the other staff of a TA can understand the technology intelligence process, and therefore more likely support it, training will be provided to both the TIS and other members of staff (item '8'). Past research had shown that the sole delegation of information gathering to a TIS can create information distortion so by other staff participating this should be circumvented. It will also reduce an over reliance on one person and other members of staff should be able to facilitate the service.

7.2.2 Sources: Exploiting Trade Association Resource Base

There are a multitude of sources available to exploit (item '4'). It is suggested that a TAs many members are considered first (item '5'). The test-bed TA demonstrated that its members could be successfully used as the main sources for two of the mechanisms implemented, conferences and the technical briefings.

The common problem inherent with using members is with them having an ulterior motive to sell their own problems. This creates the possibility of bias information, and subsequently information distortion, or the risk of a sales pitch accompanying information which would diminish the credibility of the source. It is advisable to give members guidelines on submitting information, especially discouraging sales pitches. Based upon the limited effect the test-bed had in enforcing guidelines a TA should make a member sign a contract agreeing that they will adhere to them. To encourage members the 'what's-in-it-for-me' must be satisfied. Second to members as a source university contacts ought to be used as they were enthusiastic to share their expert knowledge with less of a partiality than members.

European collaborations that TAs participated in are seen as a source of information that was very resource heavy. A member of staff's time could quite easily be taken up by a European project, hence not leaving enough time to spend looking at other sources. Much consideration should be given to joining collaborations if manpower is already a weakness for a TA. For each component of the strategy (items '1', '2' and '6') Figure 8 provides an indication of the demand that each component puts on a TAs monetary, human and time resources. A colour coded 'traffic light' system is used with red showing the biggest demand and green the least demand. Collaborations clearly demands the most resources from a TA.

Even though past research had implied tacit knowledge is difficult to obtain it is strongly recommended that a TA tries to exploit it, which goes with using members as the predominant source. This is because it is often regarded as more valuable than other migratory sources of information, like books. A conference that allows plenty of opportunity to network can greatly aid the transfer of tacit knowledge.

The **credibility** of sources for technological innovation exploited can have implications for the quality of information disseminated by the TA. If the TA was to disseminate poor quality information this could have a negative impact on a member. For each source utilised the TA should assess at least the authorship,

timeliness, purpose and content of the information in order to determine whether the credentials of the source are good enough for inclusion in the TAs technology intelligence provision. During implementation the TA did not have the resource to conduct an assessment on each source. Considering a majority of sources are TA members it may not be worthwhile spending much time assessing them individually due to the fact that if their contribution is rejected they will not receive a benefit and may question the value of their subscription. However, at the same time a TA needs to ensure that the information it disseminates is perceived as credible. If a TA maintains good quality dissemination it should be seen as a credible author/editor/provider. The online newsletters must be sent out regularly and on time (timeliness). It should maintain an unbiased entity so that members trust its purpose and quality checks should be in place to ensure that grammar and punctuation of written material is perfect (content). Future work that could assist assessing credibility of sources is given in Section 8.2. Through experience a TIS would gain a better idea as to what sources are credible and what ones are not.

7.2.3 Technology Monitoring for Trade Associations

Collection methods should not be used in isolation. Information Technology can certainly offer opportunities to collect information in more efficient ways but the cost of using software, such as VantagePoint for patent frequency analysis, can be too high for a Trade Association. However in line with the tradition of the internet there are many free tools that can be employed to search the internet, which encompasses many sources, more effectively like Google Scholar, Resource Discovery Network hubs and free journals offered by the Public Library of Science. The test-bed TA employed only a few collection methods that had been identified. This was largely due to lack of human resources to use more than several methods. It is believed that with supplementary training additional methods could be used but this must be supported by the leadership of the Trade Association.

In essence members were used as expert panels to gather information from, but in a more loose way than its usual implementation manner. It is warned that a Trade Association must look out for the Halo or Horns effect where the respect or disrespect for a panel member may influence the assessment of a technology. Those companies, especially with a strong sales team, may shout loudest about their technologies and this should not sway a Trade Associations view in relation to what technologies to collect or not. Means of accessing tacit knowledge like informal networking, demonstrated through networking through collaborations and during conferences, are important to implement.

7.2.4 Technical Information Dissemination Methods for Trade Associations

It is advocated that an electronic method, over a hardcopy method, is used to disseminate migratory information (item '6'). As demonstrated by the implementation of the Technical Briefings sending information through the medium of email is more resourceful. Moreover it generates feedback (item '7'), through open rates et cetera, without the risk of annoying members or creating research fatigue. For the format of an online newsletter the articles ought to be succinct. Again, appropriate training of staff (item '8') to teach good writing and editing skills is proposed. The revised process for producing a technical newsletter, presented in Figure 19 (Section 6.4.2.2) should be used for creating the technical newsletter. It should be noted that feedback will be hard to obtain.

Face-to-face methods have got to be used in conjunction with electronic dissemination to prevent heterogeneity between a Trade Association, its members and industry becoming too high. Hence, regular conferences can moderate the level of heterogeneity and it is also an effective way to capture the all important tacit knowledge. For conferences it is recommended that non-members are also invited in order to capture the knowledge of those outside membership. It would also encourage creation and maintenance of supply chains, which in turn promotes innovation. Also, it increases the potential of members

who are willing to be an active source of information by offering sales opportunities, hence satisfying the 'what's-in-it-for-me' syndrome.

European project collaborations were very limited to the number of members that they would benefit, mainly limited to the core and national SMEs, with the former receiving the most valuable information. If a TA wants to serve as many members as possible then the European project collaborations are not the way. However, there are many different ways to be involved in collaborations that should be explored.

7.2.5 Overview

Only a small number of sources and collection methods had been used for the test-bed due to the demand of the methods implemented in terms of manpower. It had been identified that resources are a weakness of TAs so the same problem is likely to be met. It is suggested that a TA thinks about educating its members on the methods that it does not utilise (item '9'). Even though the TA would be providing information on technology it is important that the members conducts their own research, otherwise they risk inhibiting their innovation. Educating members on sources and methods that can be used would encourage them to complete their own research.

Taking into consideration the above three main mechanisms for providing information, focused upon in this dissertation, are presented in order with the most highly recommended one first:

1. Conferences
2. Online newsletters
3. European collaborations

Utilising information technology communication capabilities, which was proposed in the first strategy, has not been incorporated into the revised one. This is due to the difficulty the GTMA found in implementing it, which reinforces

past research that states it is difficult to set-up and maintain an online community.

Even though the above mechanisms were implemented using a test-bed, that was deemed representative of a typical Trade Association, an organisation that is planning to provide a technology intelligence must identify its specific strengths, weaknesses, opportunities and threats that would influence its own strategy.

8 Conclusions

8.1 How the purpose of the study has been met

The nature of technology management meant that the research needed to cover many disciplines, such as economics, business, politics, engineering, science, information technology, psychology and sociology. This presented a challenge for one person, the researcher, to explore and understand elements of each discipline. It demonstrates a limitation of small scale research. Priority was given to the elements that were deemed most relevant to the role of TAs and to the aim of the research.

The research has fulfilled its purpose in examining the how a strategy for UK Trade Associations, related to engineering, to provide technical information to members was developed. Three key parts form the basis for offering such a service: sources; methods of collection; means of dissemination. Past research had focused upon the application of the aforementioned on companies, especially large enterprises. A Trade Association differs to companies, primarily in that its function is to serve the needs of its member companies. Therefore a diversity of factors, some dissimilar to companies, influence its capabilities for using sources and methods for collection and dissemination. Relating these factors to make recommendations as to what sources and methods are most appropriate specifically for a Trade Association points towards the originality of this research.

8.1.1 Objective 1

The factors that are likely to influence the provision of technical information have been mainly satisfied by the creation of the strengths, weaknesses, opportunities and threats (SWOT) analysis. In Section 5.3 the SWOT encompasses 65 factors that could influence provision of a technical service and prioritises the use of resources and capability for technology foresight. A massive amount of time was spent studying a multitude of materials to generate a

comprehensive SWOT. It is therefore a helpful outcome as TAs will not have to do the same as they can use the SWOT presented in this dissertation as a template. It was a suitable tool to use as it is easily understandable and hence can straightforwardly be implemented by a TA to determine its own specific potential influences and to reflect the continuously transforming and new SWOTs that are born.

8.1.2 Objective 2 to 4

For objectives one through to four many sources and methods for collecting and disseminating technical information where identified and some of the inherent advantages and disadvantages where given. A majority of these sources were identified prior to the creation of the SWOT analysis. In hindsight, it may have been best to complete the SWOT first to help narrow down the number of sources and methods that were not employed by the test-bed TA. On the other hand, it is valuable that many were given so that a TA has a broader knowledge of what can be implemented. It was commented that some methods, which are currently expensive, might become much more affordable, or even free, in the future. Therefore it is important that a TA is made aware of this. It was hard writing about some of the sources and methods separately as their inputs and outputs could be interlinked, yet it felt important to present them separately with the intention that they could be more easily referenced.

Much effort had been wielded to find information on technology monitoring process but it was not easy to find. The difficulty could be attributed to the sensitive nature of technical information as it can be used to gain a competitive edge over competitors.

Information Technology, especially the internet, is central to the provision of technical information – sourcing, collection and dissemination. The inherent difficulties with using Information Technology were substantiated. Previous research, for example De Souza *et al* and Hanrahan, remarked that technology alone cannot lead to innovation but social aspects have to be considered also. Results of this research showed the importance members put on networking and

how it increased chances of involvement in future collaborations, if already collaborating. Further to this meeting face-to-face was perceived of great importance to prevent the heterogeneity of information amongst the Trade Association, its members and industry becoming too high.

The dynamic nature of technical information and of the methods to distil it was recognised. Changes in access to sources could be foreseen, for example the possibility of groups succeeding in making access to online journals free of charge. Another issue includes the changing workforce, due to reasons like retirement, and how this can deplete tacit knowledge or how it can affect the rate of uptake of new technologies used to provide technical information. The implication of this is that Trade Associations that wish to provide technical information to their members should be aware of any new influences. That said the methodology presented in this research can be used to make them aware of the potential influences and how this may affect them.

8.1.3 Objective 5

Only a few mechanisms, that incorporated only a few of the sources of technical innovation and technology monitoring methods, were implemented using the test-bed TA. This was largely due to the limitations of human resources that could be spent, just the one researcher, and the monetary resource, as typically a TA does not have much to spend on such work.

Gaining feedback and finding parameters for gauging the success of the mechanisms implemented was troublesome, although an evident limitation is that not all members can be expected to give feedback. Questionnaires are known for having low response rates and this was experienced. Techniques suggested by the likes of Jobber *et al*, like incentives, were drawn on to improve questionnaire return rates to a degree of success. Research fatigue meant that the difficulty in gaining responses would increase each time a questionnaire was sent out. Therefore any subsequent questionnaires to the first, which were sent to the same recipients, got a very low return rate if any at all. More automated feedback

mechanisms were used later on in the project, for instance open rates for online newsletters. Ideally other mechanisms should have been identified and used. This was not within the time limits of implementation, especially considering the research was conducted within a real commercial environment that needed things to move forward quickly. More parameters came to light too late in the research. For example usability tests [15], can be used to test the degree to which texts effectively and easily enable people to accomplish their goals. The preference is to use less invasive techniques, akin to monitoring open rates of newsletters, so that research fatigue, common to questionnaires, can be avoided. Suggestions for future areas to look into to find more and potentially better parameters and feedback means were given.

Utilising IT communication capabilities (Section 6.3) did not work well at all even though freely available services were utilised. This was in-keeping with previous research. Therefore, this mechanism was not incorporated into the improved strategy presented in Chapter 7.

The progression of hardcopy newsletters to online newsletters worked very well. It was able to provide unobtrusive feedback in the form of open rates, as recommended above. It resulted in a cost saving when compared to hardcopy newsletters. Also it did not require any specialist computer skills to create and send an online newsletter. Furthermore, it automatically managed certain aspects of the contact management database, which addressed a weakness of a typical TA.

Keeping information disseminated short in length worked well for both the newsletters and for the conference. It worked well for the newsletters because it allowed a reader to scan through the newsletter quickly to identify if any articles were relevant. For the conferences succinct presentations allowed more presentations to be made that increased the possibility that a technology innovation would be of interest to the audience. Furthermore, it promoted cross fertilization of technologies.

8.1.4 Objective 6

The discussions about the implementation of sources and methods (Chapter 6) related how well, or not, they had built upon the strengths, diminished the weaknesses, exploited the opportunities or resolved the threats of a TA. This fulfilled objective six. This was then used to make recommendations (Chapter 7). There were too many SWOTs to remark on each one individually and consequently those that were perceived of most significance were presented.

The factor of a TA's resources, or lack of, was exacerbated by the test-beds participation in EU collaborative projects. They took up a majority of the Technology Intelligence Specialist's time and due to misinformation, regarding budget, provided to the TA it did not receive the financial income from the collaborations that it had planned for. Restrictions were also enforced onto the TA as to what information it could disseminate, which coincided with Howells *et al* statement that collaboration with industry can restrict the free flow of information.

8.1.5 Objective 7

A strategy for technology foresight approaches for a TA was established before implementation (Section 5.4.2) and then tested using the test-bed TA. Lessons learned from implementing the strategy were then used to create an improved strategy and to provide recommendations to aid a TA in implementing and providing engineering related technical information to its members. A new component to the strategy was added, which was conferences. The conference that the test-bed TA held was very successful as it was an economical use of resources, considering the size of the audience, and it created a synergy with the other components of the strategy by providing inputs and outputs for the technology intelligence service.

The strategy gave recommendations that a Trade Association can use to implement a technical service provision itself. The most usable source of information was a Trade Associations' many members, in particular their tacit

knowledge. This went against the grain of previous research, namely West, Hanrahan and Chang, that said tacit knowledge was the most difficult to use due to its embedded nature. The success and top recommendation of utilising conferences, based on the Emerging Technologies event, supported the use of tacit knowledge. The uniqueness of tacit knowledge made it valuable and also differentiated the information a Trade Associated could offer to members in comparison to other sources that could be used. The high possibility of noise from the bias interpretation of members, caused by ulterior sales motives, was shown.

8.1.6 Overview

Into the research it was realised that any strategy suggested could become obsolete quickly due to the constantly changing world of the methods available for collecting and disseminating technical information. However, the revised strategy can be adapted to suit other TAs.

The research is thought to have high originality as no other research had been encountered that explicitly focused upon TAs providing technology intelligence via utilisation of many sources, technology monitoring methods and appropriate means of dissemination. The value of focusing on a TA is that it can reach out and benefit many companies.

All in all, no matter how much technical information a TA sources, collects and disseminates to its members, in order for it to be of benefit the members must embrace it. If members do embrace it the provision of technical information should increase members' potential to succeed against competition by raising the technical content of their products and services, with the proviso of a TA providing members what they need.

8.2 Further Research

Future work ought to look at assessing technology intelligence methods that were not implemented within this research. Perhaps just either sources of technological innovation, technology monitoring methods or dissemination methods ought to be looked at so that the number of techniques to implement are not overwhelming. It is plausible that other research has assessed the pros and cons of methods identified in this dissertation in more detail, but it is unlikely that this would be specific to TAs.

It is important that the credibility of sources of information is assessed before they are used by a TA. This will prevent a TA disseminating information with poor credentials that could be detrimental to the member if they act upon the information received. Further research could be conducted into developing a matrix that TAs could use to score the credibility of resources in order to quickly assess whether it should be used or not.

The research on technology monitoring and dissemination techniques found for this dissertation was mainly focused upon large companies. More work must be completed into making technology monitoring and dissemination techniques more accessible to smaller companies and organisations. The researcher has recently become involved with a the newly formed Visual Strategy Network [152], led by the University of Cambridge and Loughborough University, which aims to make visual techniques like Roadmapping (Section 4.3) more robust and accessible.

Appendices

Appendix 1 – 'The real cost of tool, die and mould manufacture' paper

This was presented at the 6th International Conference on Industrial Tools and Material Processing Technologies, Bled, September 11th-14th 2007.

The Real Cost of Tool, Die and Mould Manufacture

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Abstract

As more companies look to outsource their tool, die, and mould manufacture it has become apparent that there is a need to outline all the factors to be considered when selecting a supplier. This paper contains an examination of eight generic steps of tool, die, and mould procurement and additional factors when cross boarder procurement is considered.

Keywords: *Procurement, Tools, Dies, Moulds, Low-Cost Base Suppliers, Carbon Footprint*

1. Introduction

Historically if a UK company decided to outsource the manufacture of tools, dies, or moulds (TD or Ms), then either a preferred UK toolmaker was selected or quotations were obtained from local companies, and an order placed. The global economy has made available a plethora of companies across the world quoting very good prices for the manufacture of TD and Ms. Often the quoted prices that appear most attractive are from low-cost base countries.

There exists little published quantitative analysis comparing the total costs of sourcing from within the same country or region with sourcing from different countries or continents. The mechanisms of procurement employed by large companies often means that the direct link between the TDM users or designers and the toolmakers has been broken and hence, intelligence or experience based purchasing decisions have on the whole disappeared. In the middle between the user and the designer is now the procurement or purchasing department with its own targets. This often procedural bridge rarely explores fully the difference between price quoted and the ***real*** or true cost of outsourcing. The difference being non-explicit and intangible costs, compensating actions, opportunities lost, as well as other factors that are important in sourcing decisions [1].

From the viewpoint of the buyer, total manufacturing costs are often placed under different budgets and true costs are not always recognised or evaluated. The remit of the buyer is to purchase the product at the right price and consider quality and delivery as lower priorities on the basis that Project or Production Managers will focus on quality through the manufacturing process and will expedite lead times when required.

In previous decades, there has been considerable effort by OEMs to put in place supplier performance and commitment indicators. One well known example is Rolls Royce's requirement on certain component suppliers to pursue the adoption of process simulation [2]. However, such indicators are rarely put in place by OEMs to control sourcing from lower tiers, third or fourth, which are often the supply chain position of toolmakers. Hence, if the UK TDM industry is to retain existing and win new business then it must provide a list of considerations for all purchasers enabling them to understand the true TD and M sourcing costs and justify their purchases. The method for real cost appreciation must encapsulate the greater philosophy of long-term supplier partnerships and day-to-day operations. Real cost considerations are examined in this paper.

2. Real Cost Considerations

The first group of cost considerations relate to the generic process of sourcing TD or Ms, Section 2.1. Attention is then given to the additional factors that result from purchasing from beyond a national border, Section 2.2.

2.1 The Generic Sourcing Process

When TD and Ms were purchased only from local suppliers, it was usual for the customer and supplier to meet and discuss the project [3, 4]. In addition, during manufacture any problems that arose or changes needed were discussed face-to-face and a route forward determined. In addition, if any adjustments to the TD or M were required during production trials, the close proximity of the supplier to the point of TDM use made the task easy. Finally, when the tool was in service replacement parts, refurbishments, and modifications were dealt with quickly. A key factor in this mode of operation related to the shared understanding of national customs, holidays, transportation problems, industry problems and pressures, as well as deriving the same meaning from the technical and day-to-day language spoken i.e. not only the words but the context.

Today typically, when a potential order has a significant value a procurement department will require three quotations to be obtained. It is essential that prices quoted, whether the suppliers are local or further away, be placed in the context of the total cost considerations.

2.1.1 Customer Assessment

Assuming quotations have been obtained from suppliers that have never undertaken business with the purchasing company. The purchasing company, the customer, needs to decide how it intends to determine the capability of the suppliers. If the method is to visit, then differences in costs arise depending on location. It may be possible to visit two local suppliers by car in a day with the possibility of return visits if additional queries arise. However, when the suppliers are in low-cost base countries, costs associated with flights, accommodation, interpreters, and detailed visit preparation, assuming return visits are not a possibility, need to be considered. In addition, it should be straightforward to ascertain the reputation, capacity, capability, and experience of a supplier based in the same country as the purchaser – a task that is certainly not as easy with remote suppliers.

2.1.2 Contracts

Let us assume the customer selects two suppliers', one local, UK based, and one in a low-cost base country. Contracts need to be agreed and signed satisfying the legal requirements of both parties. In the case of the local supplier, there is a single legal system and language. In the case of the foreign supplier it is unlikely that this is the case and hence a greater amount of time and expense is required in ensuring that what is being agreed (deliverables, penalty clauses etc) is understood fully by both parties and not open to misinterpretation as a result of misconstrued terminology or custom and practice.

2.1.3 Manufacture

With the contracts exchanged the tool manufacture begins with the supplier 'reading' CAD drawings, notes and specifications and combining them to produce functional TD or Ms. There is however, a much higher risk of failure with the untried foreign supplier than with the untried local supplier.

When using toolmakers from low-cost base countries, such as the Far East, fundamental mistakes have often been made at the design stage. Usually the reason for this is down to difficulty in communication. Translators are employed but they do not help much as many words, especially technical words, do not translate directly. An experiment was carried out where two interpreters were used for the same job. Different interpretations were given by both. Interpreters with an engineering background are needed, but a majority of the time young interpreters are employed [5].

The internal market for low-cost base suppliers typically requires low to mid TDM making skills when compared to the developed high-cost base TDM makers [6]. Hence, although able to offer low prices the toolmaking experience required for complex TDM requirements may be slightly lacking. A risk factor associated with the complexity of the TDM needs to be considered within the possible additional costs. To try to negate this risk it may be necessary to include additional visits or virtual visual conferencing activities so ensuring that misinterpretation is avoided.

There has however been cases reported [4] where the customer has effectively been training the foreign supplier in the skill of complex TDM manufacture. In the case of the local supplier, local intelligence if properly gathered should enable capability, competence, and experience with similar tools to be

accurately assessed. The relatively short distance between supplier and customer should ensure problems are easily resolved through face-to-face meetings. One assumption for cost implications could be that the remote supplier be visited the same number of times as the local supplier and for the same reasons.

2.1.4 Transportation

With the TD or M manufactured, the next stage is the transportation to the point of use. The time allocated should allow for all contingencies and failures in transport arrangements. In the case of the foreign supplier, the transportation will be dependant on the weight of the TD or M. For small dies, punches or pins then transport by road or train to the nearest airport and then cargo rate to a UK international airport followed by transportation to the point of use is possible. For larger tools, shipping may be more appropriate, but the time required from the point of manufacture to the point of use may take a considerable amount of time and increase the probability of delayed arrival. This may require considerable advanced contingency planning. An approximate cost to ship a die, which weighs six tonnes, from the Far East to the UK would be between three to four thousand pounds [7]. Another question the customer needs to establish is who meets the transportation costs, the insurance fee and any costs that arise if the end component/product is not produced on time due to a lack of tooling, which could lead to possible production line shutdowns.

A future consideration for manufacturers is expected to be the 'carbon footprint' per product. The UK Government's draft Climate Change Bill will legally oblige the Government to achieve a sixty percent carbon reduction on 1990 emission levels by 2050 [8]. The Carbon Trust [9] is an independent company funded by UK Government to help move the UK to a low carbon economy. Initiatives are being created to reduce carbon emissions, such as a business tool for carbon management across the supply chain [10]. Market research conducted by the Environment Agency (UK) showed that 67 percent of UK consumers are more likely to buy a product with a low carbon footprint [11].

Taking into consideration increases in energy, existing and planned legislation that penalises high energy consumption and changing consumer attitudes the customers of toolmakers may not be able to 'afford' transporting TD or Ms from overseas as this would increase the 'carbon footprint' of their product.

2.1.5 Tool Arrival and Pre-Production

Lead times for the tool are an important consideration. Lead times are longer when sourcing from abroad. A UK toolmaker will quote a lead time of twelve weeks, whereas a toolmaker from the Far East would quote sixteen weeks for the same tool [7]. This can lead to loss business for the customer if their customer needs a product quicker than the lead time quoted by the toolmaker in the Far East. In the automotive industry there have been instances where tools from Far East toolmakers have had to arrive in the UK incomplete so that the date for tools to be in production is met. There are serious implications within the automotive industry if tools aren't in production by the agreed date, hence, why this situation can occur [5].

When sourcing from low-cost base countries, buyers have sent out engineers to monitor the quality of work and to teach the toolmaker [4]. In the case of an automotive supplier three engineers were sent out for 13 weeks. This was on a one million pound project to create transfer and progressive tooling for approximately 30 pressing processes [5]. There would be the obvious costs associated with this like the cost of flights and hotels. In addition there would be intangible costs such as the opportunities lost. If the engineers weren't required to go abroad they could have been working on new projects [4].

In the case where engineers oversee the process their cost will frequently be charged to other cost centres and often do not appear within the total cost of tools provided. This creates issues when benchmarking costs from UK against overseas companies. Many case studies have confirmed that when all budgets are accrued savings of less than five percent are shown. This is without considering the affect on other production and labour issues when skilled team members are overseas for a long period of time on a single project.

The customer must determine, before placing the order, what procedures will be adopted if on arrival the TD or M fails inspection. The options may include: return the tool to the supplier; in the case of a tool supplied by a foreign manufacturer, one option could be to employ a local toolmaker to implement the corrections. In the longer term, solutions may include sending someone to inspect the tool before dispatch or training personnel at the supplying company in quality and inspection procedures.

When pre-production trials begin it is often the case that slight modifications to the tooling are required. The customer must determine, again before placing the order, what procedures will be adopted. Realistically if the tool was manufactured on the other side of the world then it cannot be economical or enhance lead times to ship it back for modifications, nor is it likely that someone will travel from the manufacturer armed with appropriate tools to undertake modifications. If either scenario is likely, who will finance the activities needs to be clear. The reality is that modifications, often required to ensure the tool functions, and future repairs will be undertaken by a local toolmaker, probably a toolmaker that failed to be awarded the original contract; a toolmaker that the tool purchaser needs to ensure a functioning tool and its long-term maintenance. A customer needs to determine the type of relationship required of domestic toolmakers and how such toolmakers are to remain financially viable to service tool users.

UK toolmakers may quote up to 30 percent more to modify or repair a tool from the Far East, than from the UK. To put a 750 tonne – moulding machine pressure – die cast mould right would cost, on average, between eight to ten thousand pounds. A reason for this is because the toolmaker expects to perform additional operations on a tool from the Far East. For example, the cap screws that hold a tool together may not be manufactured by a 'branded name' that conforms to British standards in a tool from the Far East. They are likely to be 'cheap and cheerful'. When trying to undo 'cheap and cheerful' cap screws they can break. Consequently a second operation is required to drill the cap screw out, which requires more resources [7].

2.1.6 Production

In addition to who shall perform on-site TD or M maintenance, consideration needs to be given to order quantities for replacement tools or tool parts. Hence, anticipated tool life, the volume of TDM stock to be held by the customer and the time required between ordering new stock and its delivery, TDM order schedules. As part of these considerations, plans must take account of worse case scenarios including, for example, unexpected catastrophic TD or M failure and the resultant downtimes. The anticipated supplier responsiveness as a result of commitment and physical location should be factored into the considerations. Thought must also be given to the volume and duration of the tool purchaser's (the customer) component/product production contract and the anticipated latent TDM stock if the contract is not renewed or modifications to the component/product and hence, the tools are required. The further away the supplier is from the TDM user the further from the practice of minimised inventory and Just-in-Time procedures. Hence, the risk of cash being tied up permanently in unused tooling stocks is significantly increased.

Some UK toolmakers can give customers a 24 hour 7 days a week breakdown service, for when repairs on tools are required. This is an additional service that toolmakers from the Far East cannot offer [7].

2.1.7 Trust

The customer must assess the risk associated with providing external organisations with TDM drawings and solid models and hence, the implicit product manufacturing route. Thought must be given to: the activities of the supplying toolmaker, are they also TDM users and hence potential competitors; the legal recourse and associated costs if information supplied is used to the detriment of the customer; and instinct.

2.1.8 Long-term Partnerships

A TDM purchaser, the customer, must examine the day-to-day dependencies that ensure minimum tool downtime and hence, determine which partnerships need to be maintained and built upon. In addition, the customer must develop an understanding of the significance of their business to the supplier and hence gauge the anticipated levels of support.

2.2 Purchasing beyond National Boarders

In addition to those mentioned in Section 2.1, there are additional cost considerations that result only from purchasing from foreign suppliers.

2.2.1 Customs Duties

These are fixed and readily calculated.

2.2.2 Financing and Paperwork

Terms of payment on foreign shipments may require letters of credit, bankers' acceptances, or some other international financing mechanism, most of which require a fee to be paid to a guaranteeing bank

plus additional paperwork to document the transaction.

In the UK a toolmaker is typically paid approximately a third of the cost of the tool upon delivery. The second third is paid when the customer samples the tool and the final payment is given when the customer proves the tool [7]. When buyers source from abroad they often have to pay roughly 80 percent prior to delivery to secure lower tooling prices and they have to conform to trading requirements of overseas suppliers. As a result more risk is associated with buying from low-cost base countries.

Difficulties can be incurred when sending items in and out of the Far East. If the paperwork for a shipment is not 100 percent accurate it will be stuck in the dock for up to one week. Lead times are then adversely affected [5].

2.2.3 Foreign Exchange Rate Fluctuations

If a price is specified in a foreign currency, then the purchaser bears the risk of exchange rate fluctuations before delivery and payment. A major fluctuation could reduce the local currency profitability of the contract for the foreign supplier. This could affect quality and responsiveness, ultimately raising the risk of failure to complete and deliver, if the potential loss under the contract becomes too great.

2.2.4 Time Zones

The opportunity for direct communication may be limited by difference in time zones. Other communication problems include differences in industry practices, standards and use of technical terms.

2.2.5 Materials

Many TD and Ms are manufactured from specific metal grades normally steels and require postproduction heat treatments. Purchasers should be aware that the quality of steels produced in certain regions are neither or as good or as consistent as those available in Western Europe. There have been logistical problems, in the Far East, when trying to acquire materials. Therefore, some toolmakers will take shortcuts by using different material [5]. Hence, where critical to TDM life or function material may need to be shipped to the tool supplier.

For a four impression die casting tool a UK toolmaker quoted £58,000, a Turkish toolmaker £54,000 and a Far East toolmaker £36,000. Nine times out of ten the toolmaker from the Far East would not be working to any die casting standards, whereas in the UK they would be. The standards might state, for the UK, that the bolster has got to be 40-50 percent bigger than the insert. The bolster may only be 20 percent bigger for the tool from the Far East. This makes the tool less robust. Since the toolmaker from the Far East is using less material for bolster they are saving on material costs, which allow them to quote lower. Furthermore, the UK toolmaker would use a third temper for heat treatment while the Far East toolmaker would only use two. The tempering process is important to obtain the desired strength, hardness and toughness of the tool [7].

A common steel used in cold work tooling is D2. In Japan 30 percent of the D2 market has been replaced with a ‘new’ eight percent chrome material, such as DC53. This steel is more expensive. However, using newer steels can allow a toolmaker to produce a tool quicker with easier machining and less risk of cracking. Additionally, there have been some case studies where the tool life has been extended by up to five times. This is an example of how material selection can be used to reduce lead times and manufacturing costs [12].

In the UK only about one percent of D2 has been replaced by ‘newer’ materials, such as DC53. The sales of DC53 are currently doubling every 18 months. UK toolmakers say that it is their customers who aren’t willing to change. In Japan the entire supply chain will meet when a new product needs to be produced and this is an opportunity to decide upon the best way to do the job [12]. If UK toolmakers can start to increase the speed of uptake of new materials to reduce lead times and bring down manufacturing costs they can concentrate on selling their many built-in advantages, for instance local service and quality. Therefore, reducing the price gap between them and the low-cost economy countries, and becoming more competitive [13].

As highlighted in section 2.1.4 there is a drive to a low carbon economy in the UK. Companies are now looking at their supply chain to reduce carbon emissions. For example Innocent, a fruit drinks company, is working with its supply chain to include more recycled materials, increase in use of renewable energy sources and the potential of using alternative fuels [8]. It can be assumed that it would be easier for

OEMs to reduce its supply chain carbon emissions if it is working with companies that operate from countries that are actively promoting this, such as the UK, rather than companies from low-cost base countries.

3. Discussion and Concluding Remarks

If a TDM purchaser, procurement department, is to ensure that its company is capable of consistently producing quality components and maintaining its competitiveness it must understand the risks and costs associated with TDM sourcing decisions. Several organisations have been close to seeing only the quoted price and not the real costs [4, 14]. Table 1 contains the eight generic TDM procurement steps and the five cross border factors and some of the considerations for each. One major requirement often neglected is the need for day-to-day TDM repairs and maintenance, which necessitates a local toolmaker. A factor **all** TD and M users need to appreciate.

Generic Considerations	National Supplier	Foreign Supplier
2.1.1 Customer Assessment	Local/national travel, personnel time.	Flights, travel insurance, accommodation, interpreters, personnel time, capability determination.
2.1.2 Contracts	Single legal system and language, understood jurisdiction and enforcement procedures.	Need to understand two legal systems their jurisdiction and enforcement procedures, two languages, different customs and practice.
2.1.3 Manufacture	Assess risk of failure as a function of TDM complexity. National travel for face-to-face meetings to resolve problems or agree modifications.	Assess risk of failure as a function of TDM complexity. Virtual video capable meetings, flights, travel insurance, accommodation, interpreters, personnel time to resolve problems or discuss modifications.
2.1.4 Transportation	National transport costs. Determine risk and costs of late arrival.	International air or shipping costs, goods insurance. Detailed advanced contingency planning for each changeover point. Determine risk and costs of late arrival.
2.1.5 Tool Arrival, Pre-Production	Inspection capability, willingness, and responsiveness of local supplier to engage with pre-production trial modifications, national travel, time delays.	Inspection capability. Possible additional cost of engaging a local toolmaker to work on pre-production tool modifications. Long-term: customer pre-dispatch inspection hence flights, accommodation, etc, and possible long-term investment in supplier's inspection capabilities.
2.1.6 Production	TDM maintenance, worse case scenario responsiveness, and required TDM inventory.	The cost of engaging a local toolmaker to undertake on-site TDM maintenance. TDM inventory requirements as defined by supplier response times. Risk of cash tie up and production failure where the solution is supplier dependant.
2.1.7 Trust	Assess risk of production contract loss because of breach of confidence. The method and cost of legal action and the probability of success.	Assess risk of production contract loss because of breach of confidence. The method and cost of legal action and the probability of success.
2.1.8 Long-term Partnerships	The effect on the customer if this supplier no longer existed. The commitment of the supplier to the customer in terms of support and technology in the short and long-term.	The effect on the customer if this supplier no longer existed. The commitment of the supplier to the customer in terms of support and technology in the short and long-term.
Considerations when Purchasing beyond National Boarders	**National Supplier**	**Foreign Supplier**
2.2.1 Customs Duties	Not relevant	Important consideration and additional costs
2.2.2 Financing and Paperwork	Not relevant	Important consideration and additional costs
2.2.3 Foreign Exchange Rate Fluctuations	Not relevant	Important consideration and additional costs
2.2.4 Time Zones	Not relevant	Understood
2.2.5 Materials	Not normally relevant	Important consideration and additional costs

Table 1. Consideration for TDM procurement.

4. Acknowledgements

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Appendix 2 – The first hardcopy Technical Briefing

Technical Briefing

Issue No. 1 July 2006

TECHNICAL BRIEFING INTRODUCTION

The Technical Briefing (TB) aims to provide concise relevant technical information to GTMA members. Each article will offer details for obtaining further information.

You are invited to submit technical articles for the TB, which should be approximately 150 words. Pictures/diagrams can be included. Articles should be sent to tb@gtma.co.uk.

What is laser-sintering?

Laser-sintering is a layer manufacturing technology. Prerequisite for its use is the availability of 3D CAD data of the object to be built. In the process, the 3D CAD data is converted into a set of slices, where each slice describes a cross section of the part.

The laser-sintering machine builds up these slices layer by layer to create the desired product. In each layer, powder is fused using laser energy, creating a solidified layer that later forms part of the finished product. The process repeats itself until the build is complete. The technology offers functional integration as well as freedom of design, meaning that nearly any shape can be produced. Moreover, it enables the manufacture of up to hundreds of individual products in one single process, without the need for tooling.

TB1. Laser-Sintering in UK Tool and Mouldmaking Industry

Originally applied for rapid prototyping (RP) purposes, laser-sintering is today a method for batch size adapted manufacturing in the entire product life cycle - including prototyping, production and even spare parts.

Direct Metal laser-sintering (DMLS) creates tools for injection moulding and die casting within 1-2 working days. Depending on the material, the tools are able to produce up to 100,000 to 200,000 injection moulded parts.

The EOSINT M 270, a system for DMLS, uses a new 200W diode pumped Ytterbium fibre laser. At a laser power of 100W, it achieves a focus with a diameter of 100 µm. The machine has a build volume of 250 mm x 250 mm x 215 mm and builds in layers of 20 µm.

Website: www.eos.info

TB2. Graphite Selection

There are many points to consider when selecting graphite:

- Graphite is now replacing copper as the leading EDM material. This is due to the performance of graphite under any conditions and the versatility of grades available
- HK-15 is a Tokai Carbon graphite grade that offers:
  a. Ultra fine detail
  b. Electrode machining production up to five times faster than copper
  c. Faster EDM metal removal rates

  Its application is ideal for general mould tool applications where low wear and speed is required
- Graphite materials can be more flexible in their application as they have varying performance properties. Toolmakers can choose grades that are specific to applications
- Tokai Carbon have recently created two new grades for mould and toolmaking usage:
  a. HK-20 is a grade for high speed EDM and surface finishes of 22vdi (*Verein Deutscher Ingenieure*). Its application is ideal for high quality finishing of small to medium die-casting tools
  b. HK-6 is available for high precision uses. Its application is suited to complex shapes. Surface finishes of 16vdi can be achieved.

Email: sales@tokaicarboneurope.com

TB3. HSM-EDM Decision Maker

To gain a competitive advantage tool and die makers can make use of conventional technologies such as Electric Discharge Machining (EDM) and High Speed Milling (HSM). The combined use of these should reduce lead times for die and mould manufacture.

Fastool, a European project, resulted in the creation of a HSM-EDM Decision Maker. The Decision Maker is a calculation module in an Excel spreadsheet. It calculates what to mill and what to EDM in a mould cavity.

The software is currently available for free to GTMA members. Please email scott@gtma.co.uk to obtain the software.

Website: www.fastool.org

What is acoustic emission?

Everything produces a sound, some are audible and some are not. Acoustic Emission (AE) is high frequency sound that is generated by structural alterations in materials (cracks and flaws) when they are stressed. This sound is not audible. AE sensors are mounted on the structure surface and convert the minute surface movements to electrical signals, which allow the condition of the machine to be monitored.

TB4. Pre-empting Failure or Wear of Machinery and Processes

Monitoring of the operating conditions of machines and processes is usually done by skilled practitioners determining and interpreting levels of vibrations. This can be inconvenient, time consuming and may not give condition information until wear and damage has occurred.

Everything has a unique profile known as a 'signature'. When the signature changes it indicates that the machine/system has changed. This change could be due to increased wear etc. A new handheld instrument has been developed to monitor the condition of a machine/process, which means there is no need to employ a specialist. Applications for this include monitoring machine tool wear, machinery bearings and industrial processes.

The company behind the development of the new handheld instrument is Advanced Acoustic Emission Systems Limited.

Email: Dr Joe Au joe.au@brunel.ac.uk

TB5. On-Machine Verification

On-machine verification with inspection software can allow measurements to be made on machine tools that normally require coordinate measuring machines. The software allows off-line programming of the inspection sequence for the machine tool, with fully-integrated simulation and collision checking, and so minimises the time needed for measurements to be taken.

The most obvious benefit of on-machine verification will be to those companies that do not have existing inspection capabilities. Most modern machine tools either come with, or can be retrofitted with, probing capabilities to assist in the set-up of the job. With the right software this same equipment can now be used for verification at little extra cost.

Delcam's PowerINSPECT inspection software offers the above. It gives both quick and easy comparison of tooling and sample components against CAD data, and produces clear comprehensive reports that can be understood by everyone involved in the product development process, not just inspection specialists.

Email: Roger Onions rjo@delcam.com

FAXBACK FORM

Your feedback on the Technical Briefing (TB) would be appreciated so that it can be improved. If you fill in this faxback form your company will be entered into a **free prize draw** to win the chance to have priority for an article to feature in the TB. Please **faxback to 01844 274227**.

Name: ..... Title: .....

Company: .....

Tel: .....

Email: .....

Feedback

1) Did you feel that the format of TB was useful?

☐ Yes ☐ No

Why?

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2) What would you like to see featured in future TBs i.e. micromachining or automation?

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Please send any additional comments to tb@gtma.co.uk

Appendix 3 – The second hardcopy Technical Briefing

www.gtma.co.uk

Technical Briefing

Email: tb@gtma.co.uk **Issue No. 2 (Jan. 07)**

TB6: 6th International Conference on Industrial Tools and Material Processing Technologies

(ICIT & MPT 2007, Bled, Slovenia)

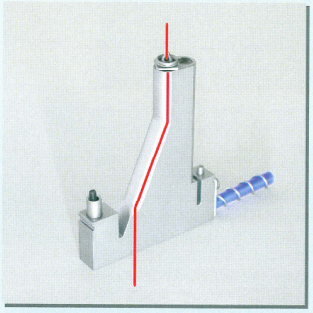
An Opportunity to see new tool manufacturing technologies and to exchange knowledge and experiences of the common tool making issues.

ICIT & MPT 2007 is an international conference covering topics related to new tool manufacturing technologies and material processing. The main topics are: Metal forming processes and tools; Injection moulding processes and tools; Materials; Tool manufacturing; Intelligence systems; Computer aided numerical methods; Machines; Management.

Respected specialists, engineers, researchers and scientists will be present to discuss the topics. In past conferences attendees have exchanged experiences with industry colleagues from Europe, America and Eastern Asia.

The event will take place on 11th – 14th September, 2007. The venue will be the alpine resort of Bled, Slovenia. GTMA members are invited to attend at a special discounted fee of €250 (35% saving), if four or more members attend. Members are called to submit papers. If you are interested in submitting a paper or attending then please contact the GTMA.

TB7: DMS-Diemould Offers Special Hot Runner Nozzles for Tight Spots



These innovative Heitec hot runner nozzles, available in the UK from DMS-Diemould, are designed for use in difficult-to-access, off-centre gate locations, and offer a maximum offset of 30mm and a minimum pitch of 13mm.

These nozzles are for use in situations where previously an offset would require an additional separate manifold and nozzle - with all the associated additional expense of time and money which that entails. With the off-set Flat-Line nozzle it is possible to achieve the desired position simply by using the special nozzle and an adaptor.

The nozzles can be used with nearly all commercial resins, including those with glass reinforcement. Nozzles can be modified to suit customers' specific requirements, providing extensive design flexibility. They are available in single and multiple units and, when used in conjunction with a manifold, open up extensive new layout possibilities, particularly with regard to exactly balancing flow channel distances.

TB8: Toolox – Special Steel for Toolmakers

In 2003 SSAB Oxelosund Sweden the manufacturer of Hardox and Weldox wear plate steels introduced Pre-Hardened Tool Steels to the UK market. Toolox 33 and Toolox 44 have now become established pre-hardened steels which are fully machineable and require no further hardening or re-machining once the tool has been produced. Toolox 33 is supplied at 280/330 Brinell (27/33 HRC) and Toolox 44 is even harder at 410/475 Brinell (41-47 HRC) and both steels are designed to be used as supplied, with no additional heat treatment required.

They are Quenched and Tempered tool steels supplied in plate form, designed to have low residual stresses and good dimensional stability. Good machining properties make them suitable for the manufacture of plastic moulds, rubber moulds, forming tools, machinery components and wear components etc.

Toolox 33 has the same hardness and durability as standard P20 but better impact resistance. It has excellent polishing and etching characteristics. Toolox 44 can also be buffed and etched with very good results.

The steels are distributed in the UK by both George H Cook & Co Ltd and Carrs Tool Steels.

NEED MORE INFORMATION ON ARTICLES?
Email tb@gtma.co.uk quoting article title and number for further information

What is cryogenic treatment?

Cryogenic treatment is the process of controlled cooling of a part down to near absolute zero and maintaining it in this condition until it is cold soaked (cold uniform temperature) to allow for changes in the crystalline state. The part is then brought back to ambient temperature. Some materials then require a cycle at elevated temperatures, as high at 650ºC, depending on the materials construction

Cryogenic treatment at the range of -77°C transforms austenite, softer and less stable phase of steel, into martensite, which is harder and more stable. When part of a heat treatment cycle, cryogenic treatment has the benefit of stabilising the material. Further benefits occur when the treatment holds the temperature at -190°C (deep cryogenic treatment). Precipitation of Eta-carbide (η-carbides – a compound of metal and carbon) takes place in the martensite. This increases the wear resistance and toughness of the part.

Figure 1 shows a section of a cutting tool prior to cryogenic treatment at -190°C. The black spots are the larger, softer austenite crystals. Figure 2 shows that after treatment the number of black spots has significantly decreased.

Figure 1. Section of cutting tool before cryogenic treatment

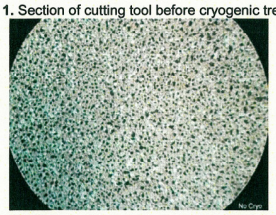
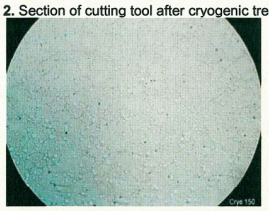


Figure 2. Section of cutting tool after cryogenic treatment



TB9: Cryogenics

Cryogenic treatment can dramatically improve the wear resistance of tooling by up to ten times. Cryogenic treatment can significantly improve the performance and life of tools. Downtime associated with tool change is reduced as more parts can be produced per tool. This can result in a reduction of overall tooling costs. Cryogenic treatment can increase the wear resistance up to ten times for a D2 tool steel stamping die. Table 1 shows the increase in wear resistance for a number of tools after deep cryogenic treatment.

There are few specialist companies that are able to offer the deep cryogenic service down to -195°C. GTMA member Cryogenic Treatment Services Limited offers this service and invites other members to trial the service. Trial parts are to be smaller than 1.5 x 0.75 x 0.75m and no heavier than 3 tonnes. Cryogenic Treatment Services is keen to exploit the potential benefits of cryogenic treatment on press/stamp, cutting and mould tools. Please contact the GTMA if you are interested in the trials.

Table 1. Increase in tool wear resistance after deep cryogenic treatment

AISI steel grade number	Tool	Factor increase in wear resistance
D2	Stamping die	10
M42, M7, C2	Drills	3
M7	Milling	2.5
M42	End mill	4.5
M42	Drill bit	4
T2	High-speed end mill	4
M7	Punch	6

WIN! WIN! WIN! WIN! WIN! WIN! WIN!
Have the chance to win a **£20 Marks and Spencer voucher** *(1st prize £20; 2nd prize £15; 3rd prize £10)* by filling in the one minute Technical Briefing Questionnaire at:
http://www.questionpro.com/akira/TakeSurvey?id=612720

GTMA, 3 Forge House, Summerleys Road, Princes Risborough, Bucks, HP27 9DT, UK. Tel: 01844 274222 Fax: 01844 274227 E-Mail: gtma@gtma.co.uk Web: www.gtma.co.uk

Appendix 4 - The first issue of the electronic Technical Briefing

This issue focused on laser for tool repair.

It should be noted that the quality of the Technical Briefing included in this dissertation does not reflect how it would have been received by GTMA members. It was sent electronically and is difficult to produce on paper as it was not designed for this purpose. Better quality versions of the GTMA Technical Briefings can be found at www.graphicmail.co.uk/GTMA.

TECHNICAL BRIEFING - Laser for tool repair

ISSUE 3, April 2007

Contents:

TB10: Technical Briefing Improved as Result of Members Input

Since the last issue of the Technical Briefing (TB) a survey was conducted to find out what members want from such a publication. The information from this survey has been used to improve future TBs.

Seventy-three percent of those that participated in the survey selected email as their preferred format for receiving the TB. In response to this the GTMA has created an online version. For those of you that still prefer to receive hardcopy then please email your preference to tb@gtma.co.uk. If you do not wish to receive the TB then please use the unsubscribe link below.

To ensure that the TB is sent to the most appropriate contacts within member companies the survey asked members who they thought the biggest users, within their companies, of the TB would be. Over half of the survey participants chose 'Engineering' and 'Senior Management'. If you would like the TB to go to different people within your company then please send their email addresses to the TB email address (above).

It was suggested that the TB should include more industry related examples. The GTMA will try to include industry related examples in future issues of the TB. 'Themes' for each issue were recommended. This issue has the overall theme of laser welding. The next issue will focus upon automation. Members are invited to submit articles. Other suggestions were made, which will be implemented in the future. Your opinion on this issue would be greatly appreciated and you are invited to complete the one minute TB questionnaire online at: http://www.questionpro.com/akira/TakeSurvey?id=684034. **Those that complete the questionnaire have the chance to win W H Smith vouchers!** If you would like a more detailed report on the results of the TB survey then please contact Scott Phillips at the GTMA (scot@gtma.co.uk).

IF YOU REQUIRE FURTHER INFORMATION ABOUT ANY ARTICLES FEATURED PLEASE USE THE CONTACTS LISTED AT THE END OF EACH ARTICLE OR CONTACT THE GTMA QUOTING THE ARTICLE ID

What is Laser Tool Repair?

Laser tool repair is a relatively new application for lasers, but in the last 5 years it has found a valuable niche, first with specialist tool repairers and now with tool users and tool makers.

The laser is a highly controllable heat source which is used to fuse fine welding wires (down to 100um/4 thou) onto build-up regions with hardness up to 64 HRC (A measure of hardness calculated from the difference in depth of penetration of an indenture between a major and a minor load – the harder the material the higher the HRC figure). Achieving this hardness does not usually require pre-heating or post treatment. Speed of welding is usually 4 to 10 pulses per second, which relates to a welding speed of 0.5 to 1mm per second.

Laser tool repair has advantages over TIG welding (tungsten inert gas, also known as gas tungsten-arc welding - GTAW) and micro-plasma welding. It offers far higher precision and repeatability, no distortion, reach to inaccessible places and very low heat input/damage. It is helping to transform the way mould tools are modified and repaired and can additionally be used for miscellaneous joining tasks.

TB11: Laser Material Build-up for Tool Repair and Modification

Relevant to: Press Tool; Mould & Die; Jig and Fixture; Precision Machining; Moulders

StarWeld Open. Pictures courtesy of Rofin-Baasel UK Ltd

Lasers can be used to locally apply fresh material to surfaces or edges of injection mould tools. Wire is manually fed into the weld pool under binocular microscope vision and can either be the same material as the mould tool itself or a different material if necessary for weldability. Typical tool steels for laser welding are: H13; P20 and Stavax. Other materials include: titanium; Aluminium; Copper alloys. The results require less finishing and apply far less heat than competitive technologies and an experienced welder will rapidly learn how to get the best out of a laser system with a short training session. In many cases, operators with no previous welding experience have been able to confidently weld challenging tools within a few days of the training. Results improve with experience and some tasks are more demanding than others. Rofin-Baasel supplies laser welding systems and offers four StarWeld Tool models. Specifications of these laser welders are listed in the table below. 'Performance' is suitable only for small parts, such as inserts or miscellaneous workshop welding. 'Select' is the newest model and is a fully integrated system. 'Integral' is a good all-rounder. Starweld 'Open' is a moveable high performance system capable of welding the largest tools.

More Information: Dave MacLellan, Rofin-Baasel UK Ltd, Tel. 01327 701100, email: sales@rofin-baasel.co.uk, **web:** www.rofin.co.uk

	StarWeld Performance	StarWeld Select	StarWeld Integral	StarWeld Open
Max. load (kg)	8	50	350	Unlimited
Max. tool size (mm)	100x100x50	250x250x200	400x400x390	Unlimited
X axis (mm)	75	180	350	75
Y axis (mm)	75	220	220	75
Z axis (mm)	50	200	390	75
Av. Power (W)	40	100	100	150
Peak power (kW)	4	12	10	10
Syncro-weld	No	Yes	Yes	Yes
Swivel optic	No	No	Yes	Yes

TB 12: Tool Repair using Laser Cladding - *Case Study*

Relevant to: Press Tool; Mould & Die; Jig and Fixture; Precision Machining; Moulders

The Nd:YAG (Neodymium-Doped: Yttrium Aluminium Garnet Laser Crystal) laser is a must-have-process for all tool makers and tool users. It allows safe modifications and repairs to be done at relatively low cost and low risk.

Carr's Welding Technologies Limited weld cast iron tools at one end for low pressure die casting and patterns, right through soft steel large tools (P20) to prototyping tools in aluminium and hardened tools in Stavax and H13 or 2767 to forming and cutting dies at 62RC (Rockwell C scale used for measuring hardness of tool steels). Carr's carry wires to match the material, better the steel or seal a crack. It is usually best just for doing edges, re-doing gates and minor modifications. If you want to lay down a lot of metal it is difficult to get a porous free weld when hundreds of layers of weld are put down. Like all processes, the laser is not a panacea to all metal-on problems but a very useful tool to keep a machine going or to do modifications at an early age of a tool's life without upsetting the heat treatment.

Phil Carr of Carr's Welding Technologies says "don't be fooled into thinking it is a skill-less process; all welding demands a huge skill level and there are few toolrooms in the UK big enough to support their own laser". There are a number of skilled laser job shops who you can go to, including Carr's Welding Technologies Limited.

More Information: Carr's Welding Technologies Ltd, Phil Carr, Tel. 01536 412828, web: www.carrswelding.co.uk

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TB 13: Using Laser to Meet the Demand of Quick Tool Repair - *Case Study*

Relevant to: Press Tool; Mould & Die; Jig and Fixture; Precision Machining; Moulders

Bropel has been using lasers for a number of years now. They have found it invaluable to their business as it gave then the ability to provide customers with a repair that requires the minimum amount of machining to get it back into production.

This has been proven particularly with materials such as aluminium or beryllium copper. These materials, although very easily welded by other methods, have always had distortion and heat affected zone problems associated with welding. This is overcome by using laser in two ways. Firstly Bropel can weld the area if it's a large repair with TIG. Then they can use the laser to take out any distortion around the welded area. Secondly, if a small area is required, the laser is ideal for repairing small cuts, dents and mishaps with no distortion and no heat affected zones.

The laser lends itself very well to repairing all materials. Bropel use it on large tools weighing up to 10 ton when small local areas get damaged and the customer does not have the time to strip the tool down and a heat issue with the surrounding areas is a problem. The laser enables them to weld down slots where previously TIG welding was unsuitable.

The usefulness of the laser is growing as people realise the potential the process has in solving issues arising from welding with normal TIG processes with the scope constantly being pushed forward through the demand for a quick repair.

More information: Bropel Specialist Welders Ltd, Steven Johnson, Tel. 01922 745745, web: www.bropel.co.uk

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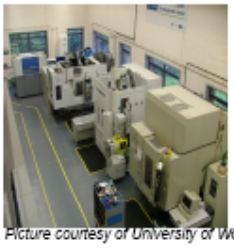
TB 14: Postgraduate Certificate (PgC) in Polymer Engineering

Relevant to: Mould & Die; Injection Moulders



Picture courtesy of University of Wolverhampton

Attendance on specific Rapra Technology courses can offer a direct pathway to achieving a Postgraduate Certificate (PgC) in Polymer Engineering with the School of Engineering and the Built Environment (SEBE) at the University of Wolverhampton, allowing managers and technologists in industry to obtain a formal and relevant qualification.

The PgC is the result of collaboration between Rapra Technology and SEBE's Innovative Product Development Centre at Telford and is based on attendance at short course events selected from a choice of dates, followed by supported study and assessment.

The West Midlands Technology Network (WMTN) are also supporting this programme, through the European Social Fund (ESF), for people working in SMEs in the West Midlands region.

At Rapra Technology students study:
- Two study modules each delivered over two-days: Plastics Materials and Products and Polymer Processing Technology

At The University of Wolverhampton students study:
- Two modules, each delivered over three successive days: Engineering Materials and Rapid Prototyping and Manufacturing Technologies.

More information: School of Engineering and the Built Environment (SEBE) at the University of Wolverhampton, http://courses.wlv.ac.uk/postGradCourse.asp?Id=2853

Appendix 5 – European Union projects partook in by GTMA

A brief description of each FP6 project that GTMA participated in is given:

Emold [138]: The aim of Emold is to define a new concept in plastic injection processing, in which tools will pass from being passive elements to becoming networked active elements with embedded knowledge. It is focused on the injection moulding process. Injection moulding is the process of heating plastic pellets or granules in a cylinder and then forcing the melted plastic into a split-die chamber, or mould, which gives the shape of the desired part(s). The molten part is then cooled so that it solidifies. The mould then opens, to release the part(s), and then closes again to produce the following part(s). Typical parts produced from this process include containers, automotive components such as speaker grills, cups etc.

The benefits that are expected to come from Emold are up to a 30 percent reduction for the set-up phase of the tooling (mould) and quality assurance. It aims to achieve a reduction of up to five percent in the final cost of plastic parts due to elimination of faulty batches and reduction of reparation requirements. Improvement of 25 percent in the efficiency of the moulding processes.

Flexform [139]:

This project focuses on European special vehicles manufacturing, such as small batch sports cars and military transportation. The main technological area to be developed is the manufacturing methodology related to the sheet metal components of the vehicle, such as the bonnet or wings of a vehicle. For this, it is planned to

use as a starting point an emerging technology for sheet metal components, Dieless Forming, which is based on incremental deformation of metal sheets. It aims to develop technologies to cut product development times by 60 percent and manufacturing times by 50 percent while increasing capacity by 50 percent.

Hipermoulding [140]:

The acronym Hipermoulding stands for 'High Performance Injection Moulds and Moulding Processes'. Its intention was to optimise the positioning of cooling channels, within the injection moulds, to obtain better control over the temperatures of the mould. It hoped to achieve at least a 35 percent reduction in the injection moulding cycle time – the time from closing the mould and injecting the plastic, to opening the mould and ejecting the part(s). In addition the energy consumption was anticipated to be reduced, by at least 30 percent, and the durability of the mould increased by about 50 percent. The result of the aforementioned would be an approximate 20 percent reduction in the cost per part and better quality control.

KnowEDM [141]:

KnowEDM centres on the two technologies Electrical Discharge Machining (EDM) and High Speed Machining (HSM) for making tools, such as injection moulding tools, and high precision components. EDM is a metal removal process by spark charges [142]. HSM is an approach to metal cutting that uses speed technologies that allows machining centres to do more work.

The partners of the project are developing a knowledge-based system – a system that stores knowledge to solve problems – to automatically choose which features of a part are best machined using HSM or EDM, based on the part geometry. Foreseen

benefits are improved communication between product designers, mould manufacturers and injection moulders. Improved part quality and reduced cost per part. Up to a 50 percent reduction in part manufacture.

T-ForM [117]:

The thermoforming process is the focus of the T-ForM project. Thermoforming is the process of heating a thermoplastic sheet – a plastic that when heated and cooled can return to its original hardness and strength – placing it over a mould and then using a vacuum to force the sheet around the mould [142]. When the plastic sheet makes contact with mould it usually sets. Examples of parts include food packaging trays to much larger items like the fronts and backs of caravans.

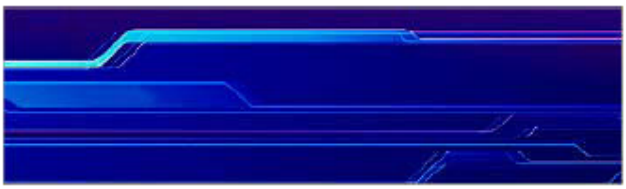
A new software platform will be developed to determine the cost of a thermoformed part, the plastic sheet thickness, the best tool material to use to improve cycle time, and processing conditions. Design Guidelines and training modules are also to be produced to promote best practise within the thermoforming industry.

Appendix 6 – The third copy of the electronic Technical Briefing

This issue focused on polymer training and funding.

It should be noted that the quality of the Technical Briefing included in this dissertation does not reflect how it would have been received by GTMA members. It was sent electronically and is difficult to produce on paper as it was not designed for this purpose. Better quality versions of the GTMA Technical Briefings can be found at www.graphicmail.co.uk/GTMA.

TECHNICAL BRIEFING - Polymer Training and Funding



ISSUE 4, July 2007

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TB15: Funding Available Through The Tooling Trust

Funding is available for GTMA members who put their employees on courses recognised and approved by GTMA. This is provided through The Tooling Trust, which supports training initiatives for the gauge and toolmaking industry. Please contact the GTMA for further information.

More information: GTMA, Tel. 01844 274222, Email: admin@gtma.co.uk, **The Tooling Trust website:** www.toolingtrust.co.uk

TB 16: Rapra Short Courses Help Companies Communicate with Customers

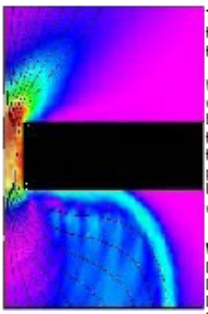
Mould designers who have some acquired knowledge of the injection moulding process and how different plastics behave in processing would be at an advantage when it comes to communicating with their customers and giving them what they want. Furthermore, the sort of problems that can occur with injection moulded components could, in some cases, be prevented by better communication between the mould designer and product design engineer.

For many years Rapra Technology has provided courses in Injection Mould Design and Plastics Injection Moulding Technology and these have enabled product design engineers to familiarise themselves with mould design and understand the possibilities and limitations in order to improve their communications with mould designers – but communication goes both ways and whilst many experienced mould designers understand a little of plastics materials behaviour in the injection moulding process, this understanding has often been gained through long experience. As manufacturers are starting to have their more basic moulded components produced in China and elsewhere there is a need for UK based moulders and mould designers to offer more added value to their customers to be able to compete, meaning that some knowledge of the materials and processes that they work with will be advantageous.

Rapra Technology offers short courses and in-company training courses which are structured to provide an awareness of the plastics injection moulding process and the issues affecting mould design as well as a range of materials appreciation courses. Members of the GTMA receive a 10% discount off the advertised course fee.

More information: Tel. 01939 252408, Email: training@rapra.net, **Web:** www.rapratraining.com

TB17: Polymer Science & Technology - 9 Day Modular Course



Viscoelastic Polymer Flow Prediction

The Polymer IRC brings together skills and resources in macromolecular science and technology from the universities of Bradford, Durham, Leeds and Sheffield with clients benefiting from our academics technical leadership and educational expertise.

We offer the following modules over two weeks each autumn. The courses are designed for personnel who need to know more about polymer science and technology and should appeal to those with some background in the sciences who wish to broaden their horizons through a general overview of these topics. The course will benefit you if: you interact with polymer scientists (customers, suppliers or R&D teams); or you are commercial/engineering/production based and need to know more about how your products and/or processes work. The courses have IOM3 (The Institute of Materials, Minerals and Mining) approval for professional development. Delegates may attend as many or as few courses as they wish.

WEEK One (Commencing 29th October 2007)
Day 1: Basic Polymer Science (part 1)
Day 2: Basic Polymer Science (part 2)
Day 3: Polymer Chemistry
Day 4: Polymer Engineering (Polymer Processing)
Day 5: Polymer Physics

WEEK Two (Commencing 5th November 2007)
Day 6: Multi-phase Polymer Materials Composites
Day 7: Polymer Dynamics and Macromolecular Rheology
Day 8: Polymer Biomaterials
Day 9: Polymer Nanotechnology

Price: £320 per module.
Prices on application for reduction in fees for multiple days or multiple delegates.

We can also offer bespoke training courses to companies in any area of polymer science.

More Information: Shelagh Cowley, Polymer IRC, Tel. 0114 222 9520, Email: s.h.cowley@sheffield.ac.uk, **Web:** www.polymerirc.org/pages/CourseDescriptions

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TB 18: Training Related to Polymers at The University of Wolverhampton

The University of Wolverhampton has for many years worked with the polymer industry to develop standard moulds and advanced moulds with conformal cooling, manufactured using the latest rapid manufacturing in metals. To provide a balanced overview the University has developed, with Rapra Technology, a set of short courses that covers both polymers and the techniques available for tooling design and manufacture. Two of the short courses studied at Rapra Technology, and each of two-days duration, are:

Plastics Materials and Products and Polymer Processing Technology

The mould making technologies are studied at the University along with Engineering Materials as two short courses each of three days in duration:
Rapid Prototyping and Manufacturing Technologies and Engineering Materials

For each short course completed, a certificate will be awarded. If all the short courses are completed then a Post Graduate Certificate in Polymer Engineering will be awarded.
While at Rapra Technology (Shrewsbury, Shropshire) you will use their excellent short course facilities. While at the University's Telford Campus, you will have access to the latest equipment including Zwick-Röell materials testing, injection moulding, rapid manufacturing and prototyping, vacuum casting of plastics, reverse engineering, CNC machining and computer-aided design and simulation.

More Information: Hayley Everett, University of Wolverhampton, Tel. 01902 321 720, Email: H.Everett@wlv.ac.uk

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TB 19: Technical Services for Toolmakers

The London Metropolitan University is one of the UK's leading polymer education facility, providing education, training and consultancy across the polymer industry, we recognise the importance of supporting toolmakers in the UK.

Polymer Centre staff with industrial experience in toolmaking, mould design, tool procurement and polymer manufacturing are well positioned to understand the needs of toolmakers.

Short courses on offer that have been of interest to toolmakers includes: Principles of injection moulding*; Introduction to injection mould design, Advanced injection mould design; Introduction to plastics technology; Introduction to rubber technology. Standard academic courses are also offered in a variety of learning modes are offered from National Certificate level to PHD. *£150 refund available for GTMA members through The Tooling Trust

We also work with toolmakers on product development projects on behalf of commercial designers, where the tooling required exceeds the capacity in our own toolroom. When toolmakers have a specific interest and need support in developing their business we can help them identify sources of funding.

Mould design advice is available, including considerations for particular materials and finishing processes, conversion from metal to plastic, trouble-shooting and failure investigation, and independent support in disputes and litigation.

A range of standardised test piece moulds are available, so that material properties and performance in injection moulding can be established to optimise mould design.

More information: Marion Ingle, London Metropolitan University, Tel. 0207 133 2292, Email: m.ingle@londonmet.ac.uk

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TB20: BEng Polymer Engineering Programme Provides Balanced Mix of Theory and Hands-On Experience

Napier University is one of just a very few centres in the UK offering **BEng Hons Polymer Engineering** and indeed the only one in Scotland. Over the years the courses have ranged from City & Guilds, through ONC, HNC and degree courses to specials Masters programmes, such as the MSc Plastics Moulding Technology. In addition specialist short course are offered, most commonly today as bespoke courses to companies or groups of companies.

With the decline in part-time student numbers Napier has concentrated on providing both full-time and part-time routes fully utilising common teaching. The 3 year BEng Polymer Engineering programme is accredited by the Institute of Materials, Minerals and Mining in fulfilment of the academic requirements for *Incorporated Engineer (IEng)* and the 4 year BEng Honours Polymer Engineering is accredited in partial fulfilment of *Chartered Engineer (CEng)* requirements. A further 1 year MSc Engineering (Polymers) programme is approved as suitable further studies to complete the academic requirements for CEng.

The School of Engineering and the Built Environment at Napier University, whose motto is *"Really Useful Engineering"*, sees the provision for both Incorporated Engineers (IEng) and Chartered Engineers (CEng) as very important.

The programme provides a balanced mix of relevant theory and hands-on experience – "really useful engineering". Specialist facilities include: 24 hour access 500 seat engineering computing facility with CAD and engineering software including specialist Moldflow MPA and MPI; 4-axis CNC machining; rapid prototyping; materials characterisation and testing laboratories; polymer processing workshop with thermoforming, compounding, extrusion, compression moulding, injection moulding and blow moulding equipment. Students will gain practical skills in all these processes, including tool changing, setting, and process optimisation.

More information: Colin Hindle, Tel. 0131 455 2622, Email: c.hindle@napier.ac.uk, **Web:** www.soe.napier.ac.uk

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TB21: Vac-Forming for the 21st Century

Vac-forming is a process which offers specific benefits for the 21st Century.

Have your moulders been properly trained – or has 'sit by Nelly' training methods affected your productivity, quality and costs?

Designs and materials change and staff must understand the vac-forming process so that they can deliver new quality products at minimal cost.

Companies can no longer afford to release key people for general training courses in the hope that they will pick up the necessary new knowledge and moulding techniques.

For the last four years David Russell has been delivering tailor-made courses within companies. After a classroom introduction the training is conducted on the shop floor on the company's own products and machines. Specific company problems are addressed – at a time which fits the company's manufacturing programme. The companies get the benefit of over 20 years of hi-tech moulding and marketing experience in a dedicated course. A second visit is arranged two weeks after the initial session and free telephone technical support is provided for 6 months after the training.

The company is provided with comprehensive training documentation for the future.

Most moulders gain commercial benefit from the input which more than covers the cost of the specialist training.

David Russell has held senior management positions in vac-forming for 20 years and was latterly the MD of High Pressure Plastics (Hpp), the pioneers of High Pressure Forming in Europe, producing specialist parts for blue chip companies.

More Information: Web: www.consultdr.net

DISCLAIMER - for information of users

This newsletter is published for the information of GTMA members. It provides only an overview of the technical data, and no action should be taken without consulting the author or seeking professional advice. Therefore no responsibility for loss occasioned by any person acting or refraining from action as a result of the material contained in this newsletter can be accepted by the authors or the Association.

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Appendix 7 – The third issue of the electronic Technical Briefing

This issue focused on automation.

It should be noted that the quality of the Technical Briefing included in this dissertation does not reflect how it would have been received by GTMA members. It was sent electronically and is difficult to produce on paper as it was not designed for this purpose. Better quality versions of the GTMA Technical Briefings can be found at www.graphicmail.co.uk/GTMA.

TECHNICAL BRIEFING - Automation

ISSUE 5, December 2007

Contents:

INTRODUCTION

This issue of the Technical Briefing has the theme of automation. **Automation** can be described as the process of machines that follow a set sequence of operations, with no or little human labour, to control and complete manufacturing processes. It can have **many advantages for toolmakers**, which are presented, by your fellow members, in this Technical Briefing. Please contact Scott at GTMA (tb@gtma.co.uk), or use the links at the end of each article for further information. There will be the opportunity to speak to an expert on automation at the GTMA Emerging Technologies 08 event, details of which are included in article TB 26.

For the first time the **Technical Standards Update** has been included in the same online newsletter as the Technical Briefing. Please be sure not to miss it at the end of this Technical Briefing.

TB 22: If you Could Automate Small Batch Production - wouldn't you?

Keeping that spindle turning is the answer to meeting delivery deadlines and reducing costs. But how can this be done without increasing overheads. If your batch sizes are small, cycle times short or you work single shift then Erowa automation is just for you.

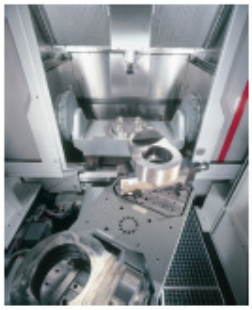
So what makes Erowa different from other forms of automation?
Standard out-of-the-catalogue Robot units keep the cost down but are highly configurable to suit widely differing applications.
Erowa Robots load standard precision pallets with fixtures or parts mounted off-line so preparation is carried out in parallel to the machine activity or during a manned shift.
A wide range of pallet sizes are available and the Robots can load a mix of pallet sizes.
Pallet sizes that suit the job means that Erowa Robots have a very small footprint and offer great flexibility and ease of use. Low cost pallets are loaded into the Robot for the next night shift or weekend – all your pallets do not have to be stored in the Robot magazine.

With optional control software and identification chips, Erowa Robots load the correct pallet and run the right NC program ensuring jobs are completed when you need them, right-first-time and with the workshop lights switched off.

More information: John Ryland, Joint Managing Director, REM Systems Limited, Tel. 01452 314100, Email: jryland@remsystems.co.uk, **Web:** www.remsystems.co.uk

REM will be giving a presentation on automation at the GTMA 'Emerging Technologies 08' event. Please see article 26 (below) for further information.

TB23: Flexible Pallet Handling and Storage for 5-axis Machining



German machining centre builder, Hermle, represented in the UK by Geo Kingsbury Machine Tools, offers multiple automation options for lights-out running based on pallet change, transport and storage. They can either serve one machine, or can be extended to configure a flexible manufacturing system. Likewise, there are robotic options for loading, handling and unloading components.

To give an idea of the machine builder's capabilities in this area, it offers the PW 160 automatic handling and storage system for up to seven machine pallets of 500 mm diameter or 400 x 400 mm. Capable of being factory-fitted or retrofitted, the system brings automation to the mould shop and complex component manufacturing environment, as pallets may be exchanged to and from the trunnion-mounted rotary table that provides the fourth and fifth CNC axes in Hermle C-Series machines.

In its simplest form, the PW 160 handles three pallets using a rotating 2APC (twin automatic pallet changer) fitted with double grippers at each end. It travels in the Y-axis direction, sharing its time between the machining area and a fixturing station at the front of the machine. The design allows a component fixtured on a pallet to be introduced to the working area and production to start while the next component is still being set up, minimising idle time. Additional flexibility can be obtained by increasing storage within the system to seven pallets.

Pallet management software is built into the machine control, either a Heidenhain iTNC 530 or a Siemens S 840D, both of which are Ethernet enabled for networking.

More information: Richard Kingsbury, Managing Director, Geo Kingsbury Machine Tools Limited, Tel. 023 9258 071, Email: mtools@gkholdings.com. **Web:** www.gkholdings.com

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TB 24: Automate or Die

'Automate or die' has been the rallying call for toolmakers to take the 'Automation Route' in order to unlock the potential within their businesses. The advantages of automation are unattended 'lights-out' production together with improved productivity. It reduces machine downtime and extends the working week and machine utilisation without having to take on any extra labour.

The ultimate destination for toolmakers taking the 'Automation Route' is optimum 24/7 working. Most companies will introduce automation in a planned programme that utilises the existing plant in the shop – probably the line of least cost – and also takes into consideration the current skill levels and work practises in the workforce. The programme has three key milestones:

1. Tooling – standardising on one workholding system throughout the shop primarily allows work pieces to be transferred from one process to another without any loss of positioning or accuracy. It is vital in many industries to select a tooling system that guarantees repeatable accuracy down to around 2 microns

2. Palletisation – this views tool holders as 'mini' pallets. Flexibility is the key in ensuring that different sizes and weights of work piece can be accommodated within the same system. Large pallet systems are available with capacities up to 10 tonnes.
3. Robots – total automation systems are a combination of tooling, palletisation, robots and an overriding software system that manages workflow and programmes the production cell. It is important to select a supplier that has a range of robots and that they have a successful track record in developing 'open architecture' systems. The more machines the robot can interact with the better.

State-of-the-art systems can include access online at all times to the entire production process and can also be remotely monitored by webcams.

A benchmark used is to compare the revenue generated per employee before and after installing automation. Increases in revenue by 18-24% have been seen. It is this added-value per employee that is the key to future prosperity for toolmakers that take the 'Automation Route'.

More information: Peter Lampitt, Head of UK Operations, System 3R UK, Tel. 01844 274455, Email: info@system3r.co.uk, **Web:** www.system3r.com

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TB 25: Toolroom Goes Wireless

FSG Tool & Die has implemented a wireless communications system for its turning, CNC grinding and high-speed CNC machining sections.

The company had been considering installing a wireless communication system for some while, and the recent relocation proved a spur to action. It was essential to create the minimum disruption to production and, in order to ensure that all went smoothly, FSG called on the expertise of DNC specialists J2com Ltd.

Jeremy Sobey of J2com explains; "We prepared proposals for both cabled and wireless installations. While the cabled solution was cheaper initially, it was clear that, in the longer-term, the wireless solution would provide greater cost savings because of the flexibility to move CNC machines about the shop-floor. An additional benefit of the system is that data can be stored in a more easily controlled way, as a central database now looks after all three machining sections on one server."

The installation at FSG consists of wireless serial device port servers for the turning and grinding machines, while the high speed machines utilise Ethernet wireless clients. Cimco DNC-Max V5.1 software is communicating remotely with CNC machines in the turning and CNC grinding areas, while for the high-speed CNC machining sections either FTP or NFS Ethernet server software is used.

FSG MD, Gareth Jenkins comments; "Altogether we are delighted with our move to a wireless environment and are thinking of moving to wireless machine monitoring / manufacturing data collection."

More information: Gareth Jenkins, Managing Director, FSG Tool & Die Limited, Tel. 01443 235800, Email: admin@fsgtoolanddie.co.uk, **Web:** www.fsgtoolanddie.co.uk

TB 26: Emerging Technologies 08

The GTMA is running the "Emerging Technologies 08" event, which is your opportunity to learn more about the new and emerging technologies within your industry that **could provide you with a competitive edge**.

Everyone is welcome to attend **free of charge**. Knowledge gained from the event should be **useful to decision makers** so that sound strategic decisions concerning new technologies can be made. **Apprentices can benefit** by having the chance to tap into the tacit knowledge of the experts that attend. 'Hot desks', where the experts will be situated during networking periods, will give the chance for companies to discuss their individual needs.

There will be a series of brief presentations on many different topics that include:
- Innovations in injection moulding
- Rapid prototyping
- Incremental die-less forming
- Electrical Discharge Machining
- **Automation**
- Thermoforming
- Cryogenic treatment
- Reconfigurable pin tooling technology
- Collaborative R&D projects

The variety of presentations will support cross **fertilisation of technology** between the GTMA sectors. The event will be held on 13th February 2008 at the Birmingham offices of Delcam UK. There is no charge for attendance but spaces are limited, for further information and to register for the event please use the contact details below.

More information: Scott Phillips, Project Manager, GTMA, Tel. 01844 274222, Email: scott@gtma.co.uk, **Web:** www.gtma.co.uk

What do you want?

You are invited to provide feedback on the Technical Briefing by completing a very short and simple online questionnaire. Feedback will be used to improve the briefings in order to give you what you want. Please use the link below to access the questionnaire:

http://www.questionpro.com/akira/TakeSurvey?id=855050

If you would like to add colleagues to the mailing list of the briefings you should email the names to jb@gtma.co.uk.

Don't Miss Out!!!

Links to previous online briefings can be found below:

Issue 4 - Polymer Training and Funding
Issue 3 - Laser for Tool Repair

Appendix 8 – Agenda for the Emerging Technologies conference

Emerging Technologies 08

GET INFORMATION ON THE NEW AND EMERGING TECHNOLOGIES WITHIN MANUFACTURING!

Date: 13th February 2008
Venue: Delcam UK, Birmingham
Time: 9:30am – 3:30pm

Please contact Leisa Goldsmith (leisa@gtma.co.uk or 01844 274 222) at the GTMA for more information or to register for the free event (lunch provided) – SPACES ARE LIMITED!!!

Please note that the agenda is subject to change

09:30am *Arrival and coffee*

09:45am *Introduction – Brian Griffiths (GTMA Project Advisor)*

10:00am **Hipermoulding** – PERA and Delcam

Three years of research has culminated in the launch of Hipermoulding software for thermal management in injection moulds. The new innovative approach of injection moulding and mould manufacturing processes will be presented along with examples of impressive validation cases - www.hipermoulding.com

10:15am **Direct Metal Laser Sintering – the coming of age** - EOS Electro Optical Systems

The presentation will be based on an update on the Direct Metal Laser Sintering technology plus an indication why the technology has taken off so well in the UK (the fastest growth in the world for EOS).

10:30am **Affordable automation** - REM Systems

We all know that one way to compete with low-wage economies is to remove the labour from our machines altogether. But automation systems have had a reputation for being too complex and too costly. This presentation will detail some recent developments that have simplified the automation process and significantly reduced its cost.

10:45am **T-ForM** – PERA

It is focused on the thermoforming industry and aims to reduce throughput-time reduction and first time right production by introducing a predictive mould design system. The results of the past 2 years work will shown - www.t-form.org

11:00am *Networking coffee break*

Event sponsored by Delcam UK

EMERGING TECHNOLOGIES 08

11:30am **Goodbye machining** – Surface Generation

Surface Generation's presentation will showcase the latest developments in Reconfigurable Pin Tooling technology and demonstrate how massive reductions in machining can be achieved using alternate manufacturing strategies. This will include methods which dramatically reduce Aerospace and Automotive prototype and short run tooling lead times and costs for thermoset and thermoplastic components for processes ranging from compression to injection moulding.

11:45am **Emold** – Rapra

A new concept of plastic injection processes in which moulds will pass from being passive elements to become networked active elements with embedded knowledge - www.emold.eu

12:00pm **Concept laser – rapid prototyping born from the tooling industry** – ES Technology Limited

LaserCUSING is the term used to describe the manufacture of fully dense metal parts directly from CAD by laser melting of powder. Concept Laser products, technology and applications will be introduced – particularly those which have been specifically designed for the tooling industry.

12:15pm **Flexform** – GTMA

It aims to develop the manufacturing methodology related to sheet metal components in order to cut product development times and manufacturing times whilst increasing capacity. Flexform focuses on European special vehicles manufacturing.

12:30pm **Incremental forming: Industrial application of incrementally formed sheet metal prototypes starts to be a hit** – OCAS

The time that incremental forming is only studied and used in academic areas, is over. For more than two years now, OCAS offers sheet metal companies the luxury of an affordable, rapid prototyping service, with incremental forming as the main process. Now that this technology seems to have reached industrialisation, it's time to summarize the benefits and to take a look at some examples.

01:00pm *Networking lunch*

01:45pm **KnowEDM** – CRDM Research

The project aims to boost precision machining by cutting lead times and developing knowledge-based automated EDM (Electrical Discharge Machining) technology - www.knowedm.com

02:00pm **Developments in EDM technology** - University of Birmingham

The talk will review the general area of electrical discharge machining (EDM) including recent advances in process productivity and minimum damage/clean cut generator technology. It will also

Event sponsored by Delcam UK

Pictures courtesy of: Top - Surface Generation. Middle - REM Systems. Bottom – ES Technology

EMERGING TECHNOLOGIES 08

highlight recent developments in ED milling, ED grinding, ED texturing, ED surface alloying, ED micro machining, the use of water based dielectrics for die sink operations and finally touch on 'dry EDM'.

02:15pm **Who's got Walt Disney's head?** - Cryogenic Treatment Services

A light hearted glance at the common myths and a serious look at some of the developments in the field of cryogenics and how these can offer real bottom line saving to engineering companies and their end customers. Some case studies with current applications.

02:30pm **Adding value – the value chain for the future** – Delcam Professional Services Group

Find out how the group can undertake consultancy projects that help companies introduce innovative manufacturing processes and embrace leading edge technology and its development. Good quality partnerships are nurtured through networking organisations during projects. Companies who have taken advantage of this have reduced the overall design and manufacturing costs, enabled new products to come to market more quickly whilst ensuring an accurate product is produced first time.

03:00pm **Tour of Delcam's toolroom facilities**

03:30pm *End of event*

Event sponsored by Delcam UK

Pictures courtesy of: Top - Surface Generation. Middle - REM Systems. Bottom – ES Technology

Appendix 9 – Positive press coverage of the Emerging Technologies conference

Emerging Technologies Event Draws Enthusiastic Audience

A Rofin-Baasel LaserCusing® tool insert for a vacuum cleaner cover, representing a cutting-edge technology discussed at GTMA's Emerging Technologies event.

The recent Emerging Technologies event sponsored by the **Gauge and Tool Makers Association** (GTMA) and hosted by member company Delcam at its Birmingham facility proved a resounding success, attracting more than 80 visitors from across the UK. The day consisted of brief presentations on a range of topics, including automation, direct metal sintering, rapid prototyping, thermoforming, and the latest innovations in injection moulding. Enabling attendees to gain insight into many new technologies in a short space of time, this format was very popular.

"In order for engineering companies to survive in today's competitive environment, it is essential that they keep informed of the latest trends and opportunities," comments GTMA chief executive officer Julia Moore. "As OEMs divest their companies of all but their core competencies, they pass their technical and development requirements down the supply chain. However, these small and medium-sized enterprises (SMEs) are often so keenly focused on day-to-day operations that scanning the horizon for technological developments is a low priority."

Continues Moore: "This is where universities, research centres, and trade associations can help by providing opportunities for SMEs to become aware of, and involved in, new product and process technologies, new markets, new techniques, and new standards and regulations."

Attendee Steve Hebdon, a senior development manufacturing engineer for BAE Systems Electronics and Integrated Solutions, says that he and his colleagues benefited from their experience in Birmingham.

"Points of contact gained have proved to be very valuable," he reports, "and have led us to follow up on a number of new technologies and possible future production methods."

Gauge and Tool Makers Association
PRINCES RISBOROUGH, BUCKS, UK
www.etmm.info/2008/05/028

Appendix 10 – Questionnaire sent with second hardcopy Technical Briefing

Presented is the questionnaire sent out with the GTMA's second technical newsletter, the Technical Briefing. Its purpose was to find out what GTMA members thought of the Technical Briefing. This was sent out during January 2007 using online survey software, QuestionPro. The format of the questionnaire presented here is not the same as the one that was sent out, due to the fact that it was not possible to reproduce the format of the online version in a hardcopy format. For the online version question five would either branch to question six or seven depending upon the recipient's response to question five.

Technical Briefing Two Questionnaire

Dear member.

You have been invited to participate in the GTMA Technical Briefing survey. You will be asked to complete questions regarding the Technical Briefing and technical information. It is important that the GTMA receives feedback about the Technical Briefing so that future issues can be improved and so that you get what you want!

It should take approximately one minute to complete. In order to qualify for the chance to win a Marks & Spencer voucher please supply your name and email when prompted.

Your participation in this study is completely voluntary. If you feel uncomfortable answering any questions, you can withdraw from the survey at any point. The answers that you give will be treated as confidential.

If you have any questions at any time about the survey then please contact Scott Phillips (GTMA) by phone on 01844 274222 or by email at scott@gtma.co.uk.

Thank you very much for your time and support.

1.

Company:

Name:

Job role:

Email:

2.

How favourable is your reaction to the Technical Briefing?

- ☐ Excellent
- ☐ Very Good
- ☐ Good
- ☐ Fair
- ☐ Poor

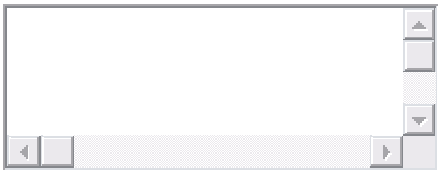
3.

	Excellent	Very Good	Good	Fair	Poor
How useful was the Technical Briefing?	☐	☐	☐	☐	☐

How would you rate the 'technical quality' of the articles?	☐	☐	☐	☐	☐
How would you rate the layout of the Technical Briefing?	☐	☐	☐	☐	☐

4.

Comments / suggestions for improvement



5.

Do you want articles at their present length, or more or less words?

☐ Less ☐ Same ☐ More

6.

A little less or a lot less?

☐ Little less ☐ Lot less

7.

A little more or a lot more?

☐ Little more ☐ Lot more

8.

Please rank the formats of receiving technical information by placing 1 next to the format most preferred, a 2 next to the format of next preference and so forth until all items are ranked.

Data i.e. tables ☐

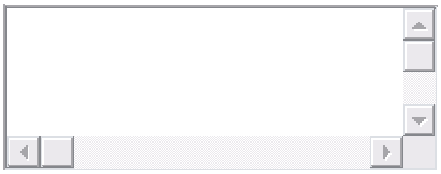
Diagrams ☐

Pictures ☐

Text

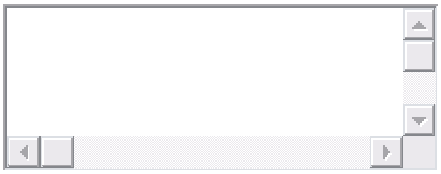
9.

What do you most like about the Technical Briefing?



10.

What do you least like about the Technical Briefing?



11. ***Please answer more than one if necessary***

Which groups of people within your company do you expect to be the greatest users of the Technical Briefing?

- Design
- Engineering
- Management
- Senior Management
- Sales
- Other

12. ***Please answer more than one if necessary***

Where do you currently get the best new technical information from?

- Journals / trade magazines
- Networking with others in your sector
- Newsletters
- Other organisations, such as research establishments
- The internet
- Other

13.

Typically, how often do you need to look for new technical information?

- ☐ Everyday
- ☐ 2-3 times a week
- ☐ 4-6 times a week
- ☐ Once a week
- ☐ 2-3 times a month
- ☐ Once a month
- ☐ Less than once a month

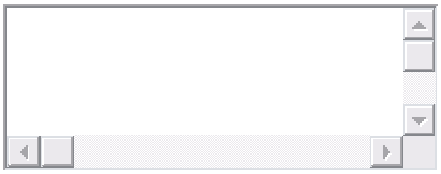
14.

Please rank the methods of receiving the Technical Briefing by placing a 1 next to the method you most prefer, a 2 next to the method that's your next prefered and so forth until all items are ranked.

Email	☐
Fax	☐
Online (on GTMA website in members area)	☐
Post (hardcopy)	☐

15.

Please give any suggestions for technical information that you would like to see in the Technical Briefing



Thank you for taking the time to participate in this evaluation.
Please contact scott@gtma.co.uk if you have any questions regarding this survey.

Appendix 11 – Questionnaire sent to ThermoForum

Presented is the questionnaire sent out electronically to the ThermoForum created in relation to the collaborative project T-ForM (Section 6.6.2). Its purpose was to find out what thermoforming companies in the United Kingdom wanted from a forum. This was sent out during March 2007 using online survey software, QuestionPro. The format of the questionnaire presented here is not the same as the one that was sent out, due to the fact that it was not possible to reproduce the format of the online version in a hardcopy format.

Thermoforming Forum Questionnaire

Dear forum member.

You have been invited to participate in the thermoforming forum questionnaire. You will be asked to complete questions regarding the UK Thermo and Vacuum Forming Industry Forum. It is important the GTMA receives feedback about the forum so that you get what you want!

It should take approximately two minutes to complete.

Your participation in the study is completely voluntary. If you feel uncomfortable answering any questions, you can withdraw from the survey at any point. The answers that you give will be treated as confidential.

Thank you very much for your time and support.

1.

Company: *

Name: *

Job role:

Email: *

Number of employees in your company:

2.

Please specify your position within the thermoforming industry:

- ☐ Thermoforming company
- ☐ Mould making company
- ☐ Design agency
- ☐ Material supplier
- ☐ Equipment supplier
- ☐ Other

3.

Are you involved in industries other than thermoforming?

☐ Yes ☐ No

4.

If yes, what industries?

5. ***Please select as many options as you like***
What industry sectors are you involved with?

- ☐ Aerospace
- ☐ Automotive
- ☐ Leisure i.e. caravans
- ☐ Medical
- ☐ Packaging
- ☐ White goods
- ☐ Other

6.

Are you looking to diversify?

☐ Yes ☐ No

7.

If yes, please specify what area:

8. ***Please select as many options as you like***
What are your motives for joining the UK Forum for the Thermo and Vacuum Forming Industry?

- ☐ Learn about development of T-ForM
- ☐ Networking opportunities
- ☐ Provision of area to exchange knowledge
- ☐ Support services
- ☐ Find out about new thermoforming technologies

- [ ] Raise profile of thermoforming industry
- [ ] Publicity as a result of being a member of the forum
- [ ] Marketing
- [ ] Other

9.

Please rank the methods of receiving updates regarding the forum or T-ForM by placing a 1 next to the method you most prefer, a 2 next to the method that's your next preferred and so forth until all items are ranked.

Email

Fax

Online (website)

Post (hardcopy)

10.

Please state if there are any services that you would like the UK Forum for the Thermo and Vacuum Forming Industry to offer:

11.

Please state any issues that you would like to see addressed by the forum:

Appendix 12 – Questionnaire given to delegates of Emerging Technologies 08

Presented is the questionnaire handed out by hand to the delegates of the Emerging Technologies 08 conference that the GTMA held (Section 6.7). Its purpose was to find out what delegates thought of the event. This was handed out during the conference in February 2008. No introduction text was provided with this questionnaire as a presenter at the Emerging Technologies 08 event communicated why and how the questionnaire should be completed.

Emerging Technologies 08 Delegate Questionnaire

Optional Information

Name:

Title:

Company:

Email Address:

How did you hear or learn about Emerging Technologies 08?

- ☐ GTMA website
- ☐ Flyer (hardcopy)
- ☐ Internet
- ☐ Phone call
- ☐ GTMA email / newsletter
- ☐ Referral
- ☐ Email / newsletter (not GTMA)
- ☐ Other:

Please specify the main reason for attending this event:

- ☐ Content
- ☐ Networking
- ☐ Personal growth & development
- ☐ Speakers
- ☐ Other:

Did the event fulfill your reason for attending?

- ☐ Yes -- Absolutely

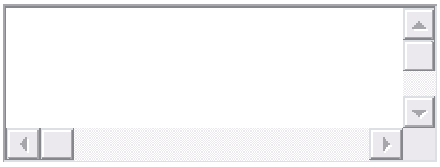
- Yes -- But not to my full extent
- No

Please tick as many as you like.

Which speaker(s) were you mostly interested in listening to?

- Speaker 1 - Hipermoulding
- Speaker 2 - Direct metal laser sintering
- Speaker 3 - Affordable automation
- Speaker 4 - T-ForM
- Speaker 5 - Goodbye machining
- Speaker 6 - Emold
- Speaker 7 - Concept laser
- Speaker 8 - Flexform
- Speaker 9 - Incremental forming
- Speaker 10 - KnowEDM
- Speaker 11 - Developments in EDM
- Speaker 12 - Who's got Walt Disney's head?
- Speaker 13 - Adding value

What was the most beneficial aspect of the conference:



Please indicate your overall satisfaction with the Emerging Technologies 08 event

	Very Satisfied	Somewhat Satisfied	Neutral	Somewhat Dissatisfied	Very Dissatisfied
Conference Content	☐	☐	☐	☐	☐
Networking	☐	☐	☐	☐	☐
Venue	☐	☐	☐	☐	☐

Food & Beverage ☐ ☐ ☐ ☐ ☐

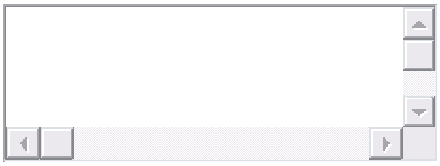
How many external technical conferences/seminars do you attend, on average, in a year?

☐ 1 - 2

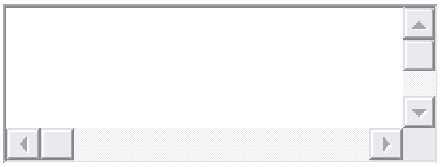
☐ 3 - 5

☐ 6 or more

What other topics or themes are of interest to you for a conference:



Additional comments about the Emerging Technologies 08 event:



Thank you for taking the time to participate in this evaluation.

Please contact scott@gtma.co.uk if you have any questions regarding this survey.

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