

ITB Journal



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Editorial

I am delighted to introduce the eight edition of the ITB Journal, the academic journal of the Institute of Technology Blanchardstown. The aim and purpose of the journal is to provide a forum whereby the members of ITB, visitors and guest contributors from other third level colleges can publish an article on their research in a multidisciplinary journal. The hope is that by offering the chance to bring their work out of their specialised area into a wider forum, they will share their work with the broader community at ITB and other academic institutions.

In this rather large eight issue we have once again a diverse mix of interesting papers from across a range of different disciplines. Respect for cultural difference and diversity forms one of the major themes in this ITB Journal. In this regard we have a paper on Teaching Culture in Business Studies from Nathalie Cazaux; a study of Diversity in the Workplace by Fionnuala Darby, and a paper on Multiculturalism in Secondary Schools – a Linguistic, Socio-Political & Pedagogic Perspective, from Maria Kenneally. A collaborative research team, Kabita Shakya and Catherine Deegan of ITB, and Fran Hegarty, of the Department of Medical Physics and Bioengineering, St James's Hospital, Dublin, report on their work in a paper on the Determination of the frequency response of an end tidal CO₂ analyser. An ITB research team working on AI and computer games give us a paper on Pathfinding in Computer Games. The team are: Ross Graham, Hugh McCabe, and Stephen Sheridan. We have a paper on current thinking and issues in problem based learning: A Preliminary Investigation of the Role of Problem Based Learning (PBL), from Alan Pike and Declan Barber, of ITB. Frameworks and systems appropriate for next generation networks are discussed in two papers in this ITB Journal. These are: Embedded Systems in a Mobile Distributed IP Network by Conor Gildea and Declan Barber, and Towards a Framework for Modelling Multimedia Conferencing Calls in the Next Generation Network by Gavin Byrne and Declan Barber. A study of Internet usage in second level schools is given by Tom Nolan, of ITB and Mark Humphrys. School of Computer Applications. Dublin City University. The paper is called Problems with Internet and Library Usage For Secondary School Children. The final paper from Sandy Fitzgerald, Director of CultureWorks and former Director of the City Arts Centre, is entitled Space - The Final Frontier and is a critical review of the effects of consumerism within our society and reflects on the ghettoisation of inner space of the individual as a consequence of this. Once again, we hope that you enjoy the papers in this issue of the ITB Journal.

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Teaching Culture in Business Studies

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Abstract

Nowadays, an intercultural component needs to be integrated in the development of any business course and research in the field of Intercultural Studies outlines issues directly relevant to the Business world. Research findings have underlined the complexity of concepts such as Culture and Stereotypes. In the light of these findings, future business courses incorporating an intercultural dimension should be developed.

I Introduction

Is globalisation reducing distances between societies? Are we becoming more identical? Although people complain about the similarities of shopping centres across Europe, this uniformity only happens at a superficial level. At a deeper level, studies show that differences between cultures are difficult to erase or overlook. Far from making every one fit in the same template, globalisation encourages differences, as Hampden-Turner and Trompenaars explain: “(...) cultural characteristics appear to persist long-term, even when managers cooperate cross-culturally. In longitudinal studies, British and French management students, educated together at INSEAD in Fontainebleau (sic), near Paris, became more distinctly British and French culturally as the course progressed. Eurocrats in Brussels, after 18 years of collaborative, international work, become more distinctively national in their views.” (1994: p. 375). The same is true in multinational corporations where “cross-cultural interaction reminds members of various notions of the differences between one set of cultural views and another, and this seems to lead to a slight intensification of cultural traits, perhaps to protect and confirm these and so maintain identity” (ibid.).

In a market place such as Ireland where survival depends on the ability to export, it is highly important to define a strategy which will help companies to develop a cultural competence. At the time when products need to become global, companies must understand the complexity of the market they wish to trade with and the complexity of its customers. Courses in Business must reflect this situation and equip the workforce with a sufficient level of intercultural competence.

In Intercultural Studies, Culture and Stereotypes are two basic concepts which need to be considered. This paper will present a quick overview of landmark researches in the field, with a particular attention on stereotypes. It will finally sketch the type of course needed to be

developed if we want to effectively educate the business force of tomorrow.

II Culture and Stereotypes

2.1 What is Culture?

Culture is a widely used term apparently understood by everybody but which turns out to be complex under close scrutiny. First of all, culture does not exist in a vacuum and can only be defined in respect and comparison to another one. Each group emphasises its own value in comparison with other groups: each group defines itself against other groups and will reinforce its own rules and values when in contact with other groups: Gauthey and Xardel note that identity only exist in difference: “L’identité n’existe que dans le rapport au différent” (1990: p23). They add that when mixed, differences do not tend to disappear (the contrary seems to be happening) because cultural codes are deeply rooted at the emotional and subconscious levels. In 1990 they forecasted that intercultural tensions would *increase* as the world becomes globalised and they seem to have been proven right.

The following represents a body of research which needs to be considered when developing an appropriate business syllabus.

Edward.T. Hall is an influential American Researcher who worked as an army engineer in Europe for several years, a position which gave him the appropriate personal experience for the basis of his research. His work focuses particularly on the cultural differences regarding time, space and context. In his book called *The Silent Language* (1959), he opposes two systems; a monochrone system like in the USA or Germany where tasks are dissociated, where there is a high level of planning, and an agenda needs to be set and a polychrone system in which several tasks can be done at the same time, with a possibility of changing the agenda. In these societies visual contact is important, and gestural language is used, in Southern Europe for instance. Since his first book, Hall has been researching intercultural communication extensively with a particular interest in non-verbal communication, which he claims represent 70% of the totality of a message and is culturally coded. He has applied his theory to the Business world in books such as *Hidden Differences: Studies in International Communication* and more recently *Understanding cultural differences* (1990).

Another prominent figure in Intercultural Studies is Geer Hofstede who conducted a massive research in one firm (IBM) throughout the world and identified the now classic four main factors of differences between cultures:

1. Uncertainty avoidance

2. Power distance
3. Masculinity-femininity
4. Individualism-collectivism

Through an extensive use of survey, questionnaires and interviews, he succeeded in defining several cultures in relation to the four items listed above. Each culture has been classified as having high or low uncertainty avoidance, high or low power distance, etc. This classification is actually very helpful for managers in Intercultural situations as it helps to forecast and maybe solve problems as they arise in Intercultural settings. For example, in his books Hofstede develops the concept of hierarchical distance, which depends on historical and religious contexts. He claims that it can be more or less long; from Great-Britain (short), to United-States (middle) to France, Latin and developing countries.

Further ground-breaking research was conducted by Fons Trompenaars in the early 90s. In his book *Riding the waves of Culture*, Trompenaars describes culture as “the way in which a group of people solves problems” (1993: p.6 in bold). For him, culture is “a shared system of meanings” (1993: p.13). He identifies several layers in any given culture, and explains that “Culture comes in layers, like an onion, to understand it you have to unpeel it layer by layer” (1993, p.6). Trompenaars defines the first layer (*outer layer*) as being the explicit products of a culture: language, food, culture, shrines, markets, fashion, arts or buildings. For instance, skyscrapers in the U.S. show the importance of private power, the importance of upward mobility, the idea that the more the better and the focus on material success which are pillars of American society (to some extent, as always, as these values seem to emerge from a Protestant ethic). The second layer is called *middle layer* and encompasses norms (what is right and wrong, written laws or social control: “This is how I should act”) and values (what is good or bad, ideals; “This is how I desire/aspire to behave) of a society. Finally, the *core of a culture* is organised around its assumptions about existence. Trompenaars also presents three levels of culture: national, corporate (or organisational) and professional. The latter posits that for example two Human Resources Managers might share more values and have more in common than two people from the same country but from a different professional background (see also Singer, 1998). However there is a strong case for cultural differences in the work place, as noticed by Trompenaars, where for example North-Western Europeans can be defined by their need for analysis, logic, systems and rationality whereas Euro-Latins are more person-related, use more intuition and sensitivity (1993: p.7).

Finally, Gauthey and Xardel (1990) have defined eight main cultural environments, which

cover different functions and where understanding difficulties can arise. These levels will have to be analysed before any business venture deals with a different culture:

1. Religion/dogma (meaning: can vary from Muslim fatalism to Protestant action)
2. Language (communication: verbal and non-verbal)
3. Society (organisation: more or less egalitarian). France has also less social mobility than America. (Six times more executive from lower middle class in America than in France)
4. Education (formation and transmission. They posit that France's education system privileges a conceptual and deductive approach whereas in Anglo-Saxon education, an empirical -through case studies- approach is favoured.)
5. Economy (production and distribution)
6. Political system (authority)
7. Legislative system (rule making: common law -deciding on the basis of previous cases or Roman law based on a constitution)
8. Technology (creation: hardware-tools, machinery, buildings, etc. /software -sciences, culture, technology...)

As these lists show, culture is a highly complex concept which can be understood from different points of view: it is all the more important to keep these different aspects in mind when developing a course.

The main problem lies in the fact that when we communicate with other cultures, we perceive their behaviour through our own cultural frame and alien attitudes might not suit ours. Bessis (in Bosche, 1990; p.142) remarks that "Apprendre une langue, des langues n'est pas fondamentalement hors de portée. Ce qui est plus ardu, c'est d'envisager la langue non seulement comme des mots et des sonorités différentes des nôtres, mais comme un ensemble langue-culture. Il est effectivement plus difficile de communiquer dans une langue si on ne la rattache pas à la civilisation, à la représentation mentale qui la sous-tend." (To learn a language is not an impossible task. What is more difficult is to apprehend language not only as words and sounds different from our own but also as a language-culture package. It is effectively more difficult to communicate in a language if we do not attach it to the civilisation, the mental representation that lies under it).

She also notes that: "Aborder une négociation interculturelle ne nécessite pas seulement de connaître ses objectifs, ses marges de manoeuvre et le fond du dossier. Il est beaucoup plus indispensable et efficace de s'être entraîné au décodage des messages non-verbaux, ce qui

inclut la connaissance de l'étiquette" (To deal with an intercultural negotiation, not only you need to know the objectives, your leeway and the bottom facts but you need to know how to decode non-verbal messages, including etiquette) (in Bosche, M., 1990: p.147). These two points are extremely important to keep in mind when developing business courses; Bessis points out that in order to be efficient professionally, our business students need more than their usual business skills with a language on top of that. They also need, and maybe even more so, a real cultural competence. A year abroad such as the ones organised through Erasmus definitely contributes to the students' experience of intercultural relations but it might not be as positive as lecturers would like them to be. The reality is that students need tools with which they can make the most of such an experience.

Particularly, individuals do not realise the influence of their culture on their behaviour although their culture has major repercussions on their perceptions and on the organisation of the group they belong to: Hampden-Turner and Trompenaars explain that "there is in every culture a tacit dimension, a set of beliefs that are subconscious because the members of that culture take these so for granted that they fall below the threshold of awareness" (, 1994: p.2). In France, for instance, hierarchical structures can be found at every level of society: French culture puts an emphasis on power and French society is highly hierarchical with little mobility, an elitist education system and a patriarchal family structure (Gauthey and Xardel, 1990: p.18). However, culture is always evolving and in the world of business where intercultural mergers are becoming extremely common; "Il faut bien garder à l'esprit ici que la culture n'est pas quelque chose de figée, d'ancrée dans le passé qui s'opposerait à tout changement, mais est au contraire une force vivante qui, prise en considération, peut permettre de cristalliser des projets de société holistes et donner ainsi une orientation au développement » (one has to keep in mind that culture is not something set in stone, attached to the past and against any kind of change, on the contrary, culture is a living force, which, when taken in account, can enable the creation of holistic project and thus give a new direction to development) (Eberhard, 1996: p.6). Of course, the question of whether or not cultural competences can be taught should also be investigated.

2.2 Stereotypes and Intercultural behaviour

According to the Oxford Dictionary, a stereotype is a "widely held but fixed and oversimplified image or idea of a particular type of person or thing". Any intercultural knowledge takes its root at the stereotype level. Stereotypes are sometimes dismissed as something that should not be considered in intercultural studies courses because they are perceived as inherently dangerous and misleading. However, while stereotypes should not form the main framework of the course, they do represent an essential part of our ability to understand others and hence

should be integrated in any intercultural curriculum. The key when dealing with stereotypes is to recognise them for what they are: a ready-made box where to put people who do not fit in our own. They represent a powerful classification device and help understanding and memory by helping people to construct frames that enable them to foresee and plan actions. This functionality has the danger of simplifying reality at a conceptual level and often results in discrimination. One is expected to go beyond; one always has to start from the admission of the stereotype and try to understand it (from the perspective of both the person who emits and the person who receives it) (Bosche, 1990). “Il est important d’interroger l’outil de mesure, qui n’est certainement pas neutre culturellement lorsqu’on interroge les différences culturelles.” (It is important to consider the measurement tool, which is certainly not neutral when dealing with cultural differences) (Bosche M., 1990: 101). In addition, although stereotypes have an inherent capacity to evolve depending on situations -education and mobility have for instance an impact on stereotypes- they can be difficult to dissipate. In the development of courses, stereotypes form a base on which to start reflecting on intercultural issues because every culture has developed some sort of stereotype, sometimes to such an extent that it appears in its language (in French for instance, “être saoul comme un polonais” -to be drunk as a Pole). To this form of stereotype must be added a more pernicious one, which appears as *expectations* towards an alien culture (For example, French are often portrayed as being rude). Too often, these hidden stereotypes jeopardize the intercultural exchange. Bosche notices that “La connaissance en management interculturel se limite encore trop souvent à des stéréotypes” (too often intercultural management is limited to this type of stereotype) (1993: p.12). The line between observed cultural traits (generalisations and interpretations of actions by an outsider) of such and such culture and stereotype is very thin and it is important to examine the two very closely when dealing with intercultural situations. For instance, when Trompenaars posits that “The French tend to identify with la *France*, la *famille*, le *cadre*; the Japanese with the corporation; the former eastern block with the communist party; and Ireland with the Roman Catholic Church” (1994, p. 53). The stereotype of the Irish as primarily belonging to the Catholic Church group seems to be oversimplified nowadays.

Here is a questionnaire that can be used as a practical survey in the intercultural class. An adaptation from Cazal in Bosche, (1990: pp196-209), it works well as an ice-breaker to start a discussion about stereotypes.

Item	Agree	Disagree	Don't know
Stereotypes regarding values			
French people appreciate beauty			
French people know how to enjoy life			
French people are rude			

French people are religious			
French men are machos			
French people have no scruples			
French people feel pity for others in difficulty			
French people lie easily			
French people accept that others' differences			
French people do not have a critical mind			
French people are proud			
French people have respect for the old			
French people have respect for others who have been there for a longer amount of time			
French people do not say what they think			
French people are patriots			
French people are materialists			
French people have humour			
French people give sexuality too much importance			
2. Stereotypes regarding usage			
Social etiquette is more important than personal consideration for French people			
French people eat unappetizing food			
French people know how to behave at the table			
French people know how to drink			
French people take great pride in their clothes			
French people have a particular way to organise their desk			
3. Stereotype concerning relation towards Time			
French people can do several things at the same time			
French people establish clear priorities in their work			
French people plan their agenda several weeks ahead			
French people scrupulously follow the established programme			
French people are always on time for a meeting			
French people want to have results too quickly			
French people are loyal			
French people can hold engagements			
4. Stereotypes concerning cognitive modes			
French people think in the same way as Irish			
French people are very logical			
French people always notice small details			
French people have difficulties with abstraction			
French people anticipate facts with logic			
French people believe more in their feelings than in their intellect			
French people are intuitive			
French people have more an abstract than a concrete mind			
5. Stereotypes regarding emotional expression modes			
French people are loyal in friendship			
French people have an inferiority complex			
French people listen to people			
French people are emotionally fragile			
French people can be very sensitive to other people's feelings			
French people know how to avoid ridicule to someone else in an embarrassing situation			
French people are aggressive when in a stressful situation			
French people show easily their resentment in conversation			
French people think that you should also say disagreeable things in conversation			
French people remain calm under pressure			
French people keep quiet in stressful situation			
French people have a good heart			
French people are afraid of being ridiculed			
6. Stereotypes regarding volition			

French people want to be efficient first of all			
French people start a new work with enthusiasm			
French people have a tendency to complete their work quickly but badly			
French people are hard-working			
French people think before acting			
French people lack will			
French people have strong work methods			
French people are easily discouraged			
French people are creative in their work			
French people use their manual ability to counter-act their intellectual disabilities			
7. Stereotypes regarding non-verbal communication			
French people are quite attractive			
French people's face is very expressive			
French people often smile			
French people use their hands when speaking			
French people look at others intensively			
French people only look at others' eyes furtively			
French people look others right into their eyes			
French people keep their eyes down as a symbol of humility			
French people smell			
French people like physical contact			
French people speak very close			
French people fear silence in conversation			
French people speak too much			

Cazal notices that people responding to such questionnaires have a tendency to answer and not use the third choice "do not know" and calls this a "propension à savoir" (a propensity to know) (in Bosche, 1990; p.210).

In conclusion, stereotypes represent a good introduction to intercultural studies because they are easily accessible, present in every group and used by everybody. However, as we saw in the first part of this paper, Culture is a highly complex concept which permeates several layers: they should only be a stepping stone in intercultural studies. The following section will present some ideas that should be considered when designing a course.

III Designing an International Business Course

Nowadays practically all businesses need to be international. Intercultural situations are becoming increasingly common and there are several levels where misunderstanding might happen. A holistic business course should have at least one component preparing the students to the shock of dealing with another culture.

First of all students should be made aware of the obstacles to intercultural communication. As a start, the lack of knowledge of one's own culture and its implications should be considered. In order to communicate efficiently with other cultures, students should be expected to have some knowledge of their own culture, even if not in depth; they should have a notion of their

history, the geo-political situation of their country and should be made aware of current affairs. Business students should also have knowledge of at least another culture in the same way. The study of both these would feed into each other and should always be consciously integrated into each other. In order for this to work, students have to be reminded of the importance of this knowledge. The *Elise* research conducted by the Interesource Group Consulting is a good start as it shows to what extent Irish companies need business people with an international competence (39% of Irish companies recognised having lost business due to a misunderstanding with a European partner). Gauthey and Xardel add that “(...) toutes les négociations commerciales nécessitent le développement d’un langage commun pour échanger de l’information, des concepts, des intentions.” (All commercial negotiations need the development of a common language in order to exchange information, concepts and intentions) (1990: p.83). Knowing other cultures also help to combat ethnocentrism and go beyond stereotypes.

A set of good practice will be encouraged as early as possible through knowledge of own and others' culture, language, willingness to take part in other culture and be ready for change. What Gauthey and Xardel propose is to try to analyse and prevent divergences and use them to create synergies, which will make the most of cultural differences. For example, According to Amado, Faucheux and Laurent, American organisations are represented by a system of tasks and goals to achieve where management is a tool to reach these goals. On the other hand, Latin organisations focus on people, organised in a hierarchy according to a vertical distribution. (Gauthey and Xardel, 1990: p13). These discrepancies may result in loss of competitiveness and business. Some solutions can be envisaged regarding communication (interpersonal, person/group, institutional) and organisation (assignment of responsibility, structures, planning) and human resources management (selection, mobility, etc). Only managers with a knowledge of both their own and other cultures will be able to benefit from the cultural differences at hand. Additionally, a solution could be to help students to create new cultures that will be suitable for all in future organisations.

Solutions to intercultural problems lie in the internationalisation of business courses and the internationalisation of students. They must be ready to study abroad for at least a few months. Tomorrow's business people need to understand what is at stake in intercultural exchanges and recognise differences within their organisation and/or with their partners and customers. Cultural differences can only become an asset if the management knows how to use it; managers need to master at least one foreign language and to gain a cultural competence which will help him or her to survive in any intercultural setting.

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Diversity in the Workplace

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1 Introduction

According to the preliminary report from the central statistics office concerning the Census 2002¹ net immigration continues to rise. Net immigration (the balance between inward and outward migration) is estimated to have reached 28,800 in the year to April 2002. The number of immigrants is estimated to have increased to 47,500 in the year to April 2002. The main features of these figures are:

- Nearly half of all immigrants originated from outside the EU and USA.
- 50% of the immigrants were aged 25-44 years.
- Returning Irish immigrants continue to be the largest immigrant group, though this share has been declining steadily from its 1999 level of 55 per cent.
- 35% are nationals of countries other than the EU and USA. This compares with over 26% in the previous year.
- UK nationals represent 11% of immigrants compared with 13% for the rest of the EU.
- All counties benefited from the combined effect of inward and internal migration flows during 1996-2002. The greatest gains were recorded in Meath, Kildare, Westmeath, Wexford and Laois.

Immigrant workers, the traveling community, single parent households, older workers, women in the workplace, workers of colour, workers with limited educational experience, persons with disabilities and dual career families all represent in real terms how diverse the Irish workplace has become. Workplace diversity is a multifaceted issue as outlined above. It is a hope and aspiration that most people hold the belief that every human being is of equal worth, entitled to the same privileges and opportunities, without regard to race, gender, disability or age. This fundamental belief has led to changes in management practices primarily relating to the recruitment, training and retention of employees who reflect the changing face of the Irish workforce.

In the broadest sense, the management of diversity is a business's reaction to rapid cultural and sociological changes. "Internally, diversity management means providing a climate where

¹ www.cso.ie/census/pressrelease.htm

all employees feel that they are valued by and contributing to an organisation. Externally, it means that organisations are flexible and astute about changes occurring in world markets.’² The hard truth, however, is that inequalities exist for employees within organisations due to stereotyping and preconceived ideas about a person based on race, gender, religious or cultural origins, age, physical or mental limitations and more. Racism, sexism, homophobia, etc., can not be managed away. It is precisely these beliefs and perceptions that necessitate managing diversity.

Being an employer of choice requires respects for the talents of all individuals regardless of gender, race, disability, age, religion etc. It means being fair to all in recruitment, promotion and the development of the workplace thereby capitalizing on the added value that diversity brings. So there is a clear business case for doing this thus warranting the subject to be included on third level programmes of education.

Companies who want to be aware and contribute to their community make a commitment to continually improve their impact on society. How they recruit, employ, train and develop their employees is central to how a company translates this commitment into action. “Every business has an interest in becoming an employer of choice and increasingly people are choosing which company to work for on the basis of how a company demonstrates its social responsibility.”³ A commitment to managing diversity in the sphere of corporate social responsibility draws in new sources of talent from beyond the traditional pools – from neighbourhoods where post codes can reduce job opportunities, from sectors of society subject to prejudice. The increased diversity that results also brings innovation and puts a business in closer touch with its wider marketplace.

This paper proposes to examine fundamental issues facing employers in Ireland with regard to managing diversity. The following sections of the paper highlight the Irish experience to date in two organisations namely, Dublin Bus and Beaumont Hospital. An attempt is then made to define diversity based on academic readings and included in defining diversity is an explanation of what diversity is and what diversity certainly is not which the author feels aids to give a more precise definition of what is meant by diversity in the workplace. The paper then goes on to discuss the national Irish identity and suggests arguments that if others do not measure up to the current national identity that they are somehow different. These differences in a majority of cases have negative connotations. Finally the paper concludes with an insight into research

that has been conducted by an external partner to an Equal project of which the Institute of Technology, Blanchardstown is also a partner.

The author feels that a brief introduction and explanation to Equal is important as it was a direct result of being involved in this project that this paper was created;

2 What is EQUAL?

Tánaiste and Minister for Enterprise, Trade and Employment, Mary Harney launched the EQUAL Community Initiative Programme on Wednesday June 6th last, 2001.⁴ The EQUAL Community Initiative Programme seeks to improve access to employment for people who are disadvantaged.

“The EQUAL programme will look at new ways of tackling disadvantage and discrimination affecting women, older persons, lone parents, long-term unemployed, travelers, and people without basic skills including literacy, numeric and IT, ex-offenders, people with disabilities or those suffering from other disadvantages such as drug misuse.” (Harney, M – Press Release 06/06/02).

EQUAL is one of four Community Initiatives co-financed by the European Union 2000-2006. EQUAL seeks to identify and address fundamental forms of discrimination and inequality in the labour market. A total of 21 projects were approved by the EQUAL Community Initiative in Ireland. ITB is a partner on one of these projects called the DAWN DP⁵. All projects have a Development Partnership, DP, which has the responsibility for the strategic management of the project.

This paper is primarily an exploratory piece of research in an attempt to fuel discussion and debate on a topic that is very much coming to the fore for Irish employers and employees.

3 The Irish Experience

The following short case studies on Dublin Bus and Beaumont Hospital highlight issues occurring in the Irish workplace with regard to diversity at present. They provide an interesting insight into the challenges that employers face, some for the first time in the organisation's existence. The case studies below were written as an adaptation of noted speakers attending a recent seminar. For details, see footnote below.

⁴ Press Release (06/06/2001) delivered by Mary Harney, TD, Tánaiste and Minister for Enterprise Trade and Employment.

⁵ DAWN DP – Diversity At Work Network Development Partnership

“The Reality of Multiculturalism in the Workplace”⁶

3.1 Dublin Bus – Ms. Patricia Normanly, Equality Officer

Historically Dublin Bus would have been considered a very traditional workplace. Almost all of the employees were men but not only that more often than not they were related to each other. Dublin Bus in the past tended to be made up of a workforce of fathers and sons, uncles and nephews or employees related through marriage. The majority of the employees were Dublin based and working on bus routes that were close to home. Therefore working in Dublin Bus was very much like working for a family since the employees, assigned to a particular depot, lived in the same areas of the city and also socialised together.

Today Dublin Bus has a workforce of 3,400 people. 70% of this number is represented by bus drivers. The remainder is made up of operations staff, maintenance staff and administrative and management staff. Four and half per cent of bus drivers are females.

Significant changes took place in Dublin Bus in 1997 when a major recruitment initiative was launched due to retention issues and the fleet of Dublin Bus had also increased, therefore more drivers were needed. Dublin Bus needed to plan ahead.

An equality programme exists in Dublin Bus today addressing issues such as recruitment and selection, training, discrimination, bullying, harassment and equal status. The aforementioned issues gained importance in Dublin Bus as the profile of Dublin Bus staff changed. As of April 2002 there are 46 different countries represented on the Dublin Bus staff. The country most highly represented is Romania. The percentage of bus drivers from outside the EU is 6%. For the first time in Dublin Bus' history it had to deal with issues like a driver requesting to get off the bus five times during the day to pray or a request for Fridays off to visit a mosque. One of the major issues for the drivers from outside the EU was the language barriers and in understanding different Irish accents of customers and other staff.

Due to the changes occurring in their staff profiles Dublin Bus needed to establish an awareness programme to deal with many issues relating to the background of their staff one being to quell the urban legends among the staff that all foreign workers at Dublin Bus received free mobile phones and did not have to pay tax.

Presently a training needs analysis for Dublin Bus could be summarized as follows:

⁶ Adapted from speeches at a seminar entitled “The Reality of Multiculturalism in the Workplace” hosted by the Eastern Chapter of Irish Institute of Training and Development, (IITD), 30/10/02.

- Cultural Awareness and Equality
- Improved Driving
- Customer Service
- Improving the command of the English language among staff

Changes were also made in the following areas:

- Recruitment – changes to the job application, educational standards and criteria set for jobs and assessing qualifications.
- Training for recruitment and selection – legal implications, work permits, visas and training the interviewers.
- Company Image – PR, advertising, AGM and any reports of Dublin Bus all had to reflect the new image.
- Internal Initiatives – newsletters, articles etc.

Looking to the future Dublin Bus sees its next challenge when coloured and ethnic workers are promoted to inspectors or higher positions and the impact that this will have on staff and customers of Dublin Bus. The benefits of having a policy on diversity have been numerous for Dublin Bus:

- Good business practice
- Improved customer service
- Positive company image
- Compliance with legal obligations
- Cost Saving
- An enriched workplace
- Motivated staff
- Learning from differences
- Working as equals

3.2 Beaumont Hospital - Ms. Carmel Fox, Nurse Tutor

The nursing sector in Ireland experienced great shortages of nurses, particularly in the 1990s, that were suitably educated, trained and qualified in order to take up positions in Irish Hospitals. Beaumont Hospital in Dublin did not escape this problem either. As a result they began to recruit nurses from abroad. Beaumont Hospital targeted in particular the Philippines because the education and training that the Philippine nurses received was very similar to the education and training the nurses received in Beaumont Hospital.

Recruitment of the Philippine nurses took place through an external agency that went to The Philippines in order to carry out its work. During the recruitment initiative with prospective candidates the agency were looking for the following; English language skills, a comprehensive medical screening and security clearance that the candidates were able to leave The Philippines in order to take up employment in Ireland. The successful candidates were also informed that they needed a licence to practice nursing in Ireland which was awarded by the Irish nursing board, An Bord Altranais. In order to receive this licence their first six weeks of employment at Beaumont Hospital were on probation at the end of which they are assessed. A successful assessment means that you receive your licence but an unsuccessful assessment means that you are returning home. Irish nurses are subject to the same procedure in order to receive their licence from An Bord Altranais. At home in Ireland Beaumont Hospital also needed to prepare and orient its own staff of the new comers.

The Philippine nurses receive much training and orientation in their first couple of weeks in Ireland. Issues addressed in the training and orientation sessions include the following:

- Introduction to Irish Culture
- HR policies in Beaumont Hospital
- Banking Procedures
- Security/Identity issues
- Social information – canteen, Internet facilities, local services etc.
- Occupational Health and Safety at Beaumont Hospital
- Computer Training
- Code of Professional Conduct and Ethics
- Salary and tax information
- INO and SIPTU information sessions

This trend in recruitment is set to continue for Beaumont Hospital thereby necessitating review and revision of its work practices in order to accommodate its evolving diverse workplace.

In the broadest sense, the management of diversity is a business's reaction to rapid cultural and sociological changes. "Internally, diversity management means providing a climate where all employees feel that they are valued by and contributing to an organisation. Externally, it means that organisations are flexible and astute about changes occurring in world markets."⁷

The hard truth, however, is that inequalities exist for employees within organisations due to stereotyping and preconceived ideas about a person based on race, gender, religious or cultural

⁷Managing Workplace Diversity – www.alexia.lis.uici.edu (Becker, Erviti & Shelley)

origins, age, physical or mental limitations and more. Racism, sexism, homophobia, etc., can not be managed away. It is precisely these beliefs and perceptions that necessitate managing diversity.

Being an employer of choice requires respects for the talents of all individuals regardless of gender, race, disability, age, religion etc. It means being fair to all in recruitment, promotion and the development of the workplace thereby capitalizing on the added value that diversity brings. So there is a clear business case for doing this thus warranting the subject to be included on third level programmes of education at ITB.

Companies who want to be aware and contribute to their community make a commitment to continually improve their impact on society. How they recruit, employ, train and develop their employees is central to how a company translates this commitment into action. "Every business has an interest in becoming an employer of choice and increasingly people are choosing which company to work for on the basis of how a company demonstrates its social responsibility."⁸ A commitment to managing diversity in the sphere of corporate social responsibility draws in new sources of talent from beyond the traditional pools – from neighbourhoods where post codes can reduce job opportunities, from sectors of society subject to prejudice. The increased diversity that results also brings innovation and puts a business in closer touch with its wider marketplace.

4 Defining Diversity

a. Rasmussen Definition

"The mosaic of people who bring a variety of backgrounds, styles, perspectives, values, and beliefs as assets to the groups and organisations with which they interact."

(Rasmussen, 1996)

Rasmussen's definition requires analysis. He refers to diversity as a mosaic and not a melting pot! A mosaic by definition depicts a design, a decoration, a model made up of different sizes forming a composite larger picture. So Rasmussen suggests an integration to form something new or put another way – maintaining individuality while contributing to a collectively larger picture. Diversity is not a melting pot where many races, ideas etc. are mixed but not necessarily forming a composite inclusive picture. Rasmussen also posits the view that diversity includes everyone. No one is excluded, we are all diverse and no one section of people "should" have superiority over another. The reality of this view can be entirely different! Rasmussen also views diversity as an "asset", something that is desirable and beneficial.

⁸ Business in the Community; www.bitc.org.uk

b. Cox Definition

“Diversity is the variation of social and cultural identities among people existing together in a defined employment or market setting.”

(Cox, 2001)

Cox in his definition suggests that diversity includes any difference so that the definition is not so narrow as to be limited to differences of gender and “race”. He rightly, the author believes refers to “social and cultural identity” as affiliation with groups have significant influence on peoples’ major life experiences.

4.1 WHAT DIVERSITY “IS”

- Diversity is about demographics. E.g. In US in 1965 the average worker was a married white male, 29 years old with 12 years of education, a wife and children at home.

Homogeneous	-----	Heterogeneous
		Women
		Minorities
		Age 40+ years old
		Variety of lifestyles
		12+ years of education

- Diversity is about Profitability – seen as an attractive employer, corporate social responsibility (CSR), identify customer needs, innovation, better/productive teamwork (avoid groupthink!)
- Diversity is about behaviour – once employees leave a workshop/anti-racism training/awareness day how do we get them to hold diversity as value? It is what people do afterwards that counts!
- Diversity is a long term process – requires long term commitment, it is a strategic issue and diversity is woven into values, vision, plans, budgets, TQM, training etc.
- Diversity is about values – it is not strictly a business issue. It also has to do with human rights, civil rights and people’s deeply held beliefs. It forces people to question 30,40,50 or more years of social conditioning that they have been subjected to since they were born.

4.2 WHAT DIVERSITY “IS NOT”

- Diversity is not just a buzz word – yes it is a hot topic but it is not something that will ever go away.

- Diversity is not culture – diversity training is not about teaching about “what Asians are like”, “characteristics of Hispanics” or “women in the workplace”, i.e. diversity is not about reinforcing stereotypes but overcoming them to value diversity.
- We are all similar and different on a number of dimensions and culture is only one of them.
- Diversity is not affirmative action – i.e. quota filling (women, coloured people, persons with disability). The insinuation that we have to help protected classes because they are not really qualified enough to succeed based on their own merits only adds to conflict and reinforces stereotypes.
- Diversity is not an absence of standards – “valuing diversity” is not a case of anything goes! The thought that you would give up standards in relation to hiring and promoting people is ludicrous. Just because we are removing our preconceived ideas about who is qualified for a job we must create clearer definitions of actual job requirements. (Lack of a focus on gender, race, age and increased focus of individuals’ capabilities.)
- Diversity is not “white male bashing” – blaming the white male for past injustices only intensifies separation between groups, rather than bringing them together.

5 Importance of Managing Diversity

1. As a marketing strategy – to better understand our customers, e.g., Quarter of the world’s population is Chinese. Immigration to the US from mostly Asian and Latin American countries is occurring at the rate of more than one million people per year. Marketing success can depend on the ability of companies to understand and respond effectively to the cultural nuances of the diverse marketplace.
2. Human Talent – by attracting, retraining and using the skills diverse workers will enjoy a competitive advantage. Effective employees from a variety of backgrounds are a major raw material in all organisations. This in turn fosters innovation and well rounded perspectives on decisions.
3. Reduce legal costs/actions.
4. Enriched Workforce/Company Image (Equal Opportunities Employer)
5. Learn from differences – organizational flexibility.

6 THE PLATINUM RULE

A good starting point for valuing diversity is to view everyone as different from us and to view them as people about whom we cannot make assumptions. The most important principle for valuing diversity is THE PLATINUM RULE – an expansion of the Golden Rule! The Golden

Rule – a time honoured practice and foundation of many religious disciplines: **“Treat others as you want to be treated.”** There is a need to expand the Golden Rule because it does not account for peoples’ different and unique needs. We cannot assume that others want to be treated exactly the way we do. By assuming that everyone else wants what we do, we perpetuate the values and beliefs of the dominant culture. The **Platinum Rule** gives others permission to be different from me/us and reminds us to honour that difference. **“TREAT OTHERS AS THEY WANT TO BE TREATED.”** By removing the “taboo” of discussing differences is the first step toward valuing them.

7 An Irish National Identity

Ireland has a culture that is based on a construction of Ireland as a homogeneous society. The national ideal was further reinforced by different institutions in society. The Church was perhaps the most influential and powerful of all the institutions. It had a role on every sphere – social, economic and political.

The Irish National Identity is according to Tracy, (2000) being: WHITE, HETEROSEXUAL, IRISH, SETTLED and CATHOLIC or WHISC. These identifiable traits of “Irishness”, (WHISC) engenders certain connotations. It represents an ideology, an ethic, a culture! It is important to look at each trait in turn.

WHITE – “Historically the Irish were simianized, (resembling a monkey or ape) by the English. An English scientist maintained that the post famine jaw structure was Negroid. Charles Kingsley wrote after his first trip to Ireland:

“I am haunted by the human chimpanzees I saw along that hundred miles of horrible country....But to see white chimpanzees is dreadful; if they were black, one would not feel it so much, but their skins, except where tanned by exposure, are as white as ours.”

It was this stereotyping that justified the British colonization of the Irish. The Irish were subordinate to the British as an ethnicity but privileged in relation to indigenous peoples around the world because of their white skin. The church also contributed to the white identity. This is illustrated by the collections for ‘Black Babies’ which were, until recently, a ubiquitous feature of Irish church propaganda. Through Irish catholic missionaries there was a construction of Black people as helpless increasing the white identification of ‘Irishness’. When the Irish were constructed by the English, the English in turn were constructing themselves. The same may be said for the Irish in their construction of the ‘black baby’ and in the context of multi-ethnic issues.

HETEROSEXUAL – Gender identity; women as the mothers and men as the breadwinners. The constitution outlawed homosexuality, as well as abortion, distribution of contraceptives, divorce and constructed women in a domestic role. Heterosexuality being demonstrated as the norm.

IRISH – The Irish language revival was used as a tool by the State to define how Irish once was. Explosion of GAA, nationalism etc.

SETTLED – Being Irish means being settled and not a Traveller. The social system in Ireland produced a greater tie to the land, since the hereditary and marital systems reinforced the importance of land ownership. If one wished to get married, one had to own land. In addition, the land was the means of production in an Ireland devoid of a significant industrial base. The consequences of not owning land were simple and clear; permanent celibacy or emigration. Is this like the need to own one's own property today?

CATHOLIC CHURCH – The role of the Church is undeniable in Irish society – born catholic in a Catholic hospital, educated at Catholic schools, married in a Catholic church, counseled by Catholic marriage advisors when there were problems in the marriage, treated for alcoholism in Catholic clinics, buried by Catholic rites. Cradle to grave attention of the Catholic Church.

The imagined homogeneity of the WHISC is a powerful way of understanding “Irishness”, since it connotes not only an identity but also a cosmology, a politics, an ethic and an ideology.

8 Research Detail and Findings⁹

The local platform for the Equal DAWN project is the South-Dublin Chamber of Commerce. “The purpose of the local platform will be to provide a bottom-up interface for the DAWN project in local sites by an action-based research and activity programme led by the Chamber of Commerce.”¹⁰ This research programme is specifically aimed at increasing awareness and understanding among employers of the needs of a diverse workplace and also to become aware and understand the needs of employees especially ethnic minority workers and their families in the workplace.

⁹ The research was undertaken by the Chambers of Commerce, Ireland under the South Dublin Chamber of Commerce led by Sarah O’Callaghan, (sarah.ocallaghan@southdublinchamber.com), for the DAWN project. Above is a summary and adaptation of the research and its findings.

¹⁰ The DAWN Project Action Plan 2002-2005, compiled by Ed Carroll, (ed.carroll@ireland.com)

8.1 Research Question

What innovative responses have been taken by the local business community to promote diversity, particularly in relation to non-Irish national workers?

8.2 Research Aims

- Identification of responses, initiatives and attempts to manage diversity, particularly in relation to non-Irish national workers.
- Identification of good business practices in the South Dublin business community in relation to managing diversity in the workplace.
- Identification of attitudes and commitment about diversity issues.

8.3 Research Methodology

A structured questionnaire was used covering eighteen questions to identify responses.

8.4 Sample Size

The sample size was four. For confidentiality reasons the company names cannot be disclosed. The sectors that the sample size came from were as follows: health, hospitality, construction and education.

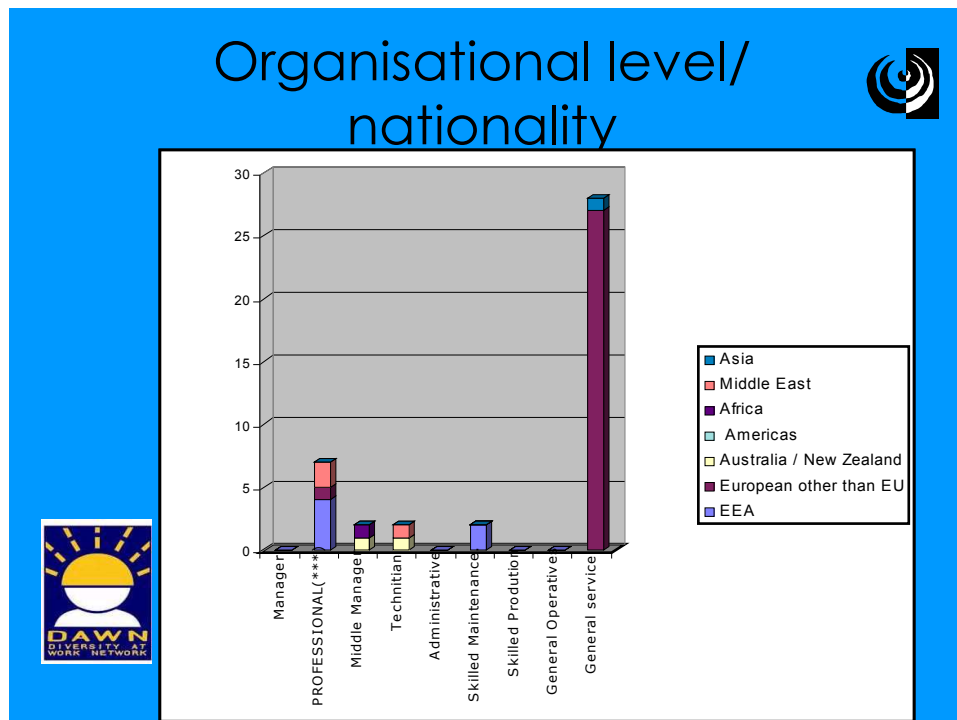
8.5 Findings

Local Business Community top needs related to non-Irish national workers:

- Information/advice on work permit and visa issues
- Information/advice on changes in Irish immigration legislation
- Information/advice on international policies and trends in diversity management
- Information/advice on setting up bank accounts
- Information/advice on getting driving licence
- Orientation pack to facilitate integration
- Development and management of diversity workplace training
- Information/training on cultural issues
- Irish Equality legislation training
- Anti-discrimination training
- Information on developing company's social activities involving non-Irish nationals
- Information/advice on dietary requirements and religious requirements of ethnic groups.

Statistical data below highlight aspects concerning the management of diversity from the research conducted by the local platform.

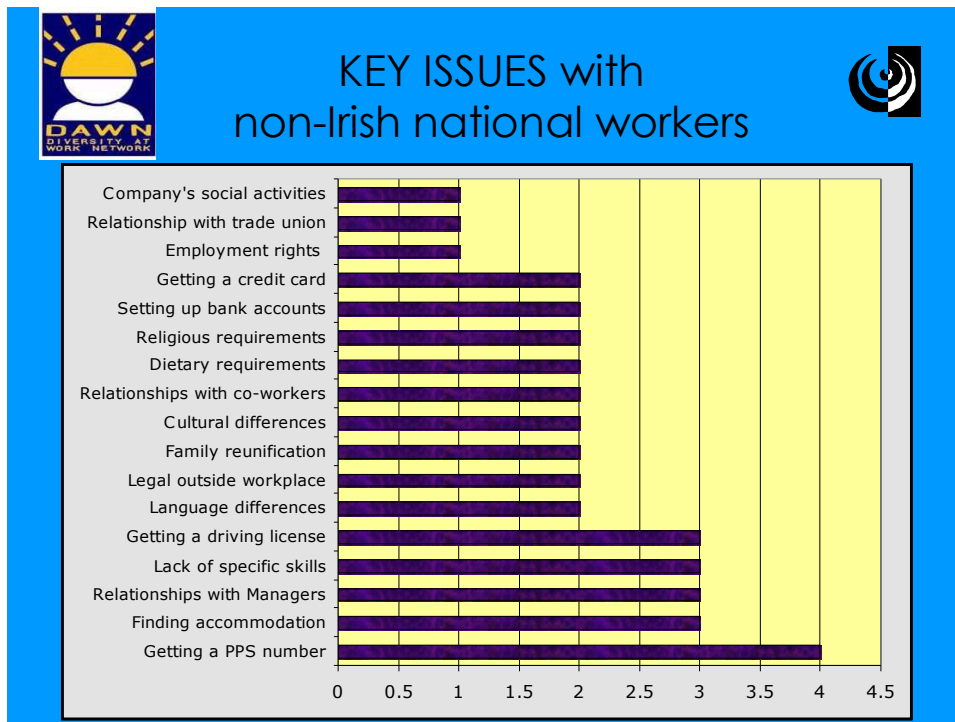
Representation of Non-Nationals in the Organisation's Hierarchy



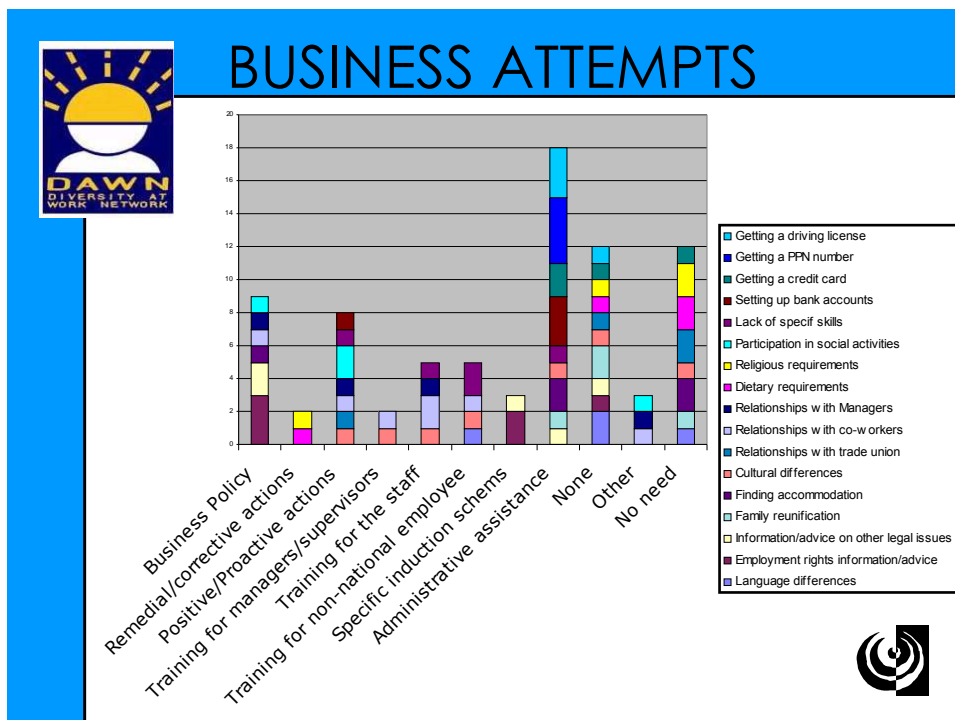
Methods of Recruitment of Non-Irish Nationals



Concerns/Issues of Non-Irish National Workers



Attempts by Businesses in Facilitating the Non-National Worker



It is interesting to note the relatively few numbers of non-nationals that have made it to management positions. A trend surely that is set to change with increased integration in the Irish workforce and one which will pose a challenge to manage for higher executives as the Dublin Bus case study also points out. It is encouraging to see that recruitment agencies appear to be keeping pace with the rate of change as the candidates on their books reflect the shifting profile of workers in Ireland. A plethora of concerns arose with regard to issues that the non national has in relation to their working environment. Some of these are bureaucratic in nature and easily rectified, e.g. obtaining a PPS number but others like religious and dietary requirements and relationships with co-workers for example require much deeper changes like increasing awareness, understanding and respect for the human race.

The demographics of the workplace are changing and will continue to change rapidly. Workforce diversity is not a matter for debate. It's a fact. It presents one of the greatest challenges facing organisations today. Through hard work and committed leadership will the potential benefit for diversity in the workplace be realised.

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www.bitc.org.uk

www.cso.ie

www.equality.ie

www.equal-ci.ie

www.gov.ie/finance/publications/

www.ibec.ie

www.justice.ie

www.knowracism.ie

Multiculturalism In Secondary Schools – A Linguistic, Socio-Political & Pedagogic Perspective

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1. Introduction

As a modern foreign language lecturer I am fascinated by issues of language, culture and identity. To an extent my interest is compounded by the belief that we Irish are bilingual, English and Gaeilge, - a rich language with a strong oral tradition that has been an integral part of Irish identity. In September 1996 I began work as a secondary teacher in an inner city London school with a high proportion of multilingual and multicultural students. My observations and interactions with pupils at Plumstead Manor proved part of a journey of self-analysis and self-discovery, and fortified my belief that these students have enriching resources to bring to the classroom – linguistic, social and educational. Upon my return to Dublin in 2001 I observed the extent to which Ireland had undergone significant social-economic change in the intermittent years. The *mélange* of languages, colours, dress codes, and cultures so apparent in Irish society today have contributed much to the making of a cosmopolitan, culturally diverse country, and have sparked off many debates centred on the benefits and drawbacks of ethnic plurality. It would be inaccurate, however, to suggest that, until the late 1990s, Ireland was “new” to diversity since the traveller community and significant minority religious groups have for many years been part of Irish society. Nonetheless the recent influx of returning Irish, EU and non-EU migrant workers, asylum seekers, and international students have raised an awareness of difference and fed attitudes about otherness.

The premise of this paper is to explore multiculturalism in the secondary school context, comparing and contrasting the English and Irish experiences. My findings are based on studies carried out while secondary teaching in the UK, and also on recent surveys conducted in 4 Dublin and Kildare secondary schools. My methodology was a process of gathering data through questionnaires that I based on the issue of multiculturalism, which were answered by staff and non-national students in these schools. I intend, firstly, to explore the linguistic aspect of this phenomenon, and will discuss the English as a Second Language issue. I maintain that, while the range of languages and associated cultures to be found in contemporary secondary schools should be seen as a valuable educational and national resource, sufficient funding must be place to support and integrate those with poor English language skills. Subsequently, I will

examine the socio-political factors underlying multiculturalism in secondary schools, and will make reference to the ethnographic profiles and anti-racist policies of the schools surveyed. I will place the issue in the larger context of pluralistic British and Irish societies where I believe biased legislation and intolerant attitudes towards minority groups adversely impact on our educational system. Finally, analysing my research and findings I will assess Department of Education and Science initiatives for a more multicultural primary school curriculum, and will offer suggestions for curricular diversity in the secondary school sector, based on strategies in place in the United Kingdom.

2 Multiculturalism

2.1 Multiculturalism – the language factor

Language is a critical channel of communication through which we human beings convey attitudes and information, express thoughts and emotions. It is the means by which we articulate and relate to other our life experiences. It is inextricably linked to our cultures, to our notions of personal identity and to the way in which we make sense of the world around us. Many people are bilingual.

“Bilingualism simply means having two languages. Bilinguals can be ranged along a continuum from the rare equilingual who is indistinguishable from a native speaker in both languages at one end to the person who has just begun to acquire a second language at the other end. They are all bilinguals, but possessing different degrees of bilingualism. A monolingual (also called a unilingual or monoglot) is thus someone who knows only one language.”¹¹

A bilingual's degree of bilingualism is determined by his or her competence in the four skills of listening, speaking, reading and writing. Abilities in these skills vary. Time spent secondary-teaching in the United Kingdom has shown me that whilst very often children of immigrant parents may possess highly developed skills in the language of their country of residence or indeed birth, English, their capacity to read and write in their parents' language, Turkish, Urdu, or Punjabi for example, may be limited or non-existent. Others may have received a comprehensive education in both the oral and literary traditions of both languages and may be termed 'balanced' bilinguals.¹² For some students, recently arrived from non-English speaking nations, the weaker language is more often than not English, the majority language, that of the school, of monolingual peers and of the community as a whole. Very often these students will experience a sense of existing in a type of limbo, oscillating between home where the first

¹¹ Saunders George, *Bilingual Children: From Birth to Teens*, (Avon, 1988) p 8.

¹² Saunders, *ibid*, p 9, concedes that even balanced bilinguals are usually “dominant” or more proficient in one of their two languages, although they may not be dominant in the same language in all areas.

language prevails and between school where they are submerged in a second language, little of which they actually understand.

Ireland of the 21st century is a vibrant mélange of colour, creed, culture, language and ethnicity. The past 8 years have seen mass inward migration onto our island in a movement led principally by returning Irish nationals and migrant workers, in addition to refugees, asylum seekers, and third level students. Though a sizeable 75% of these migrants are of Irish, British and American origin, a considerable 25% stem from areas of the EU and regions of the world where English may not necessarily be a first language.¹³

Origin of inward migrant to Ireland 1995-2001	Percentage	Number
Returned Irish	50%	123,100
UK	18%	45,600
Rest of EU	13%	33,400
USA	7%	16,600
Rest of world	12%	29,400

The children of many of these immigrant workers enter the Irish educational system at both primary and secondary level with very little if any English and are immediately confronted with a number of difficulties, linguistic and socio-cultural. They are now part of a system whose rules, regulations, procedures and practices may differ greatly to those of their previous schools, and suddenly they are participants in a learning process where for them a foreign language is the principle means of communication.

The Department of Education and Science recognises the obstacles that face many such students and it has sought to respond to the increasingly important English as a Second Language issue. An official Departmental document, based on a series of consultative meetings attended by a broad range of educational representative bodies, stipulates that

“additional teaching and non-pay resources be provided to schools at primary and second level to cater for the needs of pupils for whom English is not the mother tongue.” Moreover *“funds are being allocated to **Integrate Ireland Language Training** to provide a support programme for teachers responsible for the English language development of non-English speaking immigrant pupils.”*¹⁴

¹³ The Central Statistics Office reported that in 2002 40,000 work permits were issued to migrant workers in Ireland of Latvian, American, Philippi no, Czech, and Polish origin. The main countries of origin for asylum seekers in Ireland in 2002 were Nigeria, Romania, Czech Republic, Moldova, and Congo DR. Some 11,634 asylum applications were received in Ireland last year.

¹⁴ Department of Education and Science, *Promoting Anti-Racism and Interculturalism in Education – Draft Recommendations towards a National Action Plan*, 3.3.2 & 3.3.3. (2002)

Though government intentions are undeniably good and additional ESOL resources are most welcome it seems that the situation at the grassroots is proving problematic for management, teaching staff, and all students in the system. Within the 4 secondary schools I surveyed in the Dublin and Kildare area feelings of discomfort at the complexity of the English as a Second Language issue were expressed. The general consensus amongst principals and teachers was that the current provision of English language tuition for 2 years is not sufficient for many ESOL students. Given certain limited staffing resources it was felt that Departmental guidelines suggesting that *“English Language Tuition be provided to all who need it, regardless of place of birth”*¹⁵ was unrealistic and a policy of “who needs it most” prevails in all these schools. Similar it was held that plans *“to further resource and develop ELT services and to ensure that students gain effective mastery of English for academic and social life”*¹⁶ would be thwarted by budgetary constraints and that the English language progress of ESOL students would be decelerated by insufficient additional English language tuition. In one school with some 42 ESOL students and 3 support teachers it was reported feasible to allocate 2 recently arrived Romanian pupils with very poor English language skills a mere two weekly 40-minute sessions with language support staff within a 35-hour week timetable. Moreover it was reported that many ESOL support staff did not possess EFL qualifications, and the need for more specific training in this type of language work was highlighted in 3 of the 4 schools. All schools agreed that it was premature to celebrate linguistic and cultural diversity when evidently the language limitations of ESOL students in the mainstream classroom were adversely impacting on all students and funding as yet was insufficient to bring many ESOL students with poor English language skills to the stage where they could enjoy, actively participate and excel in their learning.

Yet all surveyed teachers and principals concurred that with time such students may adequately develop the skills to process more complex linguistic and subject matter. They accepted that in many cases bilingual students have higher levels of concept formation.

*“Intellectually (the bilingual’s) experience with two languages systems seems to have left him with a mental flexibility, a superiority in concept formation, and a more diversified set of mental abilities, in the sense that the patterns of abilities developed by bilinguals were more heterogeneous.”*¹⁷

¹⁵ *Ibid*, Appendix 1, no 35.

¹⁶ *Ibid*, Appendix 1, no 36.

¹⁷ Peal Elizabeth & Lambert Wallace, ‘Relation of bilingualism to intelligence’, *Psychological Monographs*, No 76, 1962, p 20.

It is supposed that exposure to a more complex environment charged with an increased number of social interactions contributes to greater adeptness at concept formation on the part of bilingual individuals. The advanced operational thinking among many bilingual students that I observed during my secondary school career in London very often accounted for excellent performances in subjects such as maths, science, art and in my own subject specialism, modern foreign languages. Their ability to separate sound from meaning very often contributed to more acute attention to structure and a greater readiness to reorganise sentences. 50% of Plumstead Manor secondary students that partook in my London questionnaires stated that their bilingualism in English and a community language, Punjabi, Gujarati, Hindi, or Turkish for example, facilitated their acquisition of a European language. Teachers interviewed in Ireland had noted that many non-national students with poor levels of English excelled at practical subjects such as maths, art, and physics whilst struggling with quite specific and demanding texts in the history, geography, and biology course books. It is quite probable therefore that in some students' cases the particular problem is not cognitive but rather linguistic. Successful planning of a support programme for each ESOL student upon entry to primary or secondary school will involve collaboration between parents, pupil, class teacher or subject teacher, and the language support teacher who may choose to carry out a form of assessment that will ascertain the new student's level of English. Such tests are not mandatory in Irish schools today, however. The Language Support Unit in Trinity College, Dublin receives funding from the Department of Education and Science and has devised a number of ESL tests that are available to primary and secondary schools. Nonetheless it is necessary to be aware of the strengths and weaknesses of various assessment tools so as not to bias our ESOL students. Whilst eliciting data about a child's English language competence they do not however identify capacities in other subjects. Moreover it has been commented that the nature of the assessment may erroneously disregard cultural or other language factors where a fluent English speaker who speak in one of the African English dialects has little understanding of, for example, the phrasal verbs so commonplace in Hiberno-English.

Not only are lack English language skills problematic for many ESOL students but also they constitute a barrier to the participation of many migrant parents in their children's education and in the school environment. The enrolment process of new non-national students, the presentation of relevant documentation, the participation of parents at parent-teacher meetings and the promotion of inter-ethnic relations among parent communities were all cited as occasions in which English language competences dictated the extent of involvement. The significance of language and literacy for adult asylum seekers in particular cannot be

overstated and fortunately at present a programme of ESOL provision is offered in VEC adult literacy schemes, though only to the extent that the Literacy budget allows.

*"Language, first language and ...alternative languages, are inextricably part of people's lives, their energy as learners and their sense of life's possibilities. Neither bilingualism nor the people I have talked to are marginal. Both have, in my view, something to tell us which may be central to learning and to people's lives."*¹⁸

In Plumstead Manor Secondary School, South-East London a comprehensive policy of teaching ESL was devised by the language development department accentuating the need for these pupils *"to share their experience of learning, to experience a sense of achievement, to be given the opportunity to communicate with peers, to listen without pressure to speak, and to acquire, practise and have valued language 1 literacy."* Teachers were encouraged to elaborate materials, worksheets, visuals, and explanations in which meaning was explicit. In March 1998 the school embarked on a project of training community language classroom assistants in conjunction with Greenwich University and Woolwich Polytechnic. The idea that Stage 1 and 2 ESL pupils might receive assistance with their schoolwork in their stronger language was warmly received. The British experience of multilingualism, rooted in and influenced by centuries of colonisation, is a more varied and longer established one than that of our island¹⁹. Though Ireland is quite some distance away from such community language initiatives the Department of Education and Science, has already, in these early days of multilingualism in our contemporary primary and secondary schools, called for respect of our students' native languages and their continued development, where possible. It has also stated the recruitment of bilingual support staff as a future prospect. National Council for Curriculum and Assessment documentation recognises that values held of students and attitudes directed at students play a pivotal role in determining their levels of sustained learning and motivation. Given time, training, familiarity and progressive policy in this area I believe that we will learn to exploit the highly developed linguistic and cultural awareness that permeates our classrooms to the benefit of all students.

¹⁸ Miller Jane, *Many Voices*, (London, 1985), p 2.

¹⁹ Though cultural diversity has been a feature of Irish society with communities of Travellers, Jewish, Chinese and Muslim part of our ethnic profile for many years, it is only since 1995 that there has been a proliferation in the number of people on our island for whom a language other than English is the first language.

*Have you ever hurt
about baskets?
I have, seeing my grandmother weaving
for a long time.
Have you ever hurt about work?
I have, because my father works too hard
and tells how he works.
Have you ever hurt about cattle?
I have, because my grandfather has been working
on cattle for a long time.
Have you ever hurt about school?
I have, because I learned a lot of words
from school,
And they were not my words.*

Apache child, Arizona

Cazden, C.B

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2.2 Socio-political implications in the study of multiculturalism

“Multilingualism and multiculturalism are social phenomena and it is not possible to isolate them from their political contexts. Their different manifestations are invariably shot through with the values accorded and attached to them.”

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The concept of multicultural Britain as a ‘melting pot’ in which diverse social, religious and ethnic groups coexist harmoniously is, in my opinion, an ideal constantly challenged. In many culturally pluralistic societies feelings of uncertainty and fear, ignorance and misunderstandings feed the perceptions of different social groups about each other. In present day France the immigration policies of the extreme right Front National under Jean-Maria Le Pen have amassed the support of some 38% of the French electorate, whilst in Germany the proliferation of vociferously anti-foreigner and anti-Semitic alliances are examples of increasing intolerance in our world. Dramatic shifts in the ethnic landscape of Irish society in recent years has initiated a spate of racist attacks and fomented a rise in racist attitudes. In a series of studies carried out in Ireland in 2001 the African Refugee Network questioned 40 refugees about their experiences. 75% of participants said that they were denied service because of skin colour whilst 25% of participants claimed to have been verbally abused. In a second study The Landsdowne Market Research group surveyed 1100 people aged 15 and over in a comprehensive study conducted countrywide and concluded that 27% of people were disturbed by the presence of minority groups. Additionally the findings of a Union of Students in Ireland study revealed that 39% of the 500 third-level students surveyed would find it difficult accepting a Traveller as a sibling’s spouse whilst 20% were of the view that illegal

immigrants should be deported without exception.²⁰ Yet these findings reveal nothing new about a nation undergoing multicultural development. Historically our attitudes have been prejudiced and unjust towards the Traveller and Jewish communities that have long-since been part of the fabric of Irish society. For years their needs have been neglected in a culturally “homogenous” society unexposed and perhaps unprepared for the rapid social change that gripped Ireland in the late 1990s. The central role of an educational response that will promote acceptance, respect and even curiosity about difference cannot be overstated in our contemporary context of ethnic diversity and cultural pluralism.

As I perceive it schools with their classes, students and teachers are microcosms of society outside. In Ireland 18% of asylum seekers are schoolchildren²¹, yet many students arrive at school with little understanding of the languages, customs and cultures of classmates. Their perceptions of other are tainted with insensitive generalizations and stereotypes and quite often the dominant social group develops an attitude of cultural and linguistic superiority. The values inculcated in our children today are critical to the future realisation of a society in which the rights of all individuals are respected. The sociologists Smith & Tomlinson (1989) believe that schools can have a profound effect on the nature of the interpersonal and interethnic relationships in society. Very often it is extremely difficult for students of ethnic backgrounds to find a strong self-identity and their own niche in school life. Bilingualism and biculturalism can contribute to sense of dividedness or dual existence. 90% of students surveyed in 4 Dublin and Kildare secondary schools always speak their mother tongue at home. This situation of “double ness” can have a profound impact on the personal-development of bilingual students, and their levels of attainment, educational and otherwise. For many pupils who wish to “fit in” the only means by which they might “be accepted” by the majority group in school is by denying the culture, dress, traditions, and language of the home. The National Council for Curriculum and Assessment offers primary schools excellent suggestions for the support of second language learning, English, and the valuing of first language fluency in the mainstream classroom. It stresses that a positive attitude towards language and linguistic diversity should be communicated to all children in the class.²² On occasions when indifference or even scorn is directed at a minority language and culture its users may cluster together to retain their language, and identity. 68% of non-national secondary school students I surveyed said that between and outside classes they mixed only with peers of the same ethnic group, as they felt safer and better understood by them. Only 25% stated that classmates had asked to be taught words from their different languages, and 40% had experienced incidences of racial

intolerance or verbal abuse. Educational organisations and institutions have a huge responsibility to encourage interest in cultural diversity, to develop sensitivity to difference, to promote an objective analysis of one's own cultural practices and to prevent racism within schools.

The World Conference against Racism, Racial Discrimination, Xenophobia and Related Intolerance held in Durban, South Africa in August 2001 provided an opportunity for each participating country to examine its human rights record and to discuss strategies to embrace world diversity in the 21st century. Following on from this very important initiative the Irish government set about developing and implementing a National Action Plan Against Racism (NPAR) that includes a critical section on intercultural education at all levels. The document *'Promoting Anti-Racism and Interculturalism in Education – Draft Recommendations towards a National Action Plan'*, commissioned by the Department of Education and Science and developed by the City of Dublin VEC Curriculum Development Unit, is the fruit of a consultative process involving statutory agencies, non-government organisations, and educational advisors, and it consisted of open submissions, nationwide oral hearings, and a national conference in November 2002. Recommendations made in this document are based on feedback received throughout consultation and echo loudly the advice of Amnesty and other NGOs. My interpretation is of a four-pronged approach with

- a) Department of Education policy based on interculturalism with target setting, realistic timescale implementation, adequate teacher-training and resourcing, and reliable reporting and reviewing key components.
- b) At school level the importance of anti-racist and bullying documentation incorporating a clear set of procedures to be followed by staff and students is accentuated. Toys, teaching materials, and activities should have an intercultural focus, and all members of the school community should be encouraged to contribute to a school that values cultural diversity. The urgency of additional English language support for many ESOL students and their families is recognised. Furthermore school policy on recruitment of staff and admission of students must be equal and fair, transparent and unbiased.²³
- c) An anti-racist, intercultural ethos that celebrates diversity in its many forms, cultural, linguistic, socio-economic and gender-based, should permeate all levels of the education sector.

~~Draft Recommendations~~ towards a National Action Plan, Appendix 1, 21, (2002). "Agreed guidelines on anti-racist policy and codes of practice from admissions, integration, and for monitoring and reviewing these, to be developed nationally by the relevant authorities. National and local policies should explicitly register principles of inclusion and anti-discrimination relating to ethnic identity, religious affiliation, economic status, prior education experience, and residency in Ireland."

- d) The expertise of traveller and ethnic interest groups, NGOs, National and International networks, parents, staff, and management at local level should drive dialogue and nurture policy in the creation of a culturally pluralistic and democratic educational system.

Within schools interviewed it was felt that some recommendations were unrealistic, perhaps even unattainable, whilst others were seen to be innovative and welcomed. There was consensus that implementation of equality recommendations regarding comprehensive education supports in the form of books, fees, uniforms, travel allowances etc and the provision of English Language tuition for all the family would be limited by inadequate resources and funding. Similarly the timeframe envisaged for the elaboration of culturally appropriate assessment procedures and the study of community languages and literature was questioned. Nonetheless suggestions for the design of antiracist policies, until recently “unnecessary” in all schools surveyed, were welcomed and it was agreed that they would be drawn up in a democratic manner influenced greatly by the input of parent committees, student representatives, staff members and senior management. Each of the four schools was at a different stage in developing an inclusive school but all school plans endorsed an ethos of equality of access and participation.²⁴ Whilst some intercultural targets set by schools were to be addressed in the short term, for example hanging classroom displays that represent diversity in Ireland, organising assemblies of an intercultural nature, painting signs that welcome and communicate in a variety of community languages, others were more long term and impacted on the social environment of the school. It was commented that immigrant parent participation on parents committees and in school life in general was minimal, quite often due to limited English language skills. However special effort was being made to introduce new parents at celebratory evenings, prizegivings, and parent/teacher meetings.

The sociologist Sivanandan suggests that

“Racism is about power and not about prejudice. Racism never stands still, it changes shape, size, colours, purpose, function – with changes in the economy, the social structure, *the system, and, above all, the challenge, the resistance to that system. In the field of employment, housing, health, and education, minority groups are discriminated against.*”²⁵

It is unjust to expect to our schools to be paragons of perfect intercultural practice with strong, purposeful, antiracist policies when the policies in place in the world outside their walls smacks

²⁴ Such is required in the Education Act (1998).

²⁵ Sivanandan A, in Pumfrey P & Gajendra V, Cultural Diversity and the Curriculum (London, 1993)

of discrimination and ethnocentric interests. Though the Irish government has ratified the 1965 UN Convention on the Elimination of All Forms of Racial Discrimination²⁶ and has written anti-discrimination into Irish law and educational policy²⁷ further legislation for legal rights, and will, resources, and drive to implement them is needed to promote widespread respect for difference and otherness. Our immigrant policy must provide protection and rights for the 40,000 migrant workers in Ireland each year, many of which are at the mercy of their employers who retain their work permits. In addition asylum seekers, fleeing terror, persecution, poverty or destitution at home should not be placed in a position where they arrive at points of entry in the last stages of pregnancy, are prevented from working in the state and contributing to the economy, and are very often forcefully returned to their homelands some months later after trawling through and submitting complicated but unsuccessful asylum applications.²⁸ Similarly it must be said that to be fair to all people on this island the government should ensure that the level of benefits to asylum seekers are in line with those of Irish citizens in similar need of support.

There is no instant solution to the immigration issue. One thing is certain though. If we are to create a pluralistic society that embraces mutual respect and celebrates differences of language, colour, creed, and culture then an unbiased and equitable approach must be spearheaded at the top and reinforced in a responsible media so that the message trickles down through organisational and educational institutions to nourish the grassroots consciousness.

2.3 Multiculturalism – the role of a revised, intercultural curriculum

“There is inevitable significance attached to what is institutionalised within the curriculum and what is left out of it. That significance is educational as well as politically symbolic.”²⁹

Wright, 1978

The pluralistic nature of 21st century Ireland demands a revision and re-jigging of the National Curriculum along intercultural lines. There is a real need to mediate and adapt the existing curriculum to capitalize on the multiple advantages, linguistic, social and cultural, of the ethnic ~~Paper on Adult Education~~, ‘Adult Education in an Era of Lifelong Learning’ (July, 2000) embodies three core principles – two of which are equality and interculturalism.

²⁸ Declan Keane (Master of Hollow St Hospital, Dublin) stated in a radio interview in October 2003 that between 1999 and 2000 there was a substantial increase in the number of non-EU nationals arriving in Ireland in the ninth month of their pregnancy. In 2000 70% of non-national mothers admitted in the hospital were from Sub-Saharan Africa. In January 2003 the Supreme Court decreed that the non-national parents of children born here should not automatically receive Irish citizenship.

²⁹ Wright B, in Pumfrey P & Gajendra V, *ibid*.

minorities that pass through it. When the Swann Report (the Second Report of the Committee of Inquiry into the Education of Children from Ethnic Minority Groups: Education for All) was published in Great Britain in 1985 it appeared that the moment had arrived for the implementation of

“a programme that would reshape the curriculum in keeping with the liberal rhetoric of intercultural understanding and reciprocity.”³⁰

However in a society polarized by public debate between those who advocated the reaffirmation of traditional values and educational boundaries, and those who challenged the dominance of national language and majority culture, progressive pedagogy and curriculum developments in England and Wales proved to be very contentious issues. The mélange of cultures that composed British society constituted a challenge to the nationalist, assimilationist ideals embraced by the Conservatives under Thatcher and Major. Though the endeavours of seven working groups for the secondary school subjects of Maths, Science, Technology, History, Geography, and Modern Languages, ensured the inclusion of a more comprehensive cultural perspective on curricular innovations³¹, the educationalist Gurnah (1987) noticed a discrepancy between the rhetoric and the reality of an educational initiative (the Swann Committee) that was far less intercultural than it had intended to be.

Undeniably the subject content of Irish education is culturally biased. 75% of teachers surveyed in Dublin and Kildare schools confirmed the limiting and restrictive nature of the National Curriculum. They described the difficulties encountered in attempting to incorporate cultural and critical awareness into an already extensive curriculum in a classroom situation in which many students and teachers are struggling with the problematic issue of English as a Second Language. Though 85% of teachers had expressed open interest in the origins, languages and cultures of their non-national students and, moreover, had encouraged all students to objectively analyse their own attitudes to difference, it was felt that further manipulation of the curriculum along intercultural lines would involve considerable extra time, thought and planning for an already stretched workforce. In Ireland there has been governmental recognition of the Euro centric nature of much of current curricula that requires a broadening of content to explore wide and varied strands of world history, languages, arts, sciences, economies, social and religious traditions, and of the newness of an intercultural pedagogic approach for many teacher. After a lengthy process of planning, drafting, consultation, and redrafting the National Council for Curriculum and Assessment has

³⁰ Jones C, *Intercultural Perspectives on the National Curriculum for England and Wales*, (London, 1991).

³¹ The Science Working Group contained a ‘Science in Action’ component that related Science to culture and society. The English Working Group incorporated novelists, poets, and playwrights that had not traditionally formed part of the English literary ‘canon’.

completed a document offering detailed guidelines on good practice for primary schools in this area. The suggestions are based on the existing curriculum and it is planned that they will be in place for January 2004. In effect they are detailed schemes of work for each stage of primary education replete with intelligent and innovative suggestions for the delivery of a more culturally respectful curricula.³² In 3rd and 4th class Maths, for example, core elements of the Maths curriculum are identified and useful ideas for the incorporation of themes of identity and belonging, similarity and difference, human rights and responsibilities, equality, and conflict resolution are provided. The multicultural treatment of these themes is cleverly woven into the teaching of the subject and allow for an interesting pedagogic approach. In anticipation of similar guidelines for the Irish secondary school level it may be insightful to examine practices of intercultural education already in place in the UK. I observed these strategies first hand during my time secondary teaching in multicultural London, and they complement and reiterate many NCCA primary school suggestions.³³

Mathematics & Science – Many teachers I spoke to agreed that it was very difficult to incorporate cultural awareness into the teaching of Mathematics, Information Technology and Science. However, they might introduce a religious dimension, for instance, in the calculation of the Chinese and Jewish New Years, and the Muslim tradition of Ramadan. Students who have travelled abroad on family holidays or exchange programmes may be familiar with alternative forms of measurements. Understanding of currency and exchange rates necessitates an explanation of international boundaries and socio-economic differences. Students may be particularly surprised to discover that Maths were invented by cultures from Asia or Africa, i.e., India, Egypt, and China. In Technical Drawing the history of 2D and 3D shapes (Tangram shapes from China and Origami from Japan) may interest pupils and allow for comparison of shapes in different environments (igloos in Iceland contrast with houses balanced on stilts in China.) In Science one teacher told me that he emphasised the Arabic aspect of Chemistry and used affordable resources, charts, diagrams, and maps in addition to his knowledge to support cultural awareness. In a study of the periodic table students investigated regions of the world where specific minerals were scarce and abundant, thus crossing into the Geography curriculum.

³² Similar guidelines for the secondary school level are presently being drafted. The process is overseen by a steering committee with representatives from teachers unions, management bodies, traveller education, the African Women's Network, and experts in secondary education. The approach and delivery of the secondary-level intercultural curriculum will be distinct from that of primary level due to age and curriculum differences. Guidelines for all subjects will be given to whole school to Junior Certificate. NCCA (October, 2003).

³³ In its document *Promoting Anti-Racism and Interculturalism in Education, Chapter 5, 5.11, the* Department of Education and Science recommends that research should be carried out into examples of best practice elsewhere in European institutions.

Food Technology – The introduction of foodstuffs and recipes from a wide range of countries will educate students to the different types of balanced and nutritious diets used by humans across different cultures. They should be alerted to the fact that many of the foodstuffs we eat on a daily basis originated elsewhere e.g. the potato crop, which they may have felt “belonged” historically to the Irish, came from South America. An explanation of the diet of particular religions and of the beliefs underlying the consumptions and exclusion of certain food will elaborate on the sociological, ethnographic, and cultural factors that affect people’s eating habits.

Music – The invaluable inclusion of western classical music notwithstanding, it is imperative that pupils of all cultural backgrounds see their own musical heritage adequately represented within a multi-cultural curriculum. The words of Michael Marland appeared in a 1996 edition of the Education Guardian,

“The non-statutory examples of the aspects of study for music are unexpectedly Euro centric, with only a single mention of ‘calypso’ to balance 27 western composer.”

Students should learn of the influence of Jewish synagogal songs on Gregorian chant, and no doubt will be intrigued to study the impact that African tribal drumbeats have had on the dance music of today. There is a plethora of inexpensive material for the teaching of world music. Recordings of music from many different communities can be brought to class by students, as can instruments that parents might play at home. Pupils should be given the opportunity to practise, play and record with pan-pipes from Latin America, steel-pan and calypso from the West Indies, various drums from Africa, and traditional Irish instruments. They should listen to, sing and perform the music of artists to whom they relate and who’s work deals with human rights issues and the impact of war (U2 ‘Walk On’, Live Aid ‘Feed the World’, Dolores Keane ‘The Lion’, Dire Straits ‘Brothers in Arms’, ‘1812 Overture’ by Tchaikovsky). Moreover they should identify similarities and differences in musical styles and study cultural borrowings and learning from each other. (By way of Vivaldi’s ‘Four Seasons’ students may learn of differences in world climate as they examine world regions that undergo only two seasonal changes, one humid and the other dry.)

English – *“as a subject, English has great scope for open discussion concerning beliefs, attitudes and feelings underpinning racism in a range of media.”*

(National Union of Teachers, Great Britain, 1997)

Themes and thoughts that run through novels and drama very often fuel powerful debate in the classroom about socio-political issues. The literature of all people can be explored in the analysis of art, life, love, and death. Graphic visuals and visits from community writers and ethnic poets and artists unearth a Pandora's box of cultural differences and communalities. Newspaper clippings and extracts of live media lend themselves to interesting discussions about stereotypes in contemporary society. Texts dealing with fear and aggression allow for suggestions as to how best diffuse interpersonal and wider conflict.

Modern Foreign Languages – As regards my own subject specialism, there is much to say in favour of incorporating cultural awareness into the classroom. When learning a language students should be aware of the extent to which these subjects are spoken, and with the aid of a map they can conceptualise the importance of French, Spanish or German in the world. Our food, clothes, lifestyles, customs can be compared with those of the Spanish, French and German speaking world, and indeed those of other countries as represented by their bilingual and bicultural peers. Students are immersed in a week-long course of language awareness in 1st year, drawing on the vast reserves of linguistic skill in the classroom to determine, for example, how one counts from one to ten in English, French, Spanish, Italian, Yoruba, Polish etc. Many Modern Foreign Language departments in British secondary schools encourage bilingual students to sit GCSE and A-Level exams in their mother tongue. In many schools community languages are taught outside school hours and parents are urged to provide their children with as much input as possible in the home language. Radio and TV, libraries, newspaper and other literature, in addition to Saturday schools, and the linguistic and cultural support provided by various religious institutions are cited as invaluable tools in the development of bilingualism and biculturalism.

The NCCA is keen to address the concerns of teachers who fear that this new intercultural initiative is just another “add-on” to an already stretched primary school curriculum. The Council stress that intercultural education is not confined to one single subject. Nor cannot be taught in a designated one-hour weekly slot. They believe that it is embedded in all subjects. Suggestions in their document alert teachers to existing opportunities in the curriculum for the promotion of cultural awareness and the analysis of difference. Moreover they provide these professionals with imaginative and alternative ways of approaching well-worn subject matter and dispel the belief that intercultural education involves time-consuming elaboration of new material. On the micro level teachers are best placed to celebrate the cultural diversity that is an essential component of contemporary Irish society.

3 Conclusion

Contemporary Ireland is more ethnically diverse than ever before, and demographic data suggests that it is becoming increasingly so.³⁴ International trends demonstrate that present-day society is more mobile than in the past and the constant movement of people across borders and cultural divides has huge implications for our educational systems.

It is estimated that in Irish schools multilingual and multicultural students speak over 50 languages other than English. Part 1 of this paper examined the implications of linguistic diversity in the modern-day classroom. I discussed the often-problematic issue of English as a Second Language and stressed the need for more governmental initiatives and funding to improve the situation on the ground. I looked at the interpretative, analytical and performing skills of English as Second Language students, and highlighted the benefits of linguistic diversity for all pupils when conditions are right.

Crispin Jones (1991) maintains that multiculturalism should never be theorized separately from the socio-economic and socio-political contextual conditions surrounding them. In the second section of this paper I concluded that nation state orientations have the potential to shape societal attitudes toward minority groups. I mentioned the role of a responsible and unbiased media, and the importance of balanced and just legislation. At school level I encouraged more policies of an anti-racist nature and practices that reinforce respect for difference.

Aspects of the National Curriculum reveal a certain amount of Euro centrality and cultural bias. New educational initiatives in Irish primary schools provide well thought out ideas for exploiting the existing curriculum to intercultural advantage. Part 3 of this paper describes strategies that secondary teachers might use to make the content of their classes more culturally and intellectually stimulating.

Change, though often resisted, can bring much good. If the necessary structures are put in place to manage change then its merits will be manifold. Ireland has undergone significant change to become the culturally pluralistic nation that it is today. A responsible leadership, an accessible workplace, a respectful educational system, and a well-informed public, can make multiculturalism here an unqualified good.

³⁴ In 2002 40,000 work permits were issued in Ireland to migrants from outside the EU, in comparison to 36,000 work permits in 2001. In 2002 11,634 asylum applications were received in Ireland, an increase in 1,309 from the previous year. (Department of Justice, Equality and Law Reform, 2003).

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Determination of the Frequency Response of an End Tidal CO₂ Analyser

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1 Introduction

In a health care environment, mechanical ventilation is used to support patients during acute illness and surgery. Mechanical ventilation is the process by which the patient's respiratory function is artificially supported using a respirator.

During mechanical ventilation, it is necessary to ensure the adequacy of ventilation. The patient is thus monitored for several ventilatory parameters. The end-tidal CO₂ (EtCO₂) is one of the primary monitoring parameters. EtCO₂ is the partial pressure or maximal concentration of carbon dioxide (CO₂) at the end of an exhaled breath, which is expressed as a percentage of CO₂ or mmHg.

Capnography is the technique that graphs out expired CO₂ as a function of time and measures EtCO₂. The measuring device is called a capnometer and the waveform displayed by the capnograph is called capnogram. A sketch of a typical capnogram is shown in Figure 1.

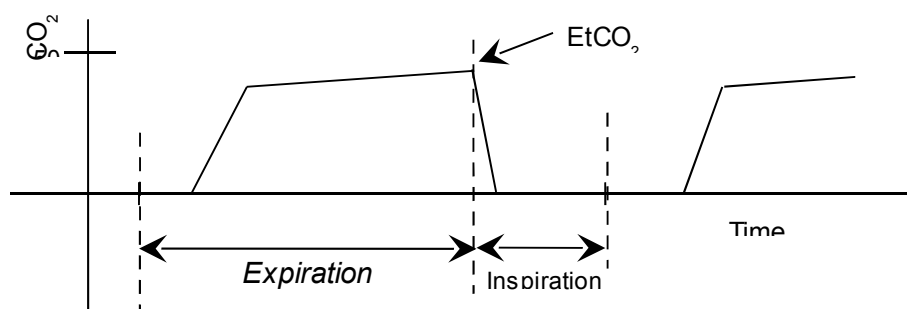


Figure 1: Normal capnogram of a healthy human.

1.1 The Importance of CO₂ (EtCO₂) Concentration Determination

The determination of CO₂ concentration is necessary to ensure the adequacy of ventilation in an artificially ventilated patient. During the respiratory cycle, the CO₂ concentration in the exhaled breath is increased as the exhalation comes to the end of a cycle. This is because the end point is the last air to leave the respiratory system and has been the deepest in the lung. The last air is called the alveolar concentration. This last peak value of expired CO₂ is accepted to be the equal to the CO₂ content of the blood and is referred to as the end-tidal CO₂ (EtCO₂). Consequently, it is an indicator of how efficiently CO₂ is cleared from the blood supply and is a vital monitoring parameter for the ventilated patient.

1.2 CO₂ Gas Sampling Technologies in EtCO₂ analysis

Many anaesthetic and ventilation units use sidestream technology for sampling the exhaled breath. In this technology, the gas sample is sampled from the ventilator circuit and the analysis occurs away from the ventilator circuit. A pump and length of tubing is used to acquire the sample from the exhaled breath. Another popular type of sampling is mainstream technology in which the CO₂ sensor is positioned directly at the patient's airway. In mainstream technology, the response time is faster and mixing of CO₂ with fresh gas is prevented to a greater extent. In practice, sidestream technology is most commonly used in the clinical setting.

Microstream technology is a comparatively new technology. It employs a unique, laser-based technology called molecular correlation spectroscopy (MCS™). The Microstream® emitter is electronically activated and self-modulating, and is operated at room temperature. The Microstream® emitter produces a focused beam of infrared energy characterized by the narrow region (0.15µm wide) of the spectrum precisely matching the absorption spectrum of CO₂. Conventional capnographs typically use a heated element called a blackbody emitter for the infrared radiation source.

1.3 The End Tidal CO₂ Analyser

The end tidal CO₂ analyser detects the CO₂ concentration in the patient's expired air using a number of methods. The technique most commonly used is based on infrared absorption. This uses absorbance spectroscopy in which the loss of infrared light is measured after having passed through the sample under study.

CO₂ absorbs infrared light at a wavelength of 4.26µm. Since the amount of light absorbed is proportional to the concentration of the absorbing molecules, the concentration of CO₂ in the exhaled breath is determined by passing infrared light through the sample and comparing the amount of energy absorbed with the amount absorbed by a sample that contains no CO₂. The

result is expressed either in terms of mmHg or as a percentage of CO_2 ($\text{PCO}_2/\text{P}_{\text{atm}}$). Analysers using infrared technology are called infrared spectrographs and are more compact and less expensive than other technologies. These types of analysers are used in ventilation units and sometimes also as a separate unit as portable, handheld capnographs.

1.4 Ventilation rate

A typical individual at rest takes about 12-18 breaths per minute, this breathing rate can triple during hard work. Generally, 15 breaths/min (0.25Hz.) to 30 breaths/min (0.5Hz) is considered to be normal in an adult. However, an infant has a higher respiratory rate, smaller tidal volume, and a low volume of CO_2 . Tidal volume is the volume of air inspired and expired with each normal breath.

The ventilation frequency is said to be 'high frequency' when it is greater than 2 Hz (120 breaths/min) and it is said to be 'low frequency' if it is below 0.25 Hz (15 breaths/min).

1.5 Calibration of (CO_2) Gas Analysers

Gas analysers are calibrated by applying a known value to the input of a measuring system and observing/recording the system output. By applying a range of inputs and recording the outputs, a calibration curve can be plotted where the input x is plotted on the abscissa versus the output y on the ordinate axes.

The most straightforward type of calibration for gas analysers is a 'static' calibration technique. In this process, a known value is input to the system under calibration and the system output is recorded. The term 'static' refers to the calibration procedure in which the values of the variables involved remain constant during a measurement, i.e. they do not change in time. The static calibration method (also called two-point method) is the current technique for calibrating EtCO_2 analysers. This method features 'zero' calibration to ambient air and 'span' calibration to a self-contained 5% (i.e. 38 mmHg) CO_2 calibration gas. Although the static method is widely accepted as a valid technique for such gas analysers, it is insufficient for describing the dynamic behavior of the analyzer.

Dynamic calibration determines the relationship between an input of known dynamic behavior and the (time-varying) measurement system output. When a time dependent variable is to be measured, a dynamic calibration is performed in addition to the static calibration. In a real time system such as EtCO_2 gas analysis, dynamic calibration should be performed.

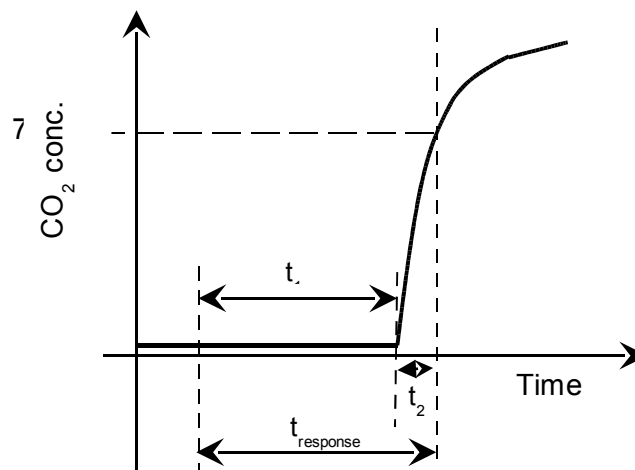


Figure 2 : Graph of a typical EtCO₂ waveform showing the transit time (t_1), sensor response time (t_2) and the total response time (t_{response}) of the sensor system.

In sidestream capnography, the CO₂ signal is delayed by the response time (t_{response}) as the gas is pumped along the sampling tube. Figure 2 shows a sketch of a typical waveform obtained from the EtCO₂ analyser. The response time, t_{response} , is the sum of t_1 and t_2 where t_1 (transit time) is the time taken for the sample gas to move from the point of sampling to the point of measurement while t_2 (sensor response time) is time taken for the waveform to reach 70% of its final value ($t_2 = t_{70}$). t_2 can also be taken as the time taken for the waveform to reach 90% of the final value ($t_2 = t_{90}$). t_{70} is generally used instead of t_{90} because the 70% point is on a steeper part of the response curve and therefore less sensitive to noise. For all practical purposes t_{90} is twice the value of t_{70} . The t_1 value generally accounts for about 89% or more of the t_{response} . Generally t_1 and t_2 are not specified in manufacturers' specifications. These factors should be measured as it has been observed that a long t_1 can prolong t_2 and can this result in the underestimation of EtCO₂. To design a system to measure t_1 and t_2 is also one of the aims of this project.

1.6 Frequency Response

Frequency response is usually presented as a plot of the output (generally amplitude) of the device versus frequency. It is used to characterize the range of frequencies in which a device is designed to operate.

In determining the frequency response of the EtCO₂ analyser, the maximum CO₂ concentration (i.e. the peak value on the waveform) is considered as the amplitude value while the oscillation frequency of the CO₂ signal is considered the frequency.

2 Measurement of the Frequency and Dynamic Response of an EtCO₂ Analyzer

Determination of the frequency response of the CO₂ analyser requires the plotting of amplitude versus frequency curve. Determining the dynamic response requires the measurement of t_1 (mechanical delay), t_2 (sensor response), and t_{response} (total response time).

2.1 The Experimental Setup

The functional block diagram shown in Figure 3 describes the current prototype dynamic calibration system. In this block diagram all components other than the *Drager Narcomed 3* Anaesthetic unit comprise the simulator (the area within the dashed border line). The capnometer being investigated is the Drager Capnolog EtCO₂ analyser.

A specialist gas mixture of 5% CO₂ in air is used to emulate the CO₂ content of an expired breath. A separate air-line is used to flush the CO₂ from the system; this is supplied by an air compressor. The CO₂ gas is under a pressure of 725 PSI while the compressed air is at a maximum pressure of 175 PSI. The two stage regulator on the CO₂ gas cylinder and the pressure regulator on the air compressor reduce the pressure at the gas lines to a maximum of 125 PSI. As the capnograph samples at a pressure just over atmospheric pressure, 14.69 PSI, it is necessary to include a gas regulation system to reduce the pressure further along the gas lines. Two in-line pressure regulators are installed to reduce the line pressure to 29 PSI.

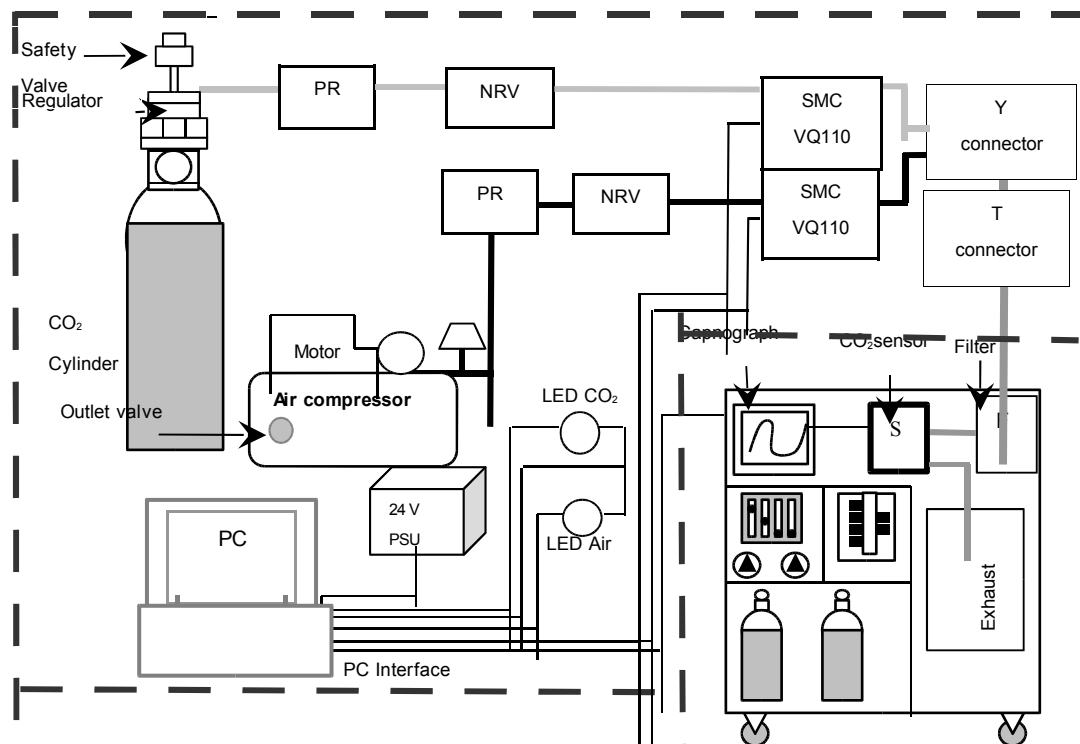


Figure 3: Functional Block Diagram of the experimental system.

(PR= Pressure regulator; NRV=non-return valve)

Non-return valves are installed to prevent back-flow and contamination. The gas channels are mixed inside the y-connector. The output gas is then passed through a T-piece that further limits the pressure of the gas mixture to the capnograph. Excess gas is vented here to the atmosphere.

A 24-volt power supply is used to power the valves. A simple LED circuit indicates when each valve is open. The valves are computer controlled using 'C' and a DAS-08 (Computer Boards Inc.) card, containing an 8254 counter timer, in order to obtain precise timing.

2.2 Data Acquisition and Analysis

For the determination of frequency response and the dynamic response of the system, a step signal is introduced to the CO₂ monitor. This is achieved by using the valve system to create a gas signal that turns on quickly (in this case 3ms, the response time of the valve). The CO₂ signal frequency is software controlled and hence straightforward to adjust.

Nine sets of data were taken, from 0.125 Hertz to 5 Hertz.

A single image of a capnogram is shown in Figure 4. It is clear from the figure that there is no amplitude or temporal information available in real time, so calibration of the data is necessary to obtain accurate amplitude information.

The primary challenge with this experiment is in data collection as the capnograph system has no means of obtaining data in the digital format necessary for analysis. Many capnograph units are completely sealed so direct data acquisition is not straightforward. As this measurement requires precise timing information, it was decided to record the capnograph trace in real-time using a digital video camera (Sony digital handycam, DCR-PC8E). The filmed traces are then downloaded to PC via a firewire interface. Each dataset, a single AVI file, is then separated into a set of bitmap images, each image corresponding to a single frame of the video sequence. With 25 frames per second, counting the number of frames allows precise timing information to be obtained.

The video sequences are subsequently analysed frame by frame in order to extract the digital waveform data.

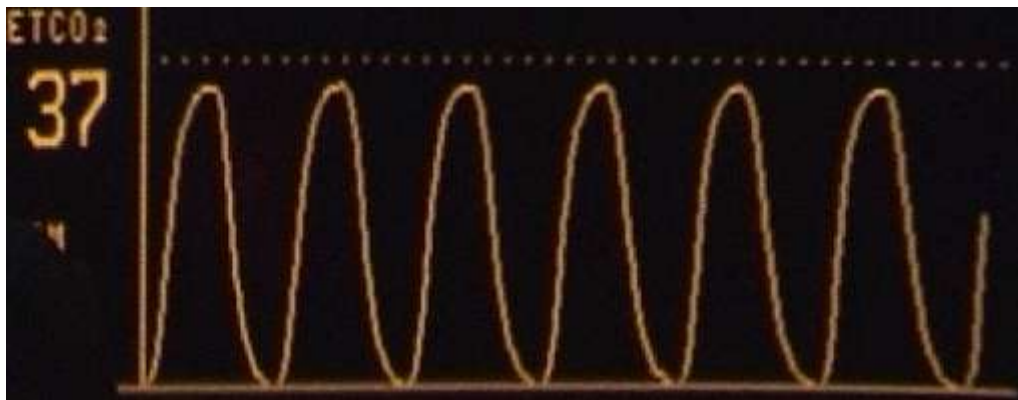


Figure 4 : Single frame from a data-collection video sequence obtained using a Sony DCR PC-8 camera.

2.3 Data Extraction using Image analysis

The bitmap files are processed and converted to array form using the image processing toolkit in MatLab. Three array sets are produced, the 'CO₂ magnitude' array, the 'framecount' (time) array and the 'ledstate' array that indicates the opening and closing of the valve in time. Figure 5 shows the result of this conversion process for a typical data experimental run.

2.4 Experimental Data Analysis

The arrays obtained for each data set are analyzed using MatLab code to obtain values for t_1 , t_2 and t_{response} . For each frequency value, the maximum amplitude value of the CO₂ magnitude array is found.

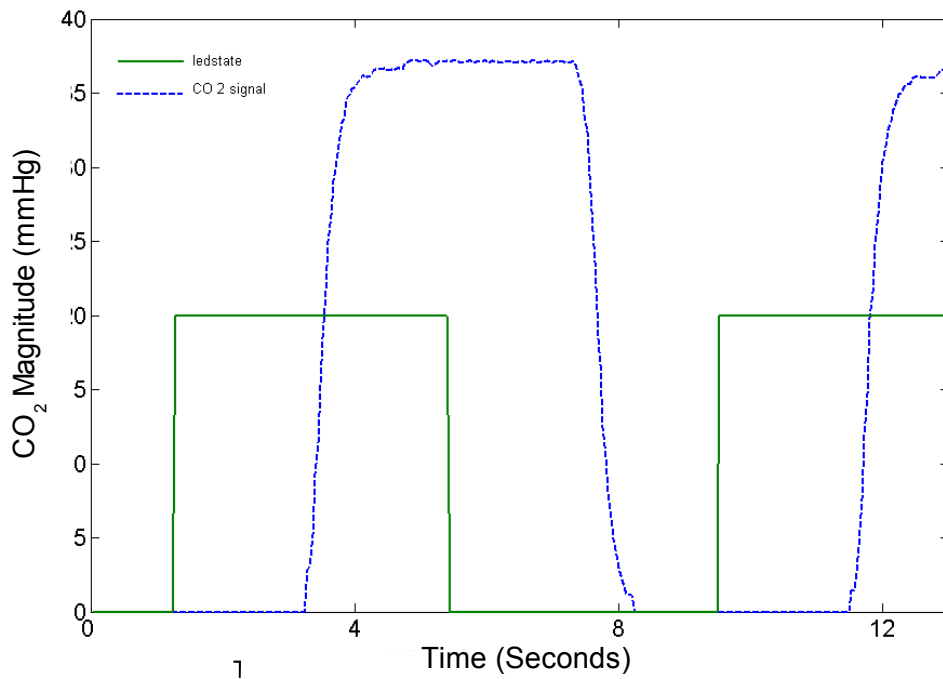


Figure 5 : A typical waveform obtained after data acquisition using the digital video camera and Matlab.

The measured values of t_1 , t_2 and t_{response} from three of the data sets are shown in table 1.

Frequency	t_1	t_2	t_{response}
0.125 Hz	2 sec	0.64 sec	2.64 sec
0.25 Hz	2 sec	0.6 sec	2.6 sec
0.5 Hz	2 sec	0.6 sec	2.6 sec

Table 1 : Measured t_1 , t_2 and t_{response} for the Drager Capnolog EtCO₂ analyser.

3 Results

The frequency response of the Drager Capnolog EtCO₂ analyser is shown in Figure 6. It is clear from this that the response of the analyser is severely degraded at respiration frequencies over 1 Hz.

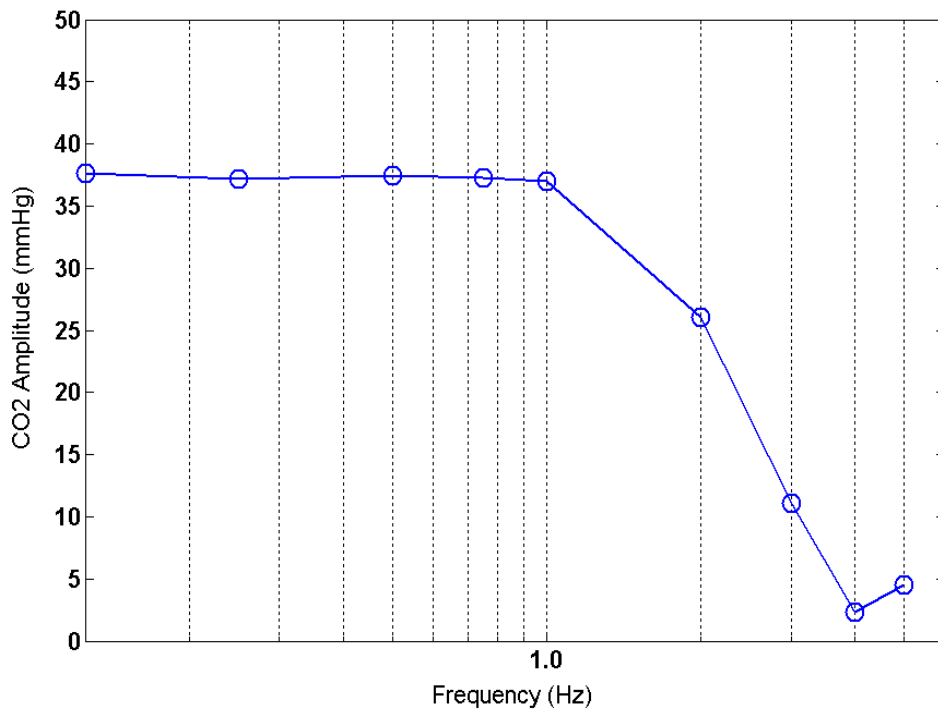


Figure 6 : Amplitude versus Frequency curve for the Capnolog EtCO₂ analyser

4 Conclusion

The project's aim is to create a method for simulation of human respiratory process sufficient to allow the accurate measurement of the dynamic response of a variety of capnography systems. The simulator mimics the 'patient' in a hospital environment. It allows the production of specific waveforms that may be used to calculate the dynamic response and the frequency response of the EtCO₂ analyser. Initial experiments determined the working frequency range of a single EtCO₂ analyser.

For the *Drager Capnolog*, the working frequency range is from 0.125 Hertz to 1 Hertz i.e. it can operate for respiratory rates from 7.5 breaths/min to 60 breaths/min. It may not give accurate performance for rates greater than 60 breaths /min.

The total dynamic response has been determined to be 2.6 seconds and is independent of the frequency of the input signal. It is intended in future experiments to determine the effects of different system settings on this key parameter.

Current work for this project involves the design, construction and characterisation of a portable simulation and data collection system so that different capnography systems (mainstream, microstream etc) can then be tested in the field.

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Pathfinding in Computer Games

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Abstract

One of the greatest challenges in the design of realistic Artificial Intelligence (AI) in computer games is agent movement. Pathfinding strategies are usually employed as the core of any AI movement system. This report will highlight pathfinding algorithms used presently in games and their shortcomings especially when dealing with real-time pathfinding. With the advances being made in other components, such as physics engines, it is AI that is impeding the next generation of computer games. This report will focus on how machine learning techniques such as Artificial Neural Networks and Genetic Algorithms can be used to enhance an agents ability to handle pathfinding in real-time

1 Introduction

One of the greatest challenges in the design of realistic Artificial Intelligence (AI) in computer games is agent movement. Pathfinding strategies are usually employed as the core of any AI movement system. Pathfinding strategies have the responsibility of finding a path from any coordinate in the game world to another. Systems such as this take in a starting point and a destination; they then find a series of points that together comprise a path to the destination. A games' AI pathfinder usually employs some sort of precomputed data structure to guide the movement. At its simplest, this could be just a list of locations within the game that the agent is allowed move to. Pathfinding inevitably leads to a drain on CPU resources especially if the algorithm wastes valuable time searching for a path that turns out not to exist.

Section 2 will highlight what game maps are and how useful information is extracted from these maps for use in pathfinding. Section 3 will show how pathfinding algorithms use this extracted information to return paths through the map when given a start and a goal position. As the A* pathfinding algorithm is such a major player in the computer games it will be outlined in detail in Section 4. Section 5 will discuss the limitations of current pathfinding techniques particularly with their ability to handle dynamic obstacles. Sections 6 and 7 will introduce the concept of using learning algorithms to learn pathfinding behaviour. The report will then conclude, in Section 8, with how learning algorithms can overcome the limitations of traditional pathfinding.

2 Game World Geometry

Typically the world geometry in a game is stored in a structure called a map. Maps usually contain all the polygons that make up the game environment. In a lot of cases, in order to cut

down the search space of the game world for the pathfinder the games map is broken down and simplified. The pathfinder then uses this simplified representation of the map to determine the best path from the starting point to the desired destination in the map. The most common forms of simplified representations are (1) Navigation Meshes, and (2) Waypoints.

2.1 Navigation Meshes

A navigation mesh is a set of convex polygons that describe the “walkable” surface of a 3D environment [Board & Ducker02]. Algorithms have been developed to abstract the information required to generate Navigation Meshes for any given map. Navigation Meshes generated by such algorithms are composed of convex polygons which when assembled together represent the shape of the map analogous to a floor plan. The polygons in a mesh have to be convex since this guarantees that the AI agent can move in a single straight line from any point in one polygon to the center point of any adjacent polygon [WhiteChristensen02]. Each of the convex polygons can then be used as nodes for a pathfinding algorithm. A navigation mesh path consists of a list of adjacent nodes to travel on. Convexity guarantees that with a valid path the AI agent can simply walk in a straight line from one node to the next on the list. Navigation Meshes are useful when dealing with static worlds, but they are unable to cope with dynamic worlds (or worlds that change).

2.2 Waypoints

The waypoint system for navigation is a collection of nodes (points of visibility) with links between them. Travelling from one waypoint to another is a sub problem with a simple solution. All places reachable from waypoints should be reachable from any waypoint by travelling along one or more other waypoints, thus creating a grid or path that the AI agent can walk on. If an AI agent wants to get from A to B it walks to the closest waypoint seen from position A, then uses a pre-calculated route to walk to the waypoint closest to position B and then tries to find its path from there. Usually the designer manually places these waypoint nodes in a map to get the most efficient representation. This system has the benefit of representing the map with the least amount of nodes for the pathfinder to deal with. Like Navigation Meshes, Waypoints are useful for creating efficient obstacle free pathways through static maps but are unable to deal with dynamic worlds (or worlds that change).

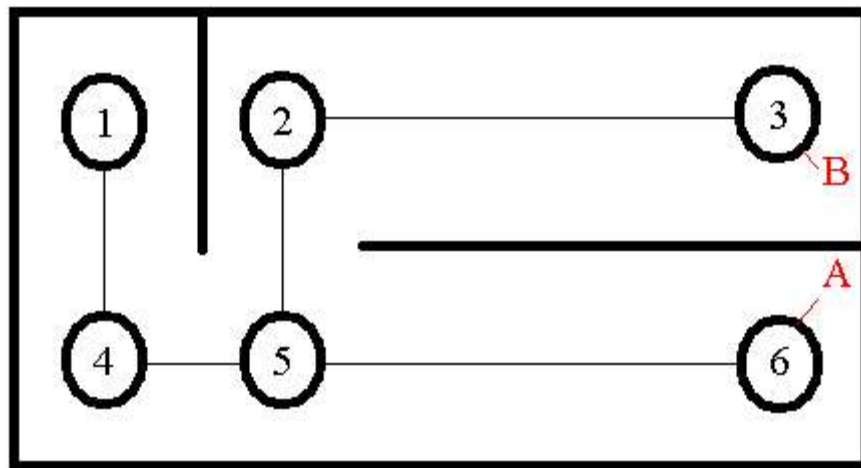


Figure 2.1

Figure 2.1 shows how a simple scene might be represented with waypoints. Table 2.1 shows the routing information contained within each waypoint. The path from (A) to (B) can be executed as follows. A straight-line path from (A) to the nearest waypoint is calculated (P1) then a straight-line path is calculated from (B) to the nearest waypoint (P2). These waypoints are 6 and 3 respectively. Then looking at the linking information, a pathfinding system will find the path as follows { P1, waypoint 6, waypoint 5, waypoint 2, waypoint 3, P2 }

Way Point Number	Link Information
1	4
2	3, 5
3	2
4	1, 5
5	2, 4
6	5

Table 2.1

2.3 Graph Theory

Pathfinding algorithms can be used once the geometry of a game world has been encoded as a map and pre-processed to produce either a Navigation Mesh or a set of Waypoints. Since the polygons in the navigation mesh and the points in the waypoint system are all connected in some way they are like points or nodes in a graph. So all the pathfinding algorithm has to do is transverse the graph until it finds the endpoint it is looking for. Conceptually, a graph G is composed of two sets, and can be written as $G = (V, E)$ where:

- **V – Vertices:** A set of discreet points in n-space, but this usually corresponds to a 3D map.

- **E – Edges:** A set of connections between the vertices, which can be either directed or not

Together with this structural definition, pathfinding algorithms also generally need to know about the properties of these elements. For example, the length, travel-time or general cost of every edge needs to be known. (From this point on cost will refer to the distance between two nodes)

3 Pathfinding

In many game designs AI is about moving agents/bots around in a virtual world. It is of no use to develop complex systems for high-level decision making if an agent cannot find its way around a set of obstacles to implement that decision. On the other hand if an AI agent can understand how to move around the obstacles in the virtual world even simple decision-making structures can look impressive. Thus the pathfinding system has the responsibility of understanding the possibilities for movement within the virtual world. A pathfinder will define a path through a virtual world to solve a given set of constraints. An example of a set of constraints might be to find the shortest path to take an agent from its current position to the target position. Pathfinding systems typically use the pre-processed representations of the virtual world as their search space.

3.1 Approaches to Pathfinding

There are many different approaches to pathfinding and for our purposes it is not necessary to detail each one. Pathfinding can be divided into two main categories, *undirected* and *directed*. The main features of each type will be outlined in the next section.

3.1.1 Undirected

This approach is analogous to a rat in a maze running around blindly trying to find a way out. The rat spends no time planning a way out and puts all its energy into moving around. Thus the rat might never find a way out and so uses most of the time going down dead ends. Thus, a design based completely on this concept would not be useful in creating a believable behaviour for an AI agent. It does however prove useful in getting an agent to move quickly while in the background a more sophisticated algorithm finds a better path.

There are two main undirected approaches that improve efficiency. These are *Breadth-first search* and *Depth-first search* respectively, they are well known search algorithms as detailed for example in [RusselNorvig95]. *Breadth-first search* treats the virtual world as a large connected graph of nodes. It expands all nodes that are connected to the current node and then in turn expands all the nodes connected to these new nodes. Therefore if there is a

path, the *breadth-first* approach will find it. In addition if there are several paths it will return the shallowest solution first. The *depth-first* approach is the opposite of *breadth-first* searching in that it looks at all the children of each node before it looks at the rest, thus creating a linear path to the goal. Only when the search hits a dead end does it go back and expand nodes at shallower levels. For problems that have many solutions the *depth-first* method is usually better as it has a good chance of finding a solution after exploring only a small portion of the search space.

For clarity the two approaches will be explained using a simple map shown in Figure 3.1.

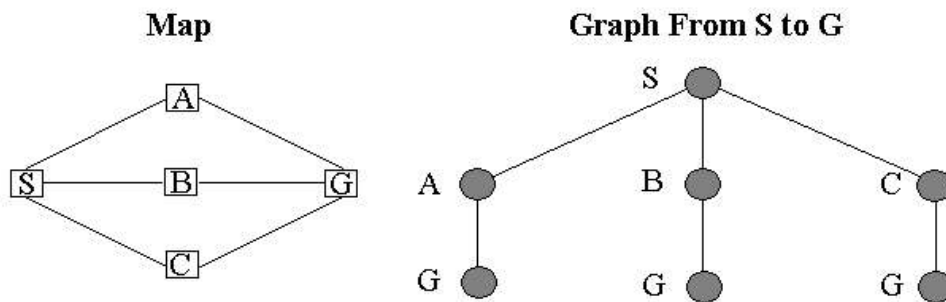


Figure 3.1

Figure 3.1 shows a waypoint representation of a simple map and its corresponding complete search tree from the start (*S*) to the goal (*G*).

Figure 3.2 shows how the two approaches would search the tree to find a path. In this example the *breadth-first* took four iterations while the *depth-first* search finds a path in two. This is because the problem has many solutions, which the *depth-first* approach is best, suited to. The main drawback in these two approaches is that they do not consider the cost of the path but are effective if no cost variables are involved.

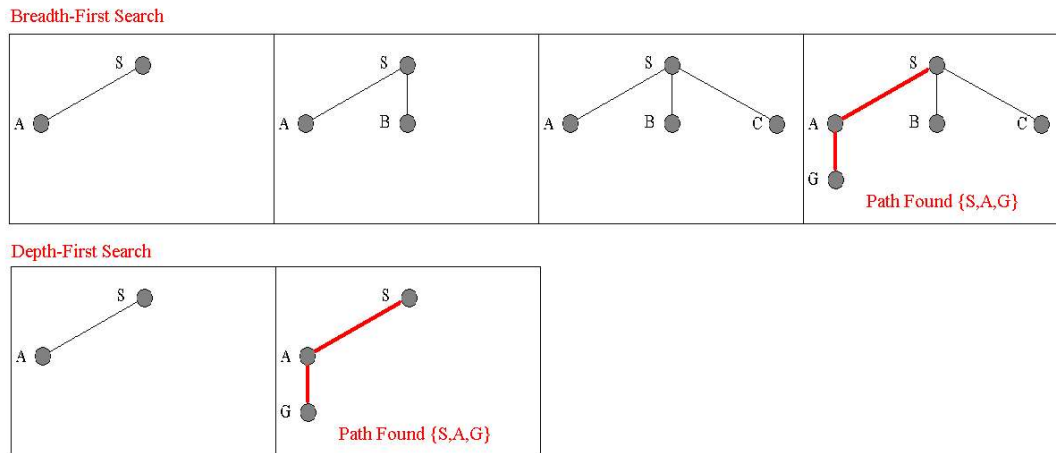


Figure 3.2

3.1.2 Directed

Directed approaches to pathfinding all have one thing in common in that they do not go blindly through the maze. In other words they all have some method of assessing their progress from all the adjacent nodes before picking one of them. This is referred to as assessing the cost of getting to the adjacent node. Typically the cost in game maps is measured by the distance between the nodes. Most of the algorithms used will find a solution to the problem but not always the most efficient solution i.e. the shortest path. The main strategies for directed pathfinding algorithms are:

- *Uniform cost search* $g(n)$ modifies the search to always choose the lowest cost next node. This minimises the cost of the path so far, it is optimal and complete, but can be very inefficient.
- *Heuristic search* $h(n)$ estimates the cost from the next node to the goal. This cuts the search cost considerably but it is neither optimal nor complete.

The two most commonly employed algorithms for directed pathfinding in games use one or more of these strategies. These directed algorithms are known as Dijkstra and A* respectively [RusselNorvig95]. Dijkstra's algorithm uses the *uniform cost strategy* to find the optimal path while the A* algorithm combines both strategies thereby minimizing the total path cost. Thus A* returns an optimal path and is generally much more efficient than Dijkstra making it the backbone behind almost all pathfinding designs in computer games. Since A* is the most commonly used algorithm in the pathfinding arena it will be outlined in more detail later in this report.

The following example in Figure 3.3 compares the effectiveness of Dijkstra with A*. This uses the same map from Figure 3.1 and its corresponding search tree from start (S) to the goal (G). However this time the diagram shows the cost of travelling along a particular path.

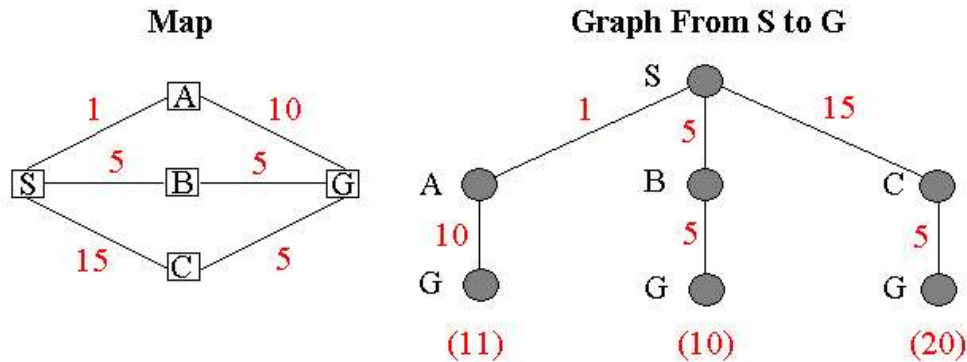


Figure 3.3

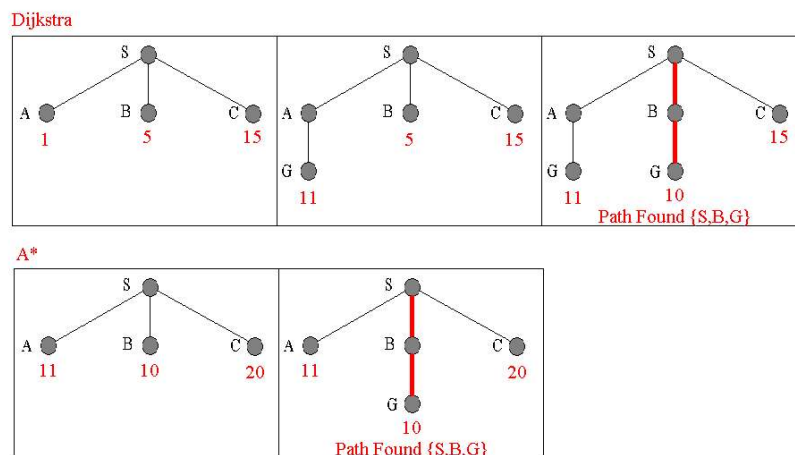


Figure 3.4

Figure 3.4 illustrates how Dijkstra and A* would search the tree to find a path given the costs indicated in Figure 3.3. In this example Dijkstra took three iterations while A* search finds a path in two and finds the shortest path i.e. the optimal solution. Given that the first stage shown in Figure 3.4 for both Dijkstra and A* actually represents three iterations, as each node connected to the start node (S) would take one iteration to expand, the total iterations for Dijkstra and A* are six and five respectively. When compared to the Breadth-first and Depth-first algorithms, which took five and two iterations respectively to find a path, Dijkstra and A* took more iterations but they both returned optimal paths while breadth-first and depth-first did not. In most cases it is desirable to have agents that finds optimal pathways as following sub-optimal pathways may be perceived as a lack of intelligence by a human player.

Many directed pathfinding designs use a feature known as *Quick Paths*. This is an undirected algorithm that gets the agent moving while in the background a more complicated directed pathfinder assesses the optimal path to the destination. Once the optimal path is found a “slice path” is computed which connects the quick path to the full optimal path. Thus creating the illusion that the agent computed the full path from the start. [Higgins02].

4 A* Pathfinding Algorithm

A* (pronounced a-star) is a *directed* algorithm, meaning that it does not blindly search for a path (like a rat in a maze) [Matthews02]. Instead it assesses the best direction to explore, sometimes backtracking to try alternatives. This means that A* will not only find a path between two points (if one exists!) but it will find the shortest path if one exists and do so relatively quickly.

4.1 How It Works

The game map has to be prepared or pre-processed before the A* algorithm can work. This involves breaking the map into different points or locations, which are called nodes. These can be waypoints, the polygons of a navigation mesh or the polygons of an area awareness system. These nodes are used to record the progress of the search. In addition to holding the map location each node has three other attributes. These are fitness, goal and heuristic commonly known as f , g , and h respectively. Different values can be assigned to paths between the nodes. Typically these values would represent the distances between the nodes. The attributes g , h , and f are defined as follows:

- g is the cost of getting from the start node to the current node i.e. the sum of all the values in the path between the start and the current node
- h stands for heuristic which is an estimated cost from the current node to the goal node (usually the straight line distance from this node to the goal)
- f is the sum of g and h and is the best estimate of the cost of the path going through the current node. In essence the lower the value of f the more efficient the path

The purpose of f , g , and h is to quantify how promising a path is up to the present node. Additionally A* maintains two lists, an *Open* and a *Closed* list. The Open list contains all the nodes in the map that have not been fully explored yet, whereas the Closed list consists of all the nodes that have been fully explored. A node is considered fully explored when the algorithm has looked at every node linked to it. Nodes therefore simply mark the state and progress of the search.

4.2 The A* Algorithm

The pseudo-code for the A* Algorithm is as follows:

1. Let P = starting point.
2. Assign f , g and h values to P .
3. Add P to the Open list. At this point, P is the only node on the Open list.
4. Let B = the best node from the Open list (i.e. the node that has the lowest f -value).
 - a. If B is the goal node, then quit – a path has been found.
 - b. If the Open list is empty, then quit – a path cannot be found
5. Let C = a valid node connected to B .
 - a. Assign f , g , and h values to C .
 - b. Check whether C is on the Open or Closed list.
 - i. If so, check whether the new path is more efficient (i.e. has a lower f -value).
 1. If so update the path.
 - ii. Else, add C to the Open list.
 - c. Repeat step 5 for all valid children of B .
6. Repeat from step 4.

A Simple example to illustrate the pseudo code outlined in section 4.2. The following step through example should help to clarify how the A* algorithm works (see Figure 4.1).

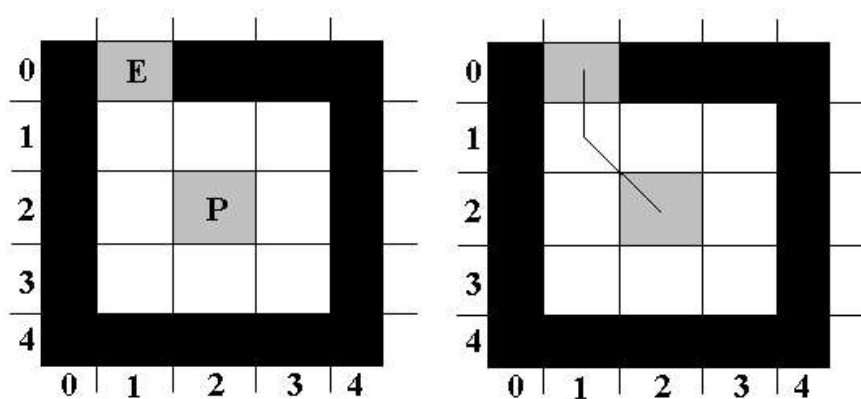


Figure 4.1

Let the center (2,2) node be the starting point (P), and the offset grey node (0,1) the end position (E). The h -value is calculated differently depending on the application. However for

this example, h will be the combined cost of the vertical and horizontal distances from the present node to (E). Therefore $h = |dx - cx| + |dy - cy|$ where (dx, dy) is the destination node and (cx, cy) is the current node.

At the start, since P(2,2) is the only node that the algorithm knows, it places it in the Open list as shown in Table 4.1.

Open List	Closed List
{ P(2,2) }	{ Empty }

Table 4.1

There are eight neighbouring nodes to p(2,2). These are (1,1), (2,1), (3,1), (1,2), (3,2), (1,3), (2,3), (3,3) respectively. If any of these nodes is not already in the Open list it is added to it. Then each node in the Open list is checked to see if it is the end node E(1,0) and if not, then its f -value is calculated ($f = g + h$).

Node	g -value	h -value	f -value
(1,1)	0 (Nodes to travel through)	1	1
(2,1)	0	2	2
(3,1)	0	3	3
(1,2)	0	2	2
(3,2)	0	4	4
(1,3)	0	3	3
(2,3)	0	4	4
(3,3)	0	5	5

Table 4.2

As can be seen from Table 4.2 Node (1,1) has the lowest f -value and is therefore the next node to be selected by the A* algorithm. Since all the neighbouring nodes to P(2,2) have been looked at, P(2,2) is added to the Closed list (as shown in Table 4.3).

Open List	Closed List
{ (1,1), (2,1), (3,1), (1,2), (3,2), (1,3), (2,3), (3,3) }	{ P(2,2) }

Table 4.3

There are four neighbouring nodes to (1,1) which are E(1,0), (2,1), (1,2), (2,2) respectively. Since E(1,0) is the only node, which is not on either of the lists, it is now looked at. Given that all the neighbours of (1,1) have been looked at, it is added to the Closed list. Since E(1,0) is the end node, a path has therefore been found and it is added to the Closed list. This path is found by back-tracking through the nodes in the Closed list from the goal node to the start node { P (2,2), (1,1), E(1,0) }. This algorithm will always find the shortest path if one exists [Matthews02].

5 Limitations of Traditional Pathfinding

Ironically the main problems that arise in pathfinding are due to pre-processing, which makes complex pathfinding in real-time possible. These problems include the inability of most pathfinding engines to handle dynamic worlds and produce realistic (believable) movement. This is due primarily to the pre-processing stages that produce the nodes for the pathfinder to travel along based on a static representation of the map. However if a dynamic obstacle subsequently covers a node along the predetermined path, the agent will still believe it can walk where the object is. This is one of the main factors that is holding back the next generation of computer games that are based on complex physics engines similar to that produced by middleware companies such as Havok (www.havok.com) and Renderware (www.renderware.com). Another problem is the unrealistic movement which arises when the agent walks in a straight line between nodes in the path. This is caused by the dilemma which arises in the trade off between speed (the less number of nodes to search the better) and realistic movement (the more nodes the more realistic the movement). This has been improved in some games by applying splines (curve of best fit) between the different nodes for smoothing out the path.

The problems listed above, are mainly due to the introduction of dynamic objects into static maps, are one of the focuses of research in the games industry at present. Considerable effort is going into improving the AI agent's reactive abilities when dynamic objects litter its path. One of the solutions focuses on giving the agent a method of taking into account its surroundings. A simple way to achieve this is to give the agent a few simple sensors so that it is guided by the pathfinder but not completely controlled by it. However this method will not be effective if the sensors used are unable to deal with noisy data.

5.1 Limitations Of A*

A* requires a large amount of CPU resources, if there are many nodes to search through as is the case in large maps which are becoming popular in the newer games. In sequential programs this may cause a slight delay in the game. This delay is compounded if A* is

searching for paths for multiple AI agents and/or when the agent has to move from one side of the map to the other. This drain on CPU resources may cause the game to freeze until the optimal path is found. Game designers overcome these problems by tweaking the game so as to avoid these situations [Cain02].

The inclusion of dynamic objects to the map is also a major problem when using A*. For example once a path has been calculated, if a dynamic object then blocks the path the agent would have no knowledge of this and would continue on as normal and walk straight into the object. Simply reapplying the A* algorithm every time a node is blocked would cause excessive drain on the CPU. Research has been conducted to extend the A* algorithm to deal with this problem most notably the D* algorithm (which is short for dynamic A*) [Stentz94]. This allows for the fact that node costs may change as the AI agent moves across the map and presents an approach for modifying the cost estimates in real time. However the drawback to this approach is that it adds further to the drain to the CPU and forces a limit on the dynamic objects than can be introduces to the game.

A key issue constraining the advancement of the games industry is its over reliance on A* for pathfinding. This has resulted in game designers getting around the associated dynamic limitations by tweaking their designs rather than developing new concepts and approaches to address the issues of a dynamic environment [Higgins02]. This tweaking often results in removing/reducing the number of dynamic objects in the environment and so limits the dynamic potential of the game. A potential solution to this is to use neural networks or other machine learning techniques to learn pathfinding behaviours which would be applicable to real-time pathfinding.

5.2 Machine Learning

A possible solution to the problems mentioned in section 5.1 is to use machine learning to assimilate pathfinding behaviour. From a production point of view, machine learning could bypass the need for the thousand lines or so of brittle, special case, AI logic that is used in many games today. Machine learning if done correctly, allows generalisation for situations that did not crop up in the training process. It should also allow the game development team to develop the AI component concurrently with the other components of the game.

Machine learning techniques can be broken into the following three groups:

- **Optimisation** – Learning by optimisation involves parameritising the desired behaviour of the AI agent and presenting a performance measure for this desired

behaviour. It is then possible to assign an optimisation algorithm to search for sets of parameters that make the AI agent perform well in the game. *Genetic Algorithms* are the most commonly used technique for optimisation.

- **Training** – Learning by training involves presenting the AI agent with a set of input vectors and then comparing the output from the AI agent to the desired output. The difference between the two outputs is known as the error. The training involves modifying the internal state of the agent to minimise this error. *Neural Networks* [Fausett94] are generally used when training is required.
- **Imitation** – Learning by imitation involves letting the AI agent observe how a human player plays the game. The AI agent then attempts to imitate what it has observed. The Game observation Capture (GoCap) technique [Alexander 02] is an example of learning through imitation.

6 Learning Algorithms

There are two machine learning approaches that have been used in commercial computer games with some degree of success. These are Artificial Neural Networks (ANNs) and Genetic Algorithms (GAs). This section will outline both of these approaches in detail followed by a discussion of the practical uses for them in learning pathfinding for computer games.

6.1 Neural Networks

An artificial neural network is an information-processing system that has certain performance characteristics in common with biological neural networks [Fausett94]. Artificial Neural networks have been developed as generalizations of mathematical models of human cognition or neural biology, based on the following assumptions:

1. Information processing occurs in simple elements called neurons
2. Signals are passed between neurons over connection links
3. Each of these connections has an associated weight which alters the signal
4. Each neuron has an activation function to determine its output signal.

An artificial neural network is characterised by (a) the pattern of connections between neurons i.e. the architecture, (b) the method of determining the weights on the connections (Training and Learning algorithm) (c) the activation function.

6.2 The Biological Neuron

A biological neuron has three types of components that are of particular interest in understanding an artificial neuron: its *dendrites*, *soma*, and *axon*, all of which are shown in Figure 5.1.

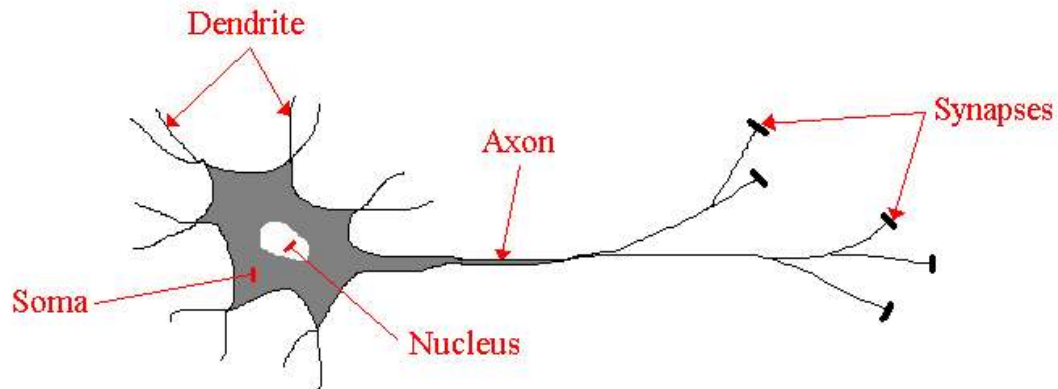


Figure 5.1

- **Dendrites** receive signals from other neurons (synapses). These signals are electric impulses that are transmitted across a synaptic gap by means of a chemical process. This chemical process modifies the incoming signal.
- **Soma** is the cell body. Its main function is to sum the incoming signals that it receives from the many dendrites connected to it. When sufficient input is received the cell fires sending a signal up the *axon*.
- **The Axon** propagates the signal, if the cell fires, to the many synapses that are connected to the dendrites of other neurons.

6.3 The Artificial Neuron

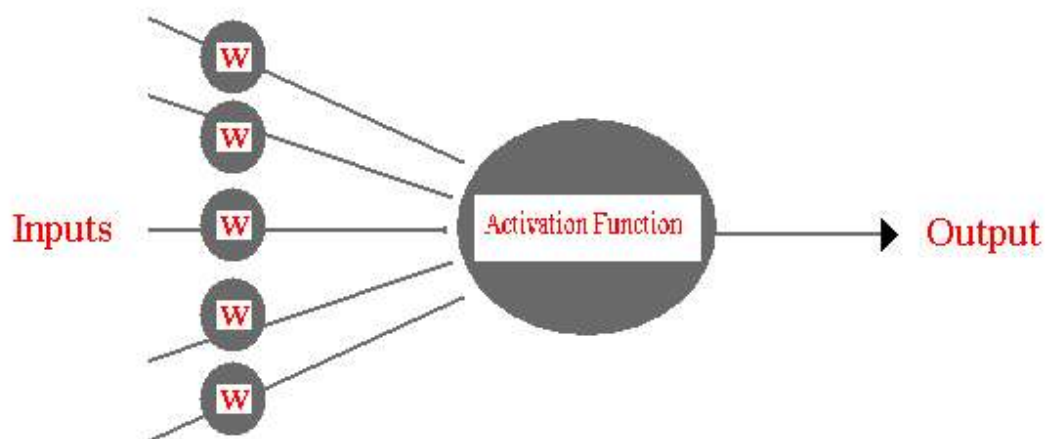


Figure 5.2

The artificial neuron structure is composed of (i) n *inputs*, where n is a real number, (ii) an *activation function* and (iii) an *output*. Each one of the inputs has a weight value associated with it and it is these weight values that determine the overall activity of the neural network. Thus when the inputs enter the neuron, their values are multiplied by their respective weights. Then the activation function sums all these weight-adjusted inputs to give an activation value (usually a floating point number). If this value is above a certain threshold the neuron outputs this value, otherwise the neuron outputs a zero value. The neurons that *receive* inputs from or *give* outputs to an external source are called *input* and *output* neurons respectively.

Thus the artificial neuron resembles the biological neuron in that (i) the inputs represent the dendrites and the weights represent the chemical process that occurs when transferring the signal across the synaptic gap, (ii) the activation function represents the soma and (iii) the output represents the axon.

6.4 Layers

It is often convenient to visualise neurons as arranged in layers with the neurons in the same layer behaving in the same manner. The key factor determining the behaviour of a neuron is its activation function. Within each layer all the neurons typically have the same activation function and the same pattern of connections to other neurons. Typically there are three categories of layers, which are *Input Layer*, *Hidden Layer* and *Output layer* respectively.

6.4.1 Input Layer

The neurons in the input layer do not have neurons attached to their inputs. Instead these neurons each have only one input from an external source. In addition the inputs are not weighted and so are not acted upon by the activation function. In essence each neuron receives one input from an external source and passes this value directly to the nodes in the next layer.

6.4.2 Hidden Layer

The neurons in the hidden layer receive inputs from the neurons in the previous input/hidden layer. These inputs are multiplied by their respective weights, summed together and then presented to the activation function which decides if the neuron should fire or not. There can be many hidden layers present in a neural network although for most problems one hidden layer is sufficient.

6.4.3 Output Layer

The neurons in the output layer are similar to the neurons in a hidden layer except that their outputs do not act as inputs to other neurons. Their outputs however represent the output of the entire network.

6.5 Activation Function

The same activation function is typically used by all the neurons in any particular layer of the network. However this condition is not required. In multi-layer neural networks the activation used is usually non-linear, in comparison with the step or binary activation function functions used in single layer networks. This is because feeding a signal through two or more layers using linear functions is the same as feeding it through one layer. The two functions that are mainly used in neural networks are the *Step* function and the *Sigmoid* function (S-shaped curves) which represent linear and non-linear functions respectively.

Figure 5.3 shows the three most common activation functions, which are binary step, binary sigmoid, and bipolar sigmoid functions respectively.

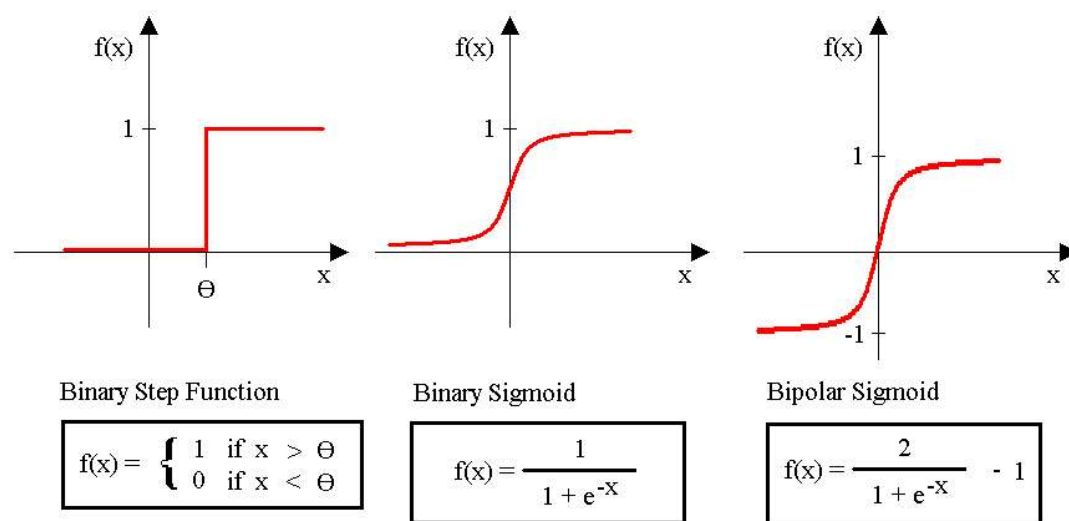


Figure 5.3

6.6 Learning

The weights associated with the inputs to each neuron are the primary means of storage for neural networks. Learning takes place by changing these weights. There are many different techniques that allow neural networks to learn by changing their weights. These broadly fall into two main categories, which are *supervised learning* and *unsupervised learning* respectively.

6.6.1 Supervised Learning

The techniques in the supervised category involve mapping a given set of inputs to a specified set of target outputs. This means that for every input pattern presented to the network the corresponding expected output pattern must be known. The main approach in this category is backpropagation, which relies on error signals from the output nodes. This requires guidance from an external source i.e. a supervisor to help (monitor) with the learning through feedback.

- **Backpropagation** – Training a neural network by backpropagation involves three stages: the feed forward of the input training pattern, the backpropagation of the associated output error, and the adjustments of the weights to minimise this error. The associated output error is calculated by subtracting the networks output pattern from the expected pattern for that input training pattern.

6.6.2 Unsupervised Learning

The techniques that fall into the unsupervised learning category have no knowledge of the correct outputs. Therefore, only a sequence of input vectors is provided. However the appropriate output vector for each input is unknown.

- **Reinforcement** – In reinforcement learning the feedback is simply a scalar value, which may be delayed in time. This reinforcement signal reflects the success or failure of the entire system after it has performed some sequence of actions. Hence the reinforcement-learning signal does not assign credit or blame to any one action. This method of learning is often referred to as the “*Slap and Tickle approach*”. Reinforcement learning techniques are appropriate when the system is required to learn on-line, or a teacher is not available to furnish error signals or target outputs.

6.7 Generalization

When the learning procedure is carried out in the correct manner, the neural network will be able to generalise. This means that it will be able to handle scenarios that it did not encounter during the training process. This is due to the way the knowledge is internalised by the neural network. Since the internal representation is neuro-fuzzy, practically no cases will be handled perfectly and so there will be small errors in the values outputted from the neural network. However it is these small errors that enable the neural network handle different situations in that it will be able to abstract what it has learned and apply it to these new situations. Thus it will be able to handle scenarios that it did not encounter during the training process. This is known as a “Generalisation”. This is opposite to what is known as “Overfitting”.

6.8 Overfitting

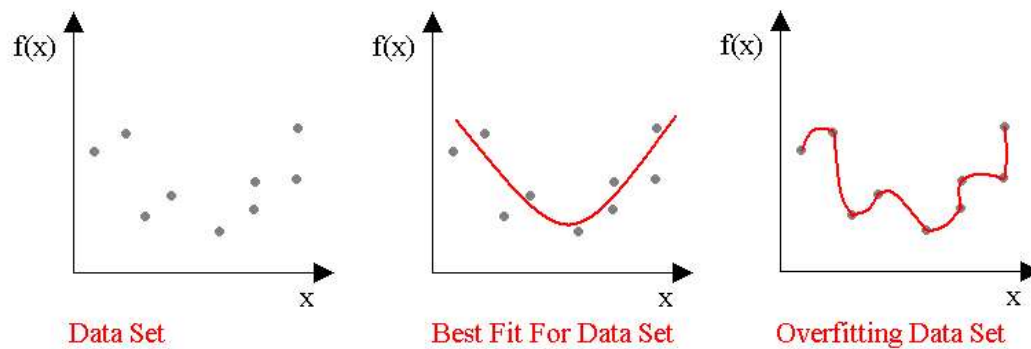


Figure 5.4

Overfitting describes when a neural network has adapted its behaviour to a very specific set of states and performs badly when presented with similar states and so therefore has lost its ability to generalise. This situation arises when the neural network is over trained i.e. the learning is halted only when the neural networks output exactly matches the expected output.

6.9 Topology

The topology of a NN refers to the layout of its nodes and how they are connected. There are many different topologies for a fixed neuron count, but most structures are either obsolete or practically useless. The following are examples of well-documented topologies that are best suited for game AI.

6.9.1 Feed forward

This is where the information flows directly from the input to the outputs. Evolution and training with back propagation are both possibilities. There is a connection restriction as the information can only flow forwards hence the name feed forward.

6.9.2 Recurrent

These networks have no restrictions and so the information can flow backward thus allowing feedback. This provides the network with a sense of state due to the internal variables needed for the simulation. The training process is however more complex than the feed forward because the information is flowing both ways.

7 Genetic Algorithms

Nature has a robust way of evolving successful organisms. The organisms that are ill suited for an environment die off, whereas the ones that are fit live to reproduce passing down their good genes to their offspring. Each new generation has organisms, which are similar to the fit members of the previous generation. If the environment changes slowly the organisms can gradually evolve along with it. Occasionally random mutations occur, and although this usually

means a quick death for the mutated individual, some mutations lead to a new successful species.

It transpires that what is good for nature is also good for artificial systems, especially if the artificial system includes a lot of non-linear elements. The genetic algorithm, described in [RusselNorvig95] works by filling a system with organisms each with randomly selected genes that control how the organism behaves in the system. Then a fitness function is applied to each organism to find the two fittest organisms for this system. These two organisms then each contribute some of their genes to a new organism, their offspring, which is then added to the population. The fitness function depends on the problem, but in any case, it is a function that takes an individual as an input and returns a real number as an output.

The genetic algorithm technique attempts to imitate the process of evolution directly, performing selection and interbreeding with randomised crossover and mutation operations on populations of programs, algorithms or sets of parameters. Genetic algorithms and genetic programming have achieved some truly remarkable results in recent years [Koza99], beautifully disproving the public misconception that a computer “can only do what we program it to do”.

7.1 Selection

The selection process involves selecting two or more organisms to pass on their genes to the next generation. There are many different methods used for selection. These range from randomly picking two organisms with no weight on their fitness score to sorting the organisms based on their fitness scores and then picking the top two as the parents. The main selection methods used by the majority of genetic algorithms are: *Roulette Wheel selection*, *Tournament selection*, and *Steady State selection*. Another important factor in the selection process is how the fitness of each organism is interpreted. If the fitness is not adjusted in any way it is referred to as the *raw fitness value* of the organism otherwise it is called the *adjusted fitness value*. The reason for adjusting the fitness values of the organisms is to give them a better chance of being selected when there are large deviations in the fitness values of the entire population.

7.1.1 Tournament Selection

In tournament selection n (where n is a real number) organisms are selected at random and then the fittest of these organisms is chosen to add to the next generation. This process is repeated as many times as is required to create a new population of organisms. The organisms that are selected are not removed from the population and therefore can be chosen any number of times.

This selection method is very efficient to implement as it does not require any adjustment to the fitness value of each organism. The drawback with this method is that because it can converge quickly on a solution it can get stuck in local minima.

7.1.2 Roulette Wheel Selection

Roulette wheel selection is a method of choosing organisms from the population in a way that is proportional to their fitness value. This means that the fitter the organism, the higher the probability it has of being selected. This method does not guarantee that the fittest organisms will be selected, merely that they have a high probability of being selected. It is called roulette wheel selection because the implementation of it involves representing the populations total fitness score as a pie chart or roulette wheel. Each organism is assigned a slice of the wheel where the size of each slice is proportional to that respective organisms fitness value. Therefore the fitter the organism the bigger the slice of the wheel it will be allocated. The organism is then selected by spinning the roulette wheel as in the game of roulette.

This roulette selection method is not as efficient as the tournament selection method because there is an adjustment to each organism's fitness value in order to represent it as a slice in the wheel. Another drawback with this approach is that it is possible that the fittest organism will not get selected for the next generation, although this method benefits from not getting stuck in as many local minima.

7.1.3 Steady State Selection

Steady state selection always selects the fittest organism in the population. This method retains all but a few of the worst performers from the current population. This is a form of *elitism selection* as only the fittest organisms have a chance of being selected. This method usually converges quickly on a solution but often this is just a local minima of the complete solution. The main drawback with this method is that it tends to always select the same parents every generation this results in a dramatic reduction in the gene pool used to create the child. This is why the population tends to get stuck in local minima as it is over relying on mutation to create a better organism. This method is ideal for tackling problems that have no local minima or for initially getting the population to converge on a solution in conjunction with one of the other selection methods.

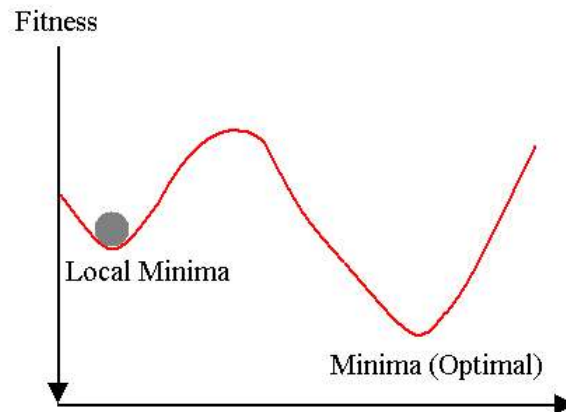
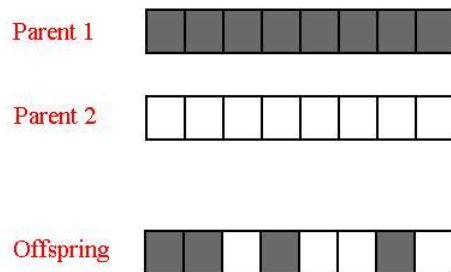


Figure 6.1

7.2 Crossover

The crossover process is where a mixture of the parent's genes is passed onto the new child organism. There are three main approaches to this *random crossover*, *single-point crossover* and *two-point crossover*.

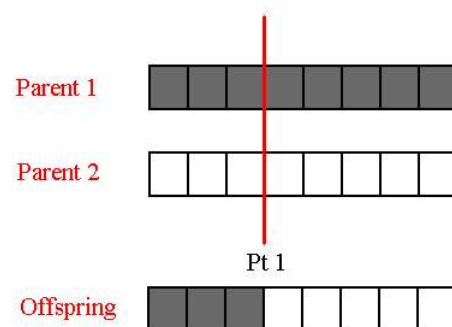
7.2.1 Random Crossover



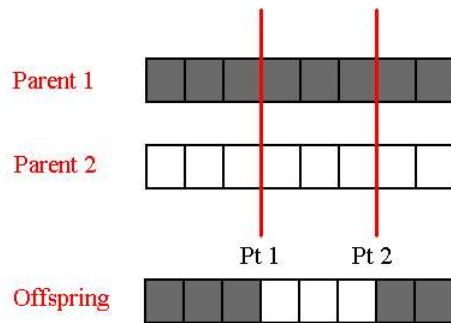
For each of the genes in the offsprings chromosome a random number of either zero or one is generated. If the number is zero the offspring will inherit the same gene in Parent 1 otherwise the offspring will inherit the appropriate gene from Parent 2. This results in the offspring inheriting a random distribution of genes from both parents.

7.2.2 Single-Point Crossover

A random crossover point is generated in the range ($0 < Pt\ 1 < \text{length of Offspring chromosome}$). The offspring inherits all the genes that occur before Pt1 from Parent 1 and all the genes that occur after Pt1 from Parent 2.



7.2.3 Two-Point Crossover



This is the same as the single-point crossover except this time two random crossover points are generated. The offspring inherits all the genes before Pt1 and after Pt2 from Parent 1 while all the genes between Pt1 and Pt2 are inherited from Parent 2.

7.3 Mutation

Mutation is another key feature of the crossover phase in genetic algorithms as it results in creating new genes that are added to the population. This technique is used to enable the genetic algorithm to get out of (resolve) local minima. The mutation is controlled by the mutation rate of the genetic algorithm and is the probability that a gene in the offspring will be mutated. Mutation occurs during the crossover stage; when the child is inheriting its genes from the parent organisms each gene is checked against the probability of a mutation. If this condition is met then that gene is mutated although this usually means a quick death for the mutated individual, some mutations lead to a new successful species.

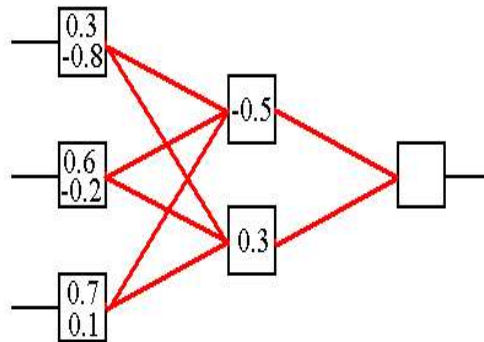
8 How Learning Algorithms Can Solve Pathfinding Problems

The main problems associated with real-time pathfinding are:

- Handling dynamic objects
- Using up too many resources especially on game consoles, which have limited memory
- Leave the AI until the end of the development process

Learning algorithms offer the possibility of a general pathfinding Application Programming Interface (API) that would allow an agent to learn how to find its way around the game world. An API is a collection of specific methods prescribed by an application program by which a programmer writing another program can make requests to. This would allow game developers experiment with training agents in more complex situations and then simply reuse this behaviour in future games even if the new game was completely different, as long as it can present the agent with the inputs it requires (as defined by the API).

8.1 Evolving the Weights of a Neural Network



$$\text{Weight Array} = \{ 0.3, -0.8, 0.6, -0.2, 0.7, 0.1, -0.5, 0.3 \}$$

Figure 8.1

The encoding of a neural network which is to be evolved by a genetic algorithm is very straightforward. This is achieved by reading all the weights from its respective layers and storing them in an array. This weight array represents the chromosome of the organism with each individual weight representing a gene. During crossover the arrays for both parents are lined up side by side. Then depending on the crossover method, the genetic algorithm chooses the respective parents weights to be passed on to the offspring.

A discussion on how learning algorithms can overcome the problems listed at the start of this section will now be looked at:

- **Dynamic problem** – Having continuous real-time sensors the AI agent should be able to learn to use this information via a neural network to steer around obstacles and adjust to a changing environment. Also because neural networks can generalise, the agent should be able to make reasonable decisions when it encounters a situation that did not arise during training. Genetic algorithms can be used to train the neural network online as new elements are added to the game.
- **Resource problem** – Neural networks do not require large amounts of memory and can handle continuous inputs in real-time as the data processing mainly involves addition and multiplication which are among the fastest processes a computer can perform

- **Speeding up the development process** – Giving the agents the ability to learn how to navigate around the map allows developers to start developing the AI at an earlier stage. If a new element is added to the game, then it should be a simple matter of allowing the agent learn the game with this new element.

8.2 Conclusion

The reason that games developers have not researched machine learning for pathfinding is that it would take too much time to do so and time is money! Games developers are also very reluctant to experiment with machine learning, as it could be unpredictable. One game that did use unsupervised machine learning was Black & White (www.lionhead.com) where the human player was able to train their own creature. A neural network was used to control the creature but while the human player was able to train the creature through reinforcement learning, it was tightly controlled to avoid totally unpredictable/unrealistic behaviour. So it seems that until the game developers are shown proof that machine learning can overcome the limitations of standard approaches they will avoid it.

Future work will involve setting up a test bed to test the practicality of using machine learning to perform pathfinding. Pacman is the game chosen for the test bed, as it is a real-time game that uses pathfinding algorithms to navigate around a 2D maze. Learning algorithms will be used to train a neural ghost that can be compared to standard ghosts in terms of speed, believability, and ability to play dynamic maps. The ghosts will use a neural network, which will decipher real-time data inputted by a number of sensors attached to the ghost, to decide what path to follow. The neural network will be trained using reinforcement learning with a genetic algorithm to evolve the weights as described in section 8.1.

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A Preliminary Investigation of the Role of Problem Based Learning (PBL)

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Abstract

Problem Based Learning (PBL) is a relatively recent innovation in education that appears to offer benefits that are not obtainable to the same extent by more traditional instructor-centred educational methodologies. This article tries to identify the key characteristics and benefits of PBL and asks how applicable they are to teaching computing at third level. The article is written as the first semester in which PBL was trialed in ITB draws to a close and is written from an active teaching rather than an educationalist research perspective.

Introduction

In recent years (since the mid 1970's) there has been an increased interest in Problem Based Learning (PBL) as an educational methodology which is not a instructor-centred as traditional educational methodologies. Education professionals are legitimately asking if PBL is applicable generally to most disciplines, and if so, should it be viewed as an alternative or a complementary methodology. Traditional teaching methodologies for technical disciplines place the instructor very much at the centre of learning for the student (with formal lectures, supervised laboratory work and tutorials), particularly in the early years of study at third level. A common view in education is that "assessment drives learning" and that "the curriculum shows you what the teaching staff are doing, assessment tells you what the students are doing"¹. Current assessment methodologies at second-level can place more emphasis on knowledge recall rather than actual understanding and this experience can be reinforced at third-level. It may be unrealistic to expect learning not to be primarily driven by assessment, but better assessment methodologies may map the student's learning more closely to the course objectives. The careful specification of course objectives and the design of curriculum, learning and assessment methodologies to support them is a problem to which PBL offers a solution. It is not the only solution. This article represents a first step in trying to define what is meant by PBL and if it can be applied to the teaching of computing at third level in an Institute of Technology

Neither of the authors had any formal experience with PBL prior to the beginning of this semester but one had experienced a form of learning that appeared, on investigation, to have some parallels. This was in professional officer training in a military academy. The approach

taken to training young officers in command of operational units to deal with operational tasks in a fluid and often adverse environment is based on the assumption that it is impossible to train them to deal with every possible eventuality. Training therefore focuses on the development of a generalised set of competencies which can then be applied in any situation. More specific knowledge-sets and competencies are also developed on required (and fast-changing) specialisations, such as weapons control or logistics, but it is the core set of competencies that are reinforced throughout the professional military life in a series of courses and exercises of escalating responsibility and complexity. Another identifiable component of this training was that assessment is primarily based on previously on live exercises which mirror as close as possible, the real-life situations in which the officer will have to act. A number of observations were made based on this experience:

- This approach to training is first carried out with learners when they have just finished their second-level education, and therefore they are initiated at the same time as our students begin third-level education.
- The model of education where training objectives encompass both general competencies and discipline specific competencies seemed to have considerable merit
- The idea of using a method of assessment that tests for learning in the same environment and in which a learned has trained and using challenging scenarios as close as possible to the real-life working environment seemed to offer benefits.

This training experience is markedly different from the authors' own experience of other third level education and seemed to offer interesting possibilities for a more thorough investigation.

What is PBL?

There is no universal view or definition of what constitutes PBL and there are different views and emphasis, depending on what is read.

Problem Based Learning is a teaching strategy for posing significant, contextualised, real-world situation and providing resources, guidance and instruction to learners as they develop content knowledge and problem solving skills.

(Mayo, Donnelly, Nash & Schwartz, 1993) ²

PBL is both a curriculum and a process. The curriculum consists of carefully selected and designed problems that demand from the learner acquisition of critical knowledge, problem solving proficiency, self-directed learning strategies, and team participation

skills. The process replicates the commonly used systemic approach to resolving problems or meeting challenges that are encountered in life and career.

(Dr. Howard Barrows)³

In Problem Based Learning, you will spend much of your time learning – by identifying what you need to know, finding out, teaching each other and then applying your new knowledge. Thus, the primary aim of the exercise is the learning, not the completion of the project. The project is the means to this end.

(Dr J. Kaya Prpic and Dr Roger G. Hadgraft)⁴

Although different definitions of PBL abound, a set of common characteristics of a PBL educational approach can be identified that includes:

- Using stimulus material to help students discuss an important problem
- Presenting the problem as a simulation of professional practice or a ‘real-life’ situation
- Appropriately guiding students’ critical thinking and providing limited resources to help them learn from defining and attempting to resolve the problem
- Having students work collaboratively as a group ... with access to a facilitator
- Getting students to identify their own learning needs and appropriate use of available resources
- Reapplying this knowledge to the original problem and evaluating their learning process

This approach is clearly different from traditional approaches, placing the learner at the centre of the education process and moving the teacher towards the facilitation end of the instructional spectrum.

Why use Problem Based Learning?

The rationale for considering the adoption of PBL must be firmly based on the desirability of its objectives its ability to meet these objectives. We will begin by briefly overviewing the objectives of PBL. A key aim of PBL is to assist students in achieving a set of core competences which can be generalised as follows:

- To adapt to a changing professional environment
- To improve decision making in unfamiliar situations
- To be able to critically analyse issues

- To be able to create solutions to certain problems
- To work effectively within a team
- To be able to identify strengths and weaknesses.

In order to be capable of benefiting from and coping with modern life, the student needs to acquire more than just a store of knowledge in the subjects that relate to their future profession. Students who embark on higher education now may still be in that active professional practise by the time they are 60 years old or later. They will need to be able to adapt to and participate in change within their professional environment. A key aim of PBL is to impart competencies for life.

A second aim of PBL is to develop effective conditions of adult learning. PBL seeks to do this by creating deeper learning and understanding through the students posing their own questions and simultaneous engagement with the broader curriculum in the context real-world problems, rather than on a course-by-course basis. This learning is carefully scaffolded through the use of a sequence of increasingly challenging problems to provide cumulative familiarity with the knowledge-sets and competencies as they are needed in real life. If these aims seem relevant, how can PBL lead to their achievement?

The PBL Process

Problem Based Learning is a system of teaching and learning where, without prior preparation, small groups of students consider an unfamiliar situation, problem or task. By exploring the nature of this unfamiliar situation, students share prior knowledge and experience. As the student progresses, they pose questions which they need to explore in order to progress with the task. After a period of individual study and research about the problem at hand, the student discusses what they have learned and how it relates to the original situation. In other words, using the normal approach to teaching, students are either taught or assumed to know how to solve the problem before they are given it, whereas with the PBL approach, the knowledge arises from working on the problem and trying to solve it.

Ross *et al'* developed a framework for problem-based curricula in 1985. In describing the initial framework, *et al* drew up distinction between different types of problem related curricula. They are as follows:

- **Problem-oriented Curricula:** Problems are used as a selection criteria for content of the course

- **Problem-based Curricula:** students work on a problems or scenarios as part of the course
- **Problem-solving Curricula:** students are trained in a process that helps them to approach a problem and create a solution

The possibility of a “hybrid” model, which can incorporate all three, seems an attractive approach. A framework overview for developing such a training model might be:

- Firstly, the design team selects a problem or scenario
- They use this problem to define an area of “knowledge” to be covered
- In relation to the problem, the team selects an event/scenario that will be given to the students
- A facilitator supports a core problem-solving process executed by the students where
 - The students must define the problem from what they have been given
 - The students must then express this problem as a set of questions
 - The students then use these questions to find out what resources they will need to use

This PBL process Model is a “guide” for the teacher/instructor on how the PBL framework could be implemented. It is divided into seven steps and it is aimed at Problem-based Curricula. This seven-step process was originally developed by the University of Maastricht in the Netherlands. Fig 1 shows a life cycle of this seven-stage process.

1. Read and analyse the scenario or situation:

Students should check their understanding of the scenario

2. List Hypotheses, ideas or hunches:

Students will have some theories or hypothesis about the cause of the problem, or may have an idea how to solve the problem, based on existing knowledge.

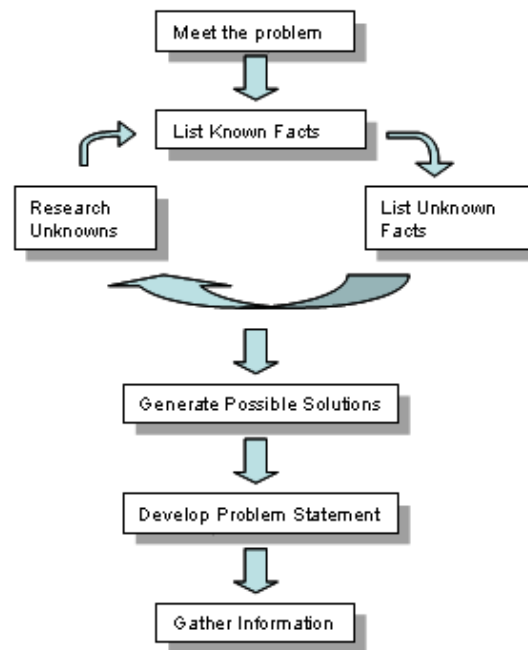


Fig 1: The seven-step process of PBL

3. List what is known:

Students should make a list of everything that is known about the scenario. No research is necessary at this point. Using only prior knowledge and information included in the scenario, students should draw up some conclusions and ideas

4. List what is unknown:

Students should now prepare a list of questions that need to be answered. Several types of questions may be appropriate. Some may address concepts that need to be understood before the scenario can be addressed, whilst other questions may request more information

5. List what needs to be done:

Students need to plan the investigation, i.e. question a leading expert, visit a library, use the Internet to find answers to questions posed in step 4

6. Develop a problem statement:

A problem statement is a one or two sentence idea what clearly identifies what the student is trying to solve or find out.

7. Gather Information:

Having completed the above steps, students will now need to gather, organise, analyse and interpret information from many sources. Students can exchange ideas, consider the pros and cons of each and as more information is gathered the problem statement may be refined or altered.

Once the above steps have been completed, the students (whether they are working in a group or individually) need to prepare some kind of report in which they make recommendations and can support their conclusions and solutions.

Are PBL objectives relevant for Computing?

If we look back at the set of generalized competences identified earlier we can clearly see their relevance to potential computer science graduates if they are to work in a professional environment such as software developers, systems architects/administrators, etc. There are of course more computing specific competences that would need to be added to meet the requirements of an undergraduate computing course, such as:

- To be able to read and write code, debug a program and execute a structured analysis, design and implementation of a software development project
- To be able to design, build, operate and manage an IT system
- To understand concepts associated with computing
- To understand how to apply computing concepts and techniques to provide solutions to real-world problems

Objectives such as these are currently addressed by traditional methodologies, typically on a knowledgebase/skillset basis, on a subject-by-subject approach. The combined application of these different subjects tends to only occur in project-based subjects and later in the third-level cycle rather than from the beginning. It is worthwhile to at least consider addressing them by using a more active adult learning approach than using conventional approaches only. For example, the teaching of programming in most third level institutions today consists primarily of students being given a lecture at the start of the week, followed by a tutorial class. The lecture introduces new topics and aspects of Java. The tutorial reinforces the information provided in the lecture but with higher interaction between the teacher and student. These activities can be largely passive on the students' part. The third teaching component involves exercising the student in applying the programming technique taught during the lecture/tutorial. Using the alternative PBL learning process, lectures are no longer the core means of imparting material to students. The process results in the students being given responsibility for their own learning from the beginning of the course and throughout. The emphasis is on the

'learning process' i.e. teaching the learner how to learn for themselves, rather than on a specific knowledge or skill. The role of the lecturer becomes one of facilitation and subject matter expert.

Core Issues in Using A PBL Approach

If PBL is worth trialling in a Computer Science environment, what are the main issues to be addressed?

Curriculum Design: The potential of PBL as an educational approach is highly dependant upon the design of the curriculum. It has been well researched that for a curriculum to achieve this, it must include the following aspects⁷:

1 Integrated Learning

Subjects should be available for study as they relate to a certain problem or task and should not be treated individually

2 Cumulative Learning

Subjects should be not studied in detail, but rather be reintroduced over and over again with increased complexity

3 Progression in Learning

As the students mature, so should the various aspects of the curriculum

4 Consistency in Learning

Students should be tested for application and understanding and not just recalling of knowledge.

Problem Formulation: The problem is all-important in PBL course design. Driven by the course objectives, the problem must stimulate, requiring the learner to engage with a range of knowledge and skills in a real-world context, while at a level consistent with the students state of development. While in our limited experience these don't seem to be radically different from current assignment or homework problems, they are broader in scope (involving knowledge/skills from a range of subjects) and mirror real-world problems e.g. the core problem trialled in PBL in computing this semester was the requirement to redesign and plan the implementation of an existing IT infrastructure to a more modern infrastructure that minimises the impact on the existing production architecture. An aspect of problem design is that it should be scalable in that, at the beginning of the year, a simpler problem is posed but it is important that it can be escalated or adapted to meet higher learning requirements. In this way, the problem serves as a vehicle through which the learner is exercised iteratively on the core PBL (self) learning process.

Assessment: Another key issue with using PBL is to establish objective assessment methodologies that are consistent with the learning aims. Although elements of traditional continuous or terminal assessment may be still prove relevant, assessment which involves real-world scenarios, or at least simulation of real-world scenarios, seems highly desirable as a measure of establishing the achievement of PBL objectives. This form of assessment should probably be proportioned more towards continuous rather than terminal assessment (dependent on the course objectives and real-world requirements).

Going Forward

This introductory discussion of PBL, coupled with our initial experiences, leads us to make a number of general observations:

- PBL seems to offer additional benefits to those provided by more traditional methodologies and therefore merits further investigation
- The general objectives of PBL seem to be relevant for the technical courses run in the Institute and appear to have the potential to prepare learners equally well for both industrial and research work.
- For students who have only experienced more didactic instructor led styles of learning, the PBL process offers a useful form of transition to the real-world where people work in teams and engage with contextually broad problems without initially knowing how to solve them
- PBL may offer an effective learning alternative for people already in the work place because it doesn't rely on attending instructor-led sessions as traditional methodologies. Instead, once the PBL process has been absorbed, it could lead to effective independent learning by learner groups. An added advantage would be that the emphasis on group interaction in PBL would leverage the experience of these people within the group, thus improving peer-learning opportunities.
- From an academic teacher perspective, the PBL methodology appears to be extremely consistent with an interest in research, insofar as the subject matter expert answers learner queries from their broad experience and current interest, rather than delivering 'set-piece' lectures.
- Although we initially approached PBL from a desire to improve retention, in our initial experience, we have identified that the PBL process is not for every learner. Some personalities are not suited to the central group dynamic and do not participate in the process. These learners fall into two groups – they are either already 'successful' independent learners who are happy to continue exclusively with their current

approach or else they are students who have a record of low performance and attendance in conventional classes.

Is Problem Based learning a better approach than traditional methodologies? We don't know, but it certainly is different. There is some evidence to suggest that in medicine at least, "for higher level courses, ... research points to the fact that students schooled in problem based learning are better able to apply their knowledge of the clinical sciences and have better developed clinical reasoning skills than (traditionally instructed) students."⁸ We expect to continue our investigation into PBL over the next academic semester and are particularly interested in researching if the implementation of the core PBL process would benefit from the development of a generic suite of IT tools that would support key issues like course objective definition, curriculum design, problem formulation, the seven stage PBL learning process and learning assessment for any course to be delivered through PBL.

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Embedded Systems in a Mobile Distributed IP Network

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Abstract

This paper describes an approach to the internetworking of mobile IP sensor nodes in a converged network environment. This preliminary investigation of sensory network models is driven by a joint applied research project between ITB and Teagasc (Grange) which seeks to establish the feasibility of the real-time remote monitoring of animal welfare while in transit between Ireland, Europe and the Middle East. The paper examines traditional system architectures, messaging paradigms and protocols with a view to establishing how the trend towards convergence in telecommunications and the emergence of new Internet Protocols could support the creation of new modes of operation for sensory networks.

Introduction

Traditional sensor network have applied centralized static models to intercommunication between relatively unintelligent sensor nodes and intelligent management stations. Recent trends are making it increasingly feasible to move away from a centralized model to a more distributed one to a point where a mobile sensor network could conceivably be modeled as ad hoc network of autonomous nodes. The impact of Moore's Law has led to the concentration of greater processing power, memory and storage (and consequently increased levels of intelligence) on small devices. Traditional switched and mobile networks are now converging around the TCP/IP model and Internet protocols are providing a means of rapidly deploying new applications and services across this converged space. IP enables the internetworking of disparate network nodes by providing a standardized addressing scheme and path determination. Higher layer protocols can provide reliability, signaling and quality of service support. One potential outcome of these trends is the repartitioning of capabilities and responsibilities within a sensory network to a more distributed model as intelligence spreads outwards from the centre to the edge of the network. Sensory nodes can now be independent computing platforms capable of peer-to-peer communication and of interacting with interim network nodes in order to provide previously unavailable services. Non-heterogenous nodes could inter-operate across a global inter-network and interact as single nodes or as logical groups. The Java language provides a platform independent application development environment and network operating system for code mobility. It increasingly provides frameworks and APIs for internet protocol implementation and telecommunications and internetworking support. Although limitations still exist in the intelligent services supported across the Internet, new protocols are services are emerging to address these shortcomings. This paper seeks to analyse the potential impact of these developments on sensor network embedded systems architectures, messaging paradigms (we will use the term messaging to include messages for carrying either data or control signals), modes of operation and supporting protocols. We will then briefly apply the analysis to the creation of a simple messaging service which could be used for sensory network communication.

Embedded Systems

An embedded system is a device that contains programmed logic on a chip that is used to control one or more functions of the device. A real-time embedded system provides deterministic performance, often in a mission critical environment. A sensor is often a real-time embedded device which is used to gather data such as the ambient temperature or humidity, in either a static or mobile environment, and report to a central management device. Mobile forms of such devices will increasingly operate in a pervasive computing environment using wireless transport technologies with IP connectivity for communication.

Evolving Architectures

Initially embedded systems were standalone devices with relatively simple interfaces and limited computational ability. The implementations were essentially proprietary in nature although they did make use of open standards at the Physical Layer (e.g. physical interfaces and signaling) of the OSI model. The advent of wire-based networking made it possible to interconnect these devices in a static deployment, while the need to monitor and control the devices gave rise to centralized management. The proprietary approach persisted. Most sensory systems today are still based on this static centralized proprietary architecture. A server or equivalent central station allows embedded devices to report based on time intervals or triggered events or else it routinely polls the devices for control or monitoring purposes. With the limited processing and memory of the sensor node, data is sent back to the more powerful and intelligent central server for storage and further processing. As edge nodes become more powerful, however, it has become possible to re-partition the distribution of intelligence and processing within the sensory system. If we consider this within a general trend towards IP convergence in the telecommunications and internetworking world, edge devices with partial TCP/IP stack support and modest processing power can provide a more distributed architecture and embedded devices with the full TCP/IP stack and more comprehensive computing power can become independent autonomous nodes in an ad hoc network. This ability to repartition sensory network architecture more flexibly than ever before based on open standards and internet protocols provides a basis for creating more flexible sensor network designs with better functionality, scalability, availability, performance, manageability and security characteristics.

Messaging Paradigms

There are two fundamental paradigms for the messaging between entities in traditional sensor network systems: Push or Pull.

In networked computing, the pull model is based on the generalized request/response paradigm (called data polling or simply polling) where the client sends a request to the server, and then the server answers, either synchronously or asynchronously. This is functionally equivalent to the client “pulling” the data off the server. In traditional sensory networks, it is typically the central or management node that sends a request to the remote sensing node which then replies. Figure 1 illustrates a pull model architecture in which a central node communicates with edge nodes using the Pull paradigm over an event channel.

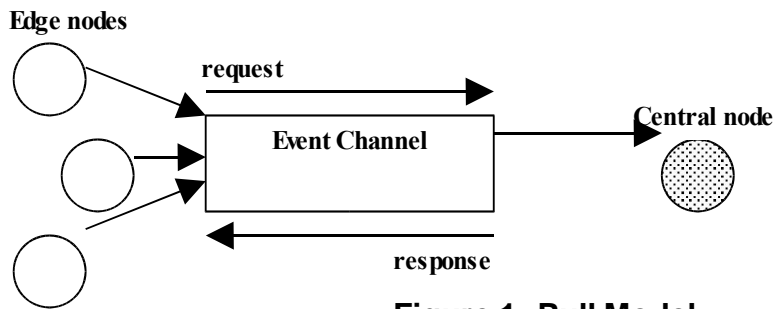


Figure 1: Pull Model

The alternative Push paradigm is based on the publish/distribute model in which the remote nodes push data into the central node at pre-determined intervals or on triggering events. In this model, agents first advertise what data they support, and what notifications they can generate; the administrator then subscribes the manager to the data of interest and specifies how often the manager should receive this data. It is then the responsibility of the agent to “push” data to the manager, either on a regular basis via a scheduler or asynchronously through message notifications. Figure 2 illustrates a push model architecture in which edge nodes communicate with a central node over an event channel.

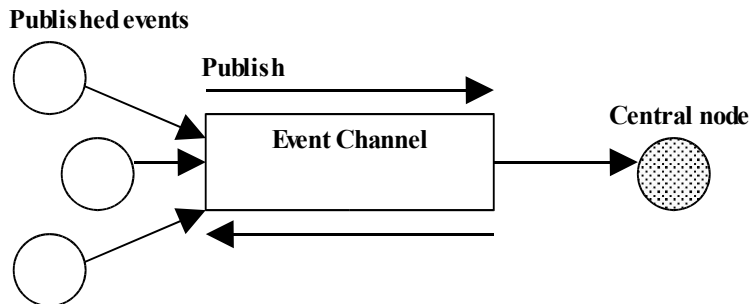


Figure 2: Push model of event transfer

The Pull paradigm has the advantage of simpler, centralized monitoring and management. It requires minimal intelligence in the edge node and is therefore conducive to a centralized architecture. It works well for regular monitoring or troubleshooting but is not appropriate for dynamic response functionality. The Push paradigm requires at least some independent decision-making at the network edge and is therefore consistent with a more distributed architecture. It is useful for generating reports triggered by events but this does not preclude it from being used for regular monitoring. It can improve bandwidth utilization by connecting only when there is something worth reporting. Where nodes become heterogeneous both paradigms require an initial registration where the node is established as a valid device and where capabilities are established.

Hybrid Push/Pull Models

It is possible to combine both modes of operation in a hybrid which seeks to combine the benefits of each paradigm. As the edge nodes and the central node can be completely decoupled from the event channel, push and pull models can be mixed in a single system. For example, edge nodes can connect to an event channel using the push model, while central or management nodes connect using the pull model. It is also possible to use different paradigms on a messaging function basis. System monitoring functions could be executed using pull messages while data retrieval functions (parameters readings, alarms, etc) could use push messages.

Same Paradigms – New Modes of Operation

Although these fundamental paradigms remain in use, the repartitioning of intelligence within the network and the use of IP make it possible to consider modes of operation which use these paradigms in other ways than those strictly based solely on a direct event channel between an edge node and a central node. One possibility is the use of an interim repository node to store edge node messages which in turn is either polled or pushes the message to the central node. This mode of operation seems attractive for mobile sensor networks in which the edge nodes may not always be able to link directly to a central node. Another mode of operation could be direct peer-to-peer messaging between edge nodes using either the push or pull paradigm. This mode of operation between autonomous or semi-autonomous nodes now moves beyond decision-making at the edge node to collective decision-making by a logical group of nodes. This type of decision making could support not just core networking functions such as availability and path determination, but also application layer decision-making e.g. a logical group of mobile sensors could transfer their collective linkage to a new central or interim node based on the group's changing geographic centre of gravity and replicate their data accordingly. With such expanded modes of operation, it is feasible to design systems not only where central nodes invoke objects on edge nodes (and vice versa) but where any type of nodes can invoke objects on any other type of node. Other modes of operation are possible and will be increasingly relevant with mobile devices that are capable of 'multi-band' transmission, are deployed in an increasingly pervasive computing environment and interface to different inertial reference frameworks. An example of such a deployment is a sensor platform that combines its core parametric sensing with GPS positional sensing, Wi-Fi networking to nearby nodes and GSM cellular sensing and communications capabilities for more remote nodes.

Internet Protocols & Embedded devices

While it may be possible to design these new architectures and modes of operation, how feasible would such designs be to implement in the NGN? If we assume that IP will provide best effort delivery in the NGN, we can focus our examination of implementation feasibility on higher layer (of the TCP/IP model) issues and largely ignore the lower data link and physical layer issues. This does not preclude the importance of key sensor network design issues such as interfacing and bandwidths but assumes that the convergence trend and constant improvements in bandwidth availability will overcome any such obstacles to implementation.

Recent innovation in embedded device technology has resulted in the placement of a thinned-out and even a full TCP/IP stack on embedded devices. This means that networked embedded devices are now in a position to leverage the power of the internet using well established protocols such as HTTP and FTP and developing protocols such as SIP (Session Initiation Protocol) for signaling.

Message Delivery

In the Internet protocol suite, IP is used as the network addressing protocol and the routed information by which paths can be determined between nodes. IP provides a best-effort connectionless delivery service. Reliability is left to the Transport layer protocol. IP delivers packets based on unicast (one-to-one), multi-cast (one-to-many) and broadcast (one-to-all) addressing.

Internet Application Protocols

The main existing Internet Application Protocols and their underlying messaging paradigms are overviewed in Table 1 below. As can be seen from the table, most of these applications are based on using either the Push or Pull paradigm. Messaging applications based on these protocols can operate across a network of TCP/IP enabled embedded devices.

Application Protocols	Function	Mode of Operation	Architecture	Delivery Mechanism	Reliability
HTTP	Data transfer	Pull	Client-Server	Unicast	Yes
FTP	Data transfer		Client-Server	Unicast	Yes
<i>Upload</i>		Push		Unicast	Yes
<i>Download</i>		Pull		Unicast	Yes
SMTP	Data transfer	Push	Client-Server	Unicast	No
IMAP/POP	Data Transfer	Pull	Client Server	Unicast	No
SNMP	Management		Client-Server	Unicast	Yes
SIP (and SDP)	Signaling	Push	Client-Server Peer-to-peer	Unicast Sig/Media Multicast Media Support	Yes

Table 1: Internet Application Protocols

Two preliminary observations can be made at this point:

- a) There is a lack of application protocols which can leverage underlying IP delivery services to provide the more advanced modes of operation
- b) Within the existing set of protocols, the SIP/SDP combination appears to offer the most flexibility for supporting advanced modes of operation for messaging.

Rationale for use of SIP

SIP is an application layer signaling protocol, designed to establish calls over which multimedia packets can be separately transferred in real-time. It is not designed to be used to transfer data/media but normally relies on RTP/RTCP to do this. This separation of signaling from the data exchange is an important characteristic that makes it possible to use different paradigms and modes of operation for signaling, control messaging and data transfer as appropriate. In typical SIP operation, SIP signaling is used to establish a call, the session characteristics are negotiated between the end devices using SDP and the media is transferred using RTP/RTCP. Further investigation of SIP reveals other advantages for building sensory network messaging:

Scalability: SIP is a very scalable protocol. It works from end-to-end across the LAN and the WAN. It does not rely solely on multicast/broadcast technologies to reach a destination endpoint. It has a strong concept of routing which enables a packet to traverse from source to destination using intermediate existing routes; hopping from one node to another till it reaches its final destination. Further SIP can operate on both UDP and TCP which allows SIP based servers to scale well.

Flexibility/Extensibility: In SIP it is very simple to add extensions to support new features. The protocol is defined in a way that any provider can define extensions easily to the existing grammar set to add features which may not exist in the core SIP specification.

Registration/Location: In SIP it is not necessary that a calling device needs to know exactly where to locate the called device. A participating device registers its current location with a central server node.

Simplicity: An important attribute for protocols to be used in the NGN is that they be simple enough to support the rapid deployment of new services. SIP enables such service creation and deployment.

Security: SIP provides both authentication and encryption to provide end-end security.

Event Notification: SIP has been extended to introduce SUBSCRIBE and NOTIFY messages which enable elements to “subscribe” to certain events and can be notified when they occur.

Unicast/Multicast Support: when used in conjunction with the Session Description Protocol (SDP), a separate protocol designed to negotiate session parameters, SIP can establish calls which will can use unicast or multicast delivery for content transfer.

Example: A SIP-based Instant Messaging Service

An interesting possibility is to consider extending the capability of SIP to include at least the transfer of short messages in real-time, which is a typical requirement of sensor nodes. Such an approach would not necessarily require SIP to establish a call but would require SIP’s ability to register and relove the names of participating nodes. Such an implementation would be useful in a mobile “bursty” environment or an environment in which bandwidth utilization is at a premium.

Instant messaging is defined as the exchange of content between a set of participants in real time. We will consider short simple textual messages only. Although forms of Instant Messaging have been in existence for quite some time, most implementations are proprietary and there is no Internet Application protocol specifically designed to support this function. Messaging between the nodes of a real-time mobile sensor network could be considered as an Instant Messaging application. Such an application could be implemented by using SIP but without requiring the establishment of a call. There is currently a proposal to extend the SIP specification by adding a new MESSAGE method. This method supports both the addressing and the transfer of any MIME type content between nodes but does not require prior call establishment. A MESSAGE request may traverse a set of SIP proxies using a variety of transport mechanisms (UDP, TCP) before reaching its destination. The destination for each hop is located using the address resolution rules detailed in the SIP specifications. During traversal, each proxy may rewrite the request address based on available routing information. This method leverages Routing like functionality (the pre-pending of proxy information in this case) to provide a reply path. Provisional and final responses to the request will be returned to the sender as with any other SIP request.

An example message flow is shown in Figure 3. The message flow shows an initial IM sent from User 1 to User 2, both users in the same domain, "domain", through a single proxy.

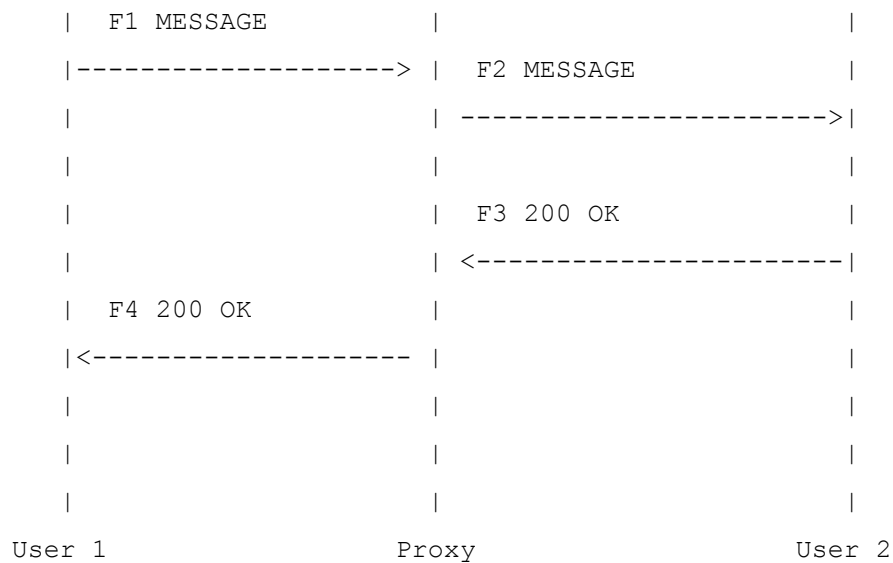


Figure 3: Example Message Flow

Message F1	Message F4
MESSAGE im:user2@domain.com SIP/2.0 Via: SIP/2.0/UDP user1pc.domain.com From: im:user1@domain.com To: im:user2@domain.com Call-ID: asd88asd77a@1.2.3.4 CSeq: 1 MESSAGE Content-Type: text/plain Content-Length: 18 Conor, hello world	SIP/2.0 200 OK Via: SIP/2.0/UDP user1pc.domain.com From: im:user1@domain.com To: im:user2@domain.com;tag=ab8asdasd9 Call-ID: asd88asd77a@1.2.3.4 CSeq: 1 MESSAGE Content-Length: 0 <i>Note that most of the header fields are simply reflected in the response. The proxy receives the response, strips off the top Via, and forwards to the address in the next Via, user1pc.domain.com and the result message is F4</i>

Conclusions

Modern embedded systems can support either partial or the entire TCP/IP stack and will be inter-networked over the NGN using Internet protocols. This implies that more distributed architectures will be possible and in the area of mobile sensor networks, it will be possible to use a model based on ad hoc networks of autonomous nodes. Although the fundamental push and pull messaging paradigms will

still provide the basic linkage, improved modes of operation such as interim and peer-to-peer messaging will be needed to support mobile sensors in increasingly pervasive computing environments. Traditional internet protocols will not support these improved modes of operation but emerging protocols such as SIP and SDP will. The design and implementation of an Instant Messaging application for embedded devices may be a convenient vehicle to research new protocols and the extension of the existing SIP protocol.

Towards a Framework for Modelling Multimedia Conferencing Calls in the Next Generation Network

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Abstract

This paper is concerned with the creation of a multiparty multimedia conferencing application which can be used in Next Generation Networks. It begins by suggesting ways in which conferencing can be modeled with a focus on separating signaling and media transfer functionality. Enabling technologies which could support the modeling framework derived and which are compatible with Next Generation Network (NGN) principles are reviewed. Finally, a design and implementation for a simple multimedia conferencing application are described.

Keywords

Multiparty conferencing, Multicast, SIP, RTP, Java, JAIN, collaboration

Introduction

Multiparty conferences over the Internet are increasingly capable of providing real-time media distribution (voice or video) rather than the non or near real-time functionality (message board, chat room) of the past. One reason for this is the increasing availability of broadband access and the introduction of Universal Mobile Telecommunications Systems (UMTS), which offers considerably more bandwidth than Global Systems for Mobile Communications (GSM). This increase in bandwidth will be a key factor in the increased use of media rich real-time conferencing. Another reason is the increasing support for real-time communication provided by Internet Protocols such as RTP/RTCP and SIP. This article represents an approach taken in the early stages of an applied project in ITB that is focused on researching the potential for creating new real-time multimedia conferencing services in the NGN. Potential applications areas include education, emergency response services, gaming and any general collaborative application.

This paper makes certain assumptions based on earlier work^{1,2,3} that can be summarised as follows:

- Convergence in the NGN will be based firmly on open standards and the TCP/IP protocol stack in particular
- Applications leveraging existing and emerging Internet Protocols will dominate

- Bandwidth availability will steadily increase from end-to-end and decreasingly represent a technical constraint

Part I: Multiparty Conferencing Models

It is possible to identify differing models for multiparty conferencing based on the physical topology, media (type, bandwidth usage and heterogeneity), logical connectivity, network-layer delivery, the distribution of intelligence within the network, signaling and application. There are inter-relationships between these issues. Assuming that IP will provide best effort delivery in the NGN over an essentially transparent data-link, we will focus our discussion on conferencing models to the issues of topologies (and the distribution of intelligence within the topology), signaling, media transfer and higher layer protocols. Aspects of lower layer functionality such as bandwidth usage and differing codecs for speech/video will be assumed to have been resolved by the trend towards convergence.

Topology and the Partitioning of Intelligence

Multiparty Conferencing can use a centralized (Star/Hub & Spoke), distributed (Full Mesh/Partial Mesh) or hybrid (Partial Mesh/Tree/Extended Star) topology.

Centralised: In the centralized model, a central server receives the media streams from different participants, combines them and redistributes them as needed. This model emphasizes the placement of intelligence (for combining, codec translation and redistribution) at the central processing node and means the end-user nodes can be relatively simple. Other important advantages are the relative ease with which conference participants with different media codecs can be supported and the ability to track participants and manage the conference. The obvious disadvantage is the reliance on the central node for conferencing.

Fully Distributed: In a distributed topology, each end node sends a copy of its media stream to all other participating end nodes. This requires each end node to have sufficient intelligence and processing power to translate codings, sum incoming media streams and negotiate and manage participation. It also adds complexity in the event of people joining or leaving the conference on an ad hoc basis.

Hybrid: The hybrid model combines some of the benefits of both the centralized and distributed models, requiring intelligence in both the central and end-user nodes. It behaves like the central model insofar as some media or signaling streams are sent to the central node but the central node is only required to re-distribute the incoming streams. There is no need to

centrally mix or filter the streams before redistribution. Interim nodes such as gateways can provide codec translation between SIP and H.323, GSM, ISDN or other codings.

Network Delivery

It is possible to deliver media for conferencing using IP Unicast, Broadcast, Multicast or any combination of these. We summarily dismiss broadcast for media transfer because of its impact on connected host networks, bandwidth and the lack of support for broadcast in IPv6. Multicast trees offer clear advantages in terms of bandwidth usage and scalability for conferencing, as the media stream is only replicated once for each subscribed branch of the multicast routed tree. This use of bandwidth can be further optimized with multicast-aware OSI model layer 2 switching. Multicasting is therefore ideal for conferencing applications both on the LAN and the wider internetwork. While easily achieve on the enterprise LAN, however, native multicast capabilities are still not widespread on the Internet and this is a limiting constraint on existing approaches to multiparty conferencing. Unicast works well for a small number of conference participants but does not scale well for a large number of users. It is possible, however, to use combine unicast and multicast in an effective manner where the number of speakers is low e.g unicast could be used for sending media streams to a central node while the conference output stream can be redistributed using multicast to the participating end-nodes. In this way, any participant node in a given conference merely subscribes to the corresponding multicast address. Speaking generally, this hybrid will scale best (i.e. the disadvantages of unicast for transmission to the central node will be mitigated) if the number of conference speakers is small while the number of listeners is large.

Signaling for Multiparty Conferencing

Signaling refers to the exchange of information between call components required to provide and maintain service between two or more endpoints. This is achieved by exchanging protocol specific messages. Signaling messages carry information related to the following:

- capabilities exchange
- opening and closing of logical channels used to carry media streams
- flow-control messages
- general commands and indications

Signaling is a critical mechanism for call setup and service delivery in conferencing. Signaling protocols make it possible to establish point-to-point and point-to-multipoint links over a converged network architecture that can span TCP/IP LANS, the Internet, traditional WANS (PSTN, ISDN, FR), etc. With this link established it will not only be possible to send voice and video, but any IP based packet data like multimedia presentations, still images, text, etc. The

differences in the signaling protocols that have emerged arise largely from the different origins and philosophical approaches that spawned them and can be summarised as:

Intelligent Network Approach (Centralised): is the traditional approach of the telecommunications industry and assumes that the network is intelligent and the end nodes are dumb e.g. MGCP (Media gateway Control Protocol), H.248/Megaco, etc. These protocols are highly complex, they don't fit the Internet model and are not directly compatible with existing LAN infrastructures.

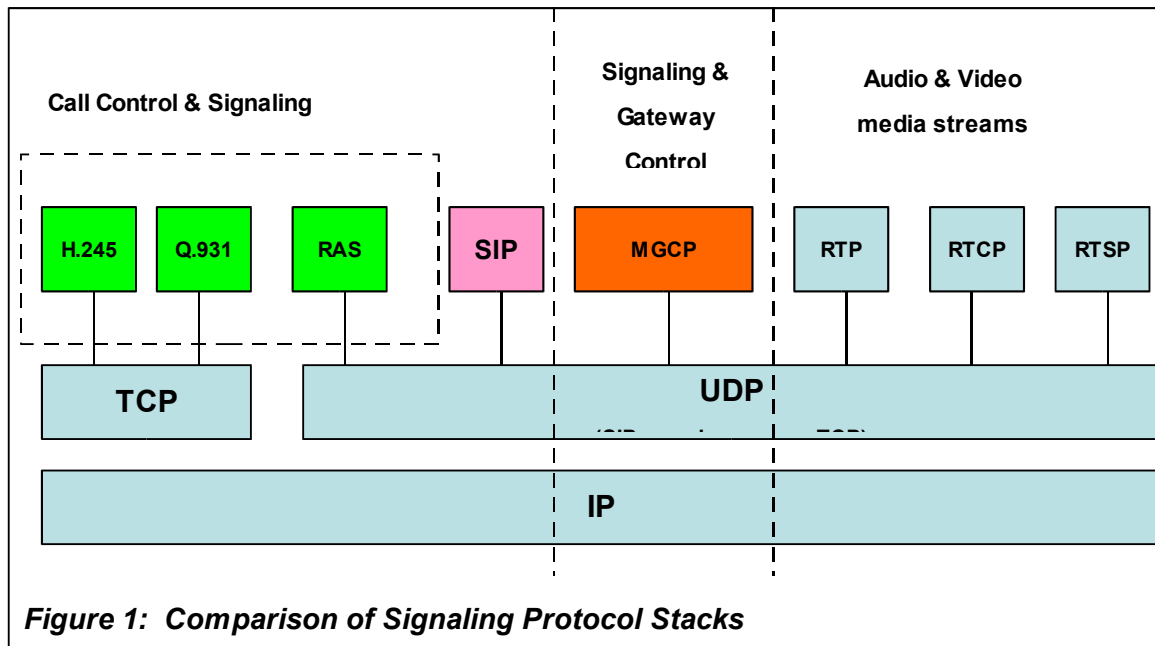
Intelligent Node Approach (Distributed): The end nodes are intelligent but the network is dumb e.g. the Session Initiation Protocol (SIP) which is designed for use over the Internet. SIP has low complexity, is designed for the Internet and provides a simple clean end-to-end architecture.

Intelligent Nodes & Network Approach (Hybrid) Both the network and the end nodes are intelligent e.g. H.323 which was designed for use over the enterprise LANs. Although the best established protocol for multimedia conferencing on the enterprise LAN, H.323 is highly complex, not very scalable, doesn't fit the internet model and is expensive to deploy.

The figure below summarises the protocol stacks used with each of the signalling protocols.

Media Transfer

The Real-Time Protocol (RTP) and the Real-Time Control Protocol (RTCP) are the main IETF protocols for transferring media in real-time over the Internet. The User datagram Protocol (UDP) is used at the transport layer because of the reliability provided by RTCP. RTP/RTCP packets can in turn be delivered using unicast, multicast or broadcast addressing. The fact that SIP separates signaling from media transfer is an illustration of an important modeling concept in conferencing, namely that it is possible to separate the design of the signaling from the design of the media transfer. Indeed, different aspects of signaling and different aspects of media transfer could be handled separately, allowing a more granular approach to the design of these aspects of conferencing.



Application

Applications may vary according to the conference size (number of participants), profile (ratio of speakers to listeners, open or closed), media type (text, audio, video or combined), environment (LAN, WAN, Internet or combination) and the end-node profile (access bandwidths, codecs, user interfaces and available protocols). The ratio of speakers to listeners is an important aspect of the conference system design. Multicast will scale well for listeners but not necessarily as well for speakers, especially in a shared or non-intelligent layer-2 switched environment. So the number of speakers impacts more directly on scalability. The conference media type will directly impact on required bandwidths while its open or closed requirements will add management overhead. The capabilities of the end nodes in terms of access bandwidth, employed codecs, interfaces and available protocols are also an influencing factor in system design. The Application goals and constraints will represent the main drivers in design of a conferencing system solution and it is difficult to see how any approach other than a structured top-down approach could be adopted.

Towards a Framework for Conference Modeling

One framework for modeling conferencing systems that may be useful is to consider the following design issues separately:

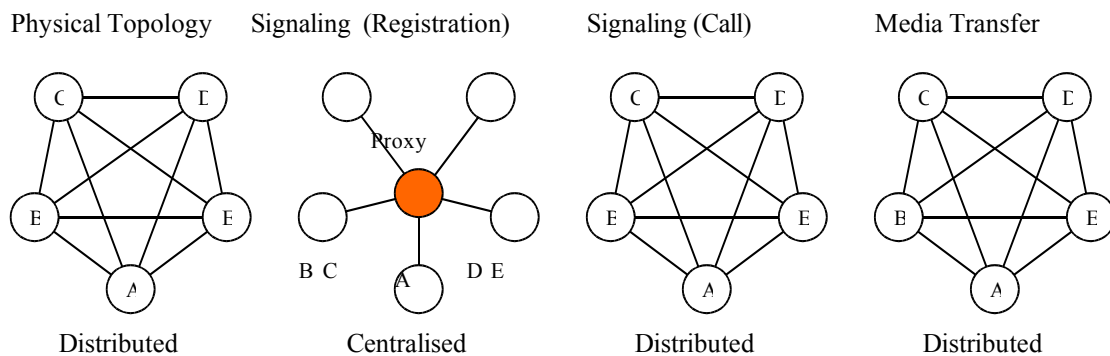
- Physical topology/Logical Connectivity
- Packet Delivery
- Signaling (Registration, Naming and Location)
- Signaling (Call establishment, maintenance/manipulation and termination)

- Media Transfer
- Application

This framework model is clearly consistent with the existing OSI and TCP/IP models. Not only could it be applied separately to the signaling and media transfer function, to could also be applied to different aspects of the signaling function (e.g. registration and calling) or of the media transfer function (e.g. for incoming and outgoing media streams). Centralised structures imply that unicast or broadcast (from central node) are possible for delivery. Distributed structures imply that unicast or broadcast (from central node) are possible for delivery. Distributed structures imply multicast is also an option. The following Figures illustrate the use of such a modeling framework to develop some basic conferencing models.

Example 1: In this fully meshed example, each participant in the conference has a direct connection with each other participant. Signaling could be provided separately using a centralized model for registration and address resolution functions while calls could be established directly between peers. In the full mesh, any node could function as the registration proxy or it could be a separate node. User A would have 4 incoming streams, and 4 outgoing streams. That is 8 media streams to send over one link and to process with one device. Straight away it is clear to see that this architecture is not very scalable all and would be appropriate only for conferences with a small number of participants.

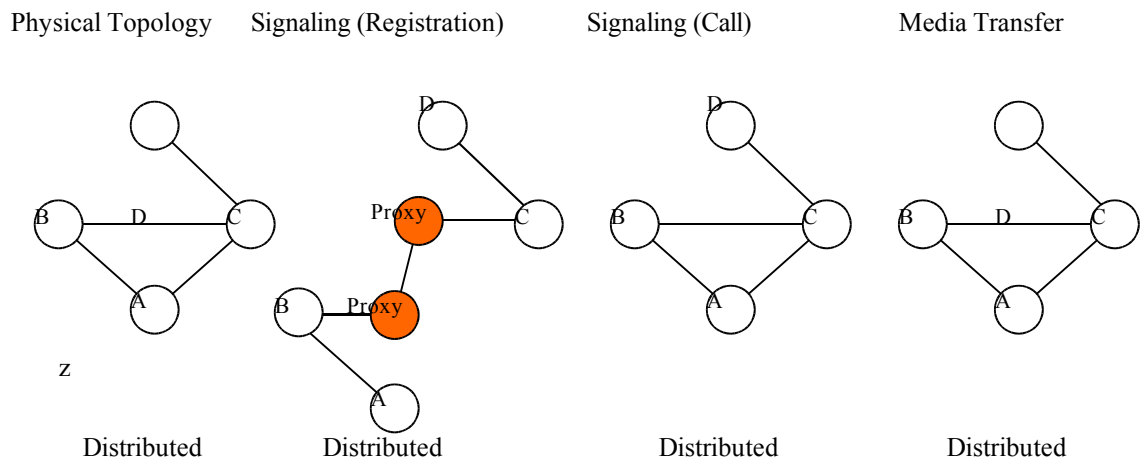
Figure 2: Fully Meshed Conference Architecture



Example 2: In a partially meshed architecture, some users can connect to each other directly but others can only see each other through indirect connections. In signaling terms, each node must be able to directly connect to a proxy however or initial registration/location is not possible. A has a connection to both B and C, but B and C only have a single connection to A. C now calls D and brings it into the conference. D receives its media stream through C regardless of the source, so forwarding is a key function which the partial mesh model needs and which was not needed by the full-meshed model. This architecture scales better than the

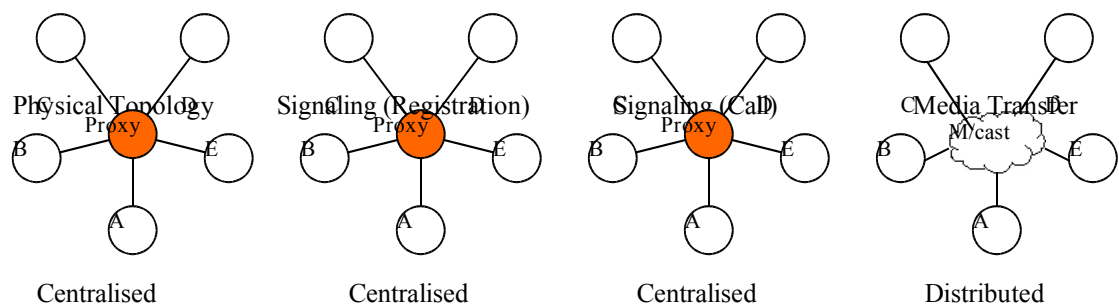
fully meshed and would suit small to medium sized conferences, but again would not scale easily to a large conference. This architecture would most likely arise in the form of an 'ad-hoc' conference where A and B are in a call, and A decides to invite C. In this example, signaling is achieved by one or more centralized proxies. Each node must be in direct connection with a proxy in order to register initially.

Figure 3: Partially Meshed Conference Architecture



Example 3: A more centralized approach is shown in this example. A conference server approach uses an architecture where a central server maintains a signaling dialogue and media transfer dialogue with each participant. For conferencing purposes, the nodes can only send signaling and media to the conference server node (although this does not preclude them from other peer-to-peer sessions with other nodes if the topology allows). The server plays the role of the centralized manager of the conference. Signaling could be unicast and media transfer could be either unicast or multicast, depending on whether it is the incoming or outgoing stream.

Figure 4: Conference Server Architecture



Part II: Enabling Technologies

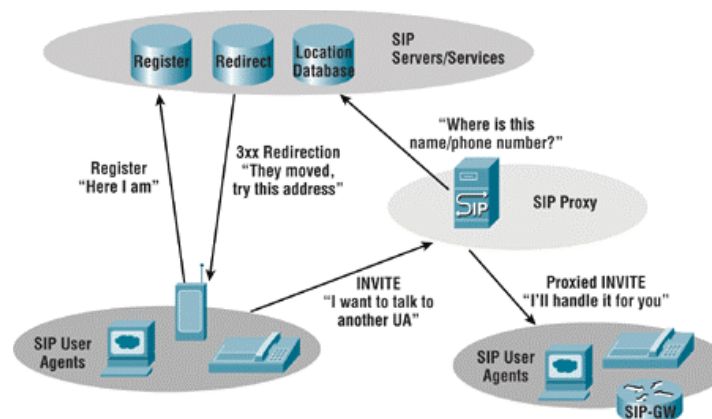
Signaling

SIP is an application layer signalling protocol which provides call set-up, modification and termination. It can also provide services such as name translation, user location, feature negotiation and call participant management.

We believe that SIP will be the protocol of choice for Next generation Networks and we have chosen SIP to develop our multimedia conferencing application because of its ease integration with existing IETF protocols, simplicity, mobility, scalability, and ease of development, extensibility and deployment in the core and at the edge of the enterprise and support for multicast, unicast or a combination of both. It is designed for integration with existing IETF protocols, using existing protocols and extensions to provide message formatting (HTTP), media (RTP), name resolution and mobility (DNS and DHCP) and multimedia (MIME).

The main SIP protocol components are User Agents (end system) and Network Servers. Each Agent has a Client (caller) and Server (receiver) component. Examples of SIP Network Servers are Registration Server, Redirect Server, Voicemail Server, etc. These Servers can be separate devices in logical terms, but be physically implemented on the one network device, or alternatively can be physically distributed over multiple devices to provide greater scalability. These servers can be stateful (knows the state of all current calls), or stateless (doesn't track calls). SIP provides its own reliability mechanism so it runs over UDP. Importantly, participants can communicate using multicast, unicast or a combination of both.

As a protocol used in a distributed architecture, SIP allows you to build large-scale networks that are scalable, resilient, and redundant. It provides mechanisms for interconnecting with other VoIP networks and for adding intelligence and new features on either the endpoints or the SIP proxy/redirect servers. Each signaling protocol follows this general idea, but each protocol's implementation of signaling varies. The diagram below (International Engineering Consortium/Cisco) shows an example of SIP architecture.

Figure 5: SIP Architecture

As an application layer signaling protocol used in a distributed architecture, SIP is best suited to meet our scalability, real-time, simplicity and extensibility design requirements.

The Session Description Protocol is used in conjunction with SIP for exchanging session capabilities (ability to send and/or receive audio or video, supported codecs, IP address to send media, etc.).

Media Transmission

The Real-time Transmission Protocol (RTP) was defined by the IETF and is used for the delivery of time-sensitive data (e.g. voice, video). As retransmission of lost, or out of sequence, packets is in reality pointless for this kind of time-sensitive data, RTP uses the User Datagram Protocol (Postel, 1980) which has a 'best effort' approach. UDP also has a much lower protocol overhead than the connection oriented Transmission Control Protocol (TCP) (Postel, 1981), which is important for efficiency reasons.

The functionality of RTP is simple. The data to send is divided up into smaller parts, to which an RTP header is added. This header includes information such as the sequence number, a timestamp, and a header which identifies the type of payload. RTP is not able to prevent jitter but it provides enough parameters to compensate for its effects. In fact it is the Real-time Transport Control Protocol (RTCP) which enables the senders and receivers to adapt their sending rates and buffer sizes. RTCP has to be supported by RTP devices in any case. It is suggested that the proportional relation of RTCP in RTP traffic should not exceed 5 percent (I. Miladinovic and J. Stadler).

JAVA support for conferencing applications

This next section focuses on the Java programming language and how it is enabling the development of computer telephony applications which leverage the functionality of the

previously described protocols. The Java platform is based on the idea that the same software should run on many different kinds of computers, consumer gadgets, and other devices. Java's main strengths are this platform independence (or portability), adaptability, scalability, multithreaded ability, and Object Oriented Design.

Java has historically been viewed inferior to C for real-time applications (such as computer telephony applications) as C is able to talk directly to the native code where Java talks through an interpreter called the Java Virtual Machine (JVM). This JVM translates Java classes to byte code which the underlying operating system can understand (which gives Java's its portability). In certain circumstances, Java can talk directly to native code written in languages such as C. This weakness of Java is slowly becoming less of an obstacle to real-time programming with the development of JIT (Just In Time) controllers and with the emergence of real-time Java.

Java provides a wide range of programming API's for various application functions: networking (net package), multimedia (JMF package), encryption (crypto package), GUI design (awt/swing packages), etc. This range of API's is ever increasing, as both developers create their own API's, and third party vendors create publicly available API's, thus enabling developers to easily and seamlessly add new functionality to their systems.

Java also provides support for a wide variety of Internet protocols such as HTTP (applet/servlet packages), SIP (JAIN Framework), RTP (JMF package), IP (net package), which allow development of inter-networked applications. The Java API's of most importance to this project are:

The Java Network package (java.net.*): Through the java.net package, Java provides the ability to create both unicast and multicast sockets for the transmission and receipt of data. This ability to create multicast sockets will be an advantage in certain circumstances where we are sending identical data to multiple recipients as multicast is far more bandwidth and processor efficient than having to open up multiple unicast sockets for the same data. Multicast is a far more scalable solution than unicast and will be very useful for sending & receiving data in conference calls.

The Java Media Framework (javax.media.*): The Java Media Framework (JMF) is a package for developing multimedia applications with Java. It enables easy integration of audio and video clips into an application from a local file, URL, or a device such as a microphone or

web-cam. JMF also provides the necessary methods for the transmission and receipt of real-time media streams using the Real Time Protocol (RTP) and the Real Time Control Protocol (RTCP), which will obviously be necessary for transmitting audio and video during calls.

The Java Intelligent Network Framework: (JAIN including javax.sip.*, javax.sdp.*): The Java Intelligent Network Framework (JAIN) is a set of Java technology based APIs which enable the rapid development of Next Generation communications-based products and services on the Java platform. By providing a new level of abstraction and associated Java interfaces for service creation across point-to-point, circuit-switched (PSTN, ISDN), packet/cell-switched (X.25, Frame Relay, ATM) networks. JAIN technology enables the integration of Internet (IP) and Intelligent Network (IN) protocols. This is referred to as Integrated Networks. JAIN provides specifications for signaling and network service creation, some of which are Protocol API specifications; others are Application API specifications as shown in the table below:

Figure 6: The JAIN Framework

<u>Protocol API Specifications</u>	<u>Application API Specifications</u>
JAIN TCAP 1.1 (<i>Final Draft</i>)	JAIN Call Control 1.1 (<i>Final Draft</i>)
JAIN INAP 1.0 (<i>Final Draft</i>)	JAIN Coordinations and Transactions (<i>Final Draft</i>)
JAIN MGCP 1.0 (<i>Final Draft</i>)	JAIN Service Logic Execution Environment (SLEE)
JAIN OAM 1.0 (<i>Final Draft</i>)	JAIN Presence and Availability Management (PAM)
JAIN MAP	Java Payment API (JPay)
JAIN MEGACO	JAIN Presence
JAIN SIP 1.0 (<i>Final Draft</i>)	JAIN Instant Messaging
SIP API for J2ME	JAIN SIMPLE Instant Messaging
JAIN ENUM	JAIN SIMPLE Presence
JAIN SDP	SIP Servlets 1.0 (<i>Final Draft</i>)
	JAIN SIP Lite
	JAIN Service Creation Environment (SCE) - SCML
	JAIN Service Creation Environment (SCE) - Java
	Server API for Mobile Services (SAMS): Messaging

The two specifications we are currently using to implement our conferencing applications are JAIN SIP 1.0 and JAIN SDP. The SIP and SDP protocols have been outlined in the previous section of this paper.

For service creation, the JAIN connectivity management specification was submitted for review. This is a specification that encompasses different layers of interfaces for controlling connectivity in intelligent IP networks. Connectivity management is a collection of services for dynamically providing connectivity with specified QoS (Quality of Service), security (using IPSec), and routing attributes in IP networks. This specification was later withdrawn and has

yet to be replaced with another specification which provides these connectivity management services.

The JAIN initiative brings service portability, convergence, and secure network access to telephony and Internet networks. This will positively alter the current business structure of these networks as follows:

- **Service Portability:** - Write Once, Run Anywhere. Technology development is currently constrained by proprietary interfaces. This increases development cost, time to market, and maintenance requirements. With the JAIN initiative, proprietary interfaces are reshaped to uniform Java interfaces delivering truly portable applications.
- **Network Convergence:** (Integrated Networks) - Any Network. By delivering the facility to allow applications and services to run on PSTN, packet (e.g. IP or ATM) and wireless networks, JAIN technology speeds network convergence. As demand for services over IP rises, new economies of scale are possible as well as more efficient management and greater integration with IT.
- **Secure Network Access** - By enabling applications residing outside the network to directly access network resources and devices to carry out specific actions or functions, a new environment is created for developers and users. The market opportunity for new services is huge when controlled access is provided to the available functionality and intelligence inside the telecommunications networks.

Part III - Current Work

Our current research is in the area of sensor data retrieval, display, and collaborative analysis. As part of this, we are working on a SIP agent which offers telephony functionality (one-to-one calls, call forward, busy here, forward to voicemail on busy/no answer, etc) as well as the ability for users to participate in conference calls with a view to collaboratively analysing sensor data. The following section give an overview of our analysis & design, our prototype implementation, and an example usage scenario of this system. Our initial simple application assumes a single source for the distribution of all combined conference media to which other participants contribute or listen.

Analysis & Design

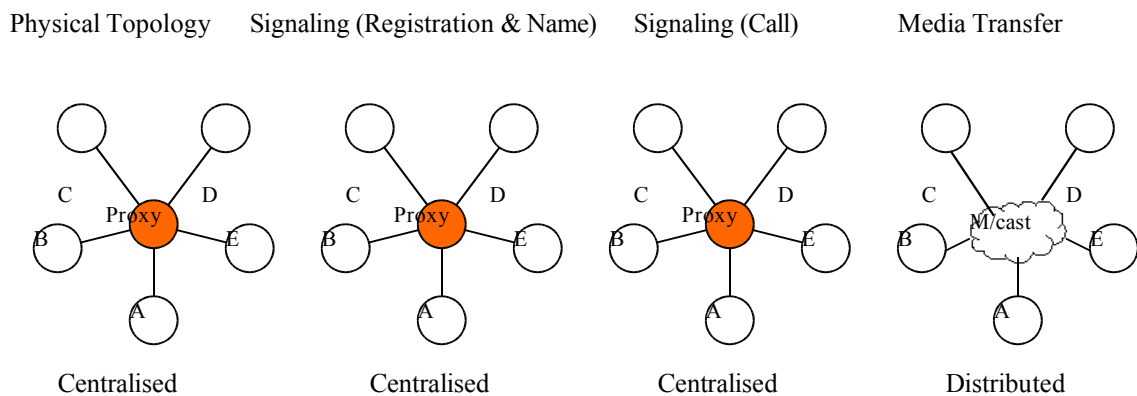
Our conferencing system had the following design requirements:

- Scalability in the number of users (primarily affected by media transfer)

- Efficiency in its use of network and node resources
- Simplicity of implementation
- Extensibility for the rapid deployment of new services
- Real-time Functionality: it must allow effective real-time conferencing

For simplicity and efficiency our approach uses a centralized signaling architecture and hybrid media delivery, where unicast is used for signaling and multicast or a mixture of unicast/multicast is used for media delivery. This is scalable large numbers of participants and bandwidth utilization and processing. Overheads are good. Each participant makes a normal peer-to-peer SIP call to the conference server using unicast signaling. Once the call is established media is sent and received on a multicast connection. The role of the conference server is to act as the centralized manager of the conference, and to maintain a signaling dialog with each participant in the conference.

Figure 7: Conference Server Architecture



Users wishing to join the conference can simply send a standard SIP INVITE message to the conference server which in turn can choose to authenticate the user or simply send an immediate ACK reply to set-up the call. Users currently participating in a conference who would like to invite other users into the conference can send a SIP REFER message with the URI of the conference server, inviting them into the call (this REFER message could alternatively be sent to the conference server with the intended recipient's URI).

Implementation

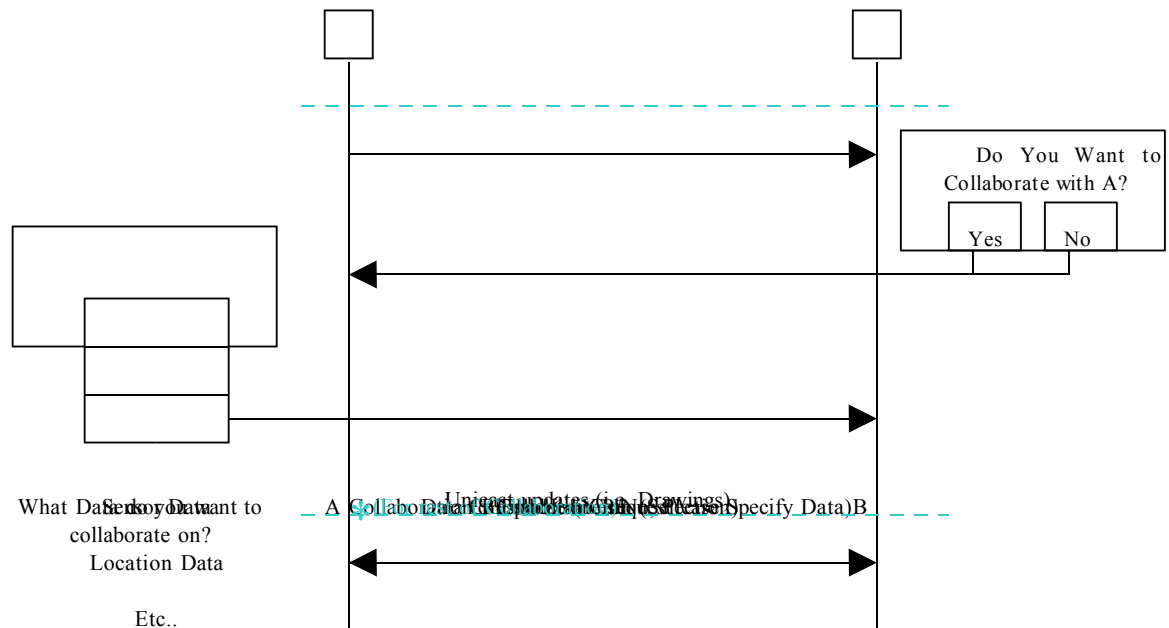
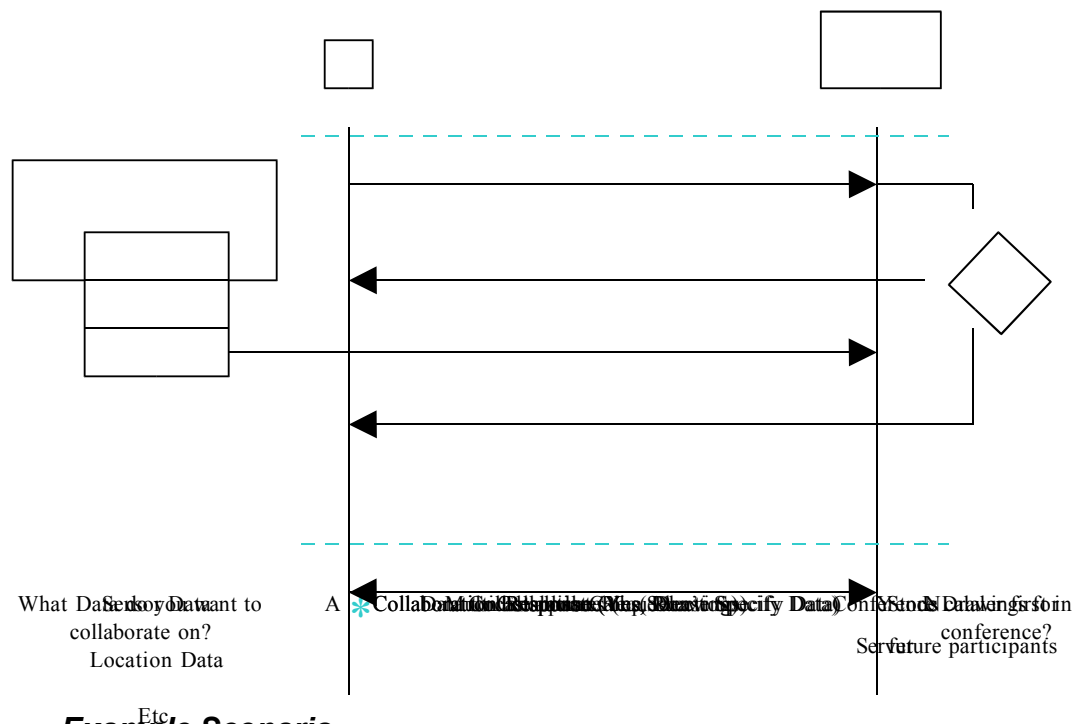
The SIP agent was implemented by extending the functionality of the basic reference implementation developed by Emil Ivov. These extensions include:

- Converting the application to an applet.

- SIP proxy/registrar registration (the reference implementation was supposed to do this, but it needed some alterations to successfully register to a SIP registration server)
- Call forwarding when busy/unavailable.
- Calls to conference servers using multicast address for audio and video.
- Enabling the applet to identify more SIP messages (e.g. Temporarily Unavailable).
- The ability to view sensor data in graph form which is stored in a web server database, or to collaboratively view these graphs with other called parties (both on-to-one calls and conference calls) and highlight (by drawing on the graph) interesting findings.

The conference server was implemented by altering the SIP web client previously described. The purpose of the conference server is to simply give the conference a focus, or endpoint, to call (and to also store information about collaboration taking place in the conference call allowing users joining the conference to know what everyone is looking at and what has so far been highlighted by others). The conference server does not receive or send any media streams. It simply returns a multicast address to which all users who want to participate can do so to a multicast group to which all other users subscribe.

For collaboration during a conference, the aim was to make the task of collaboration the same for a user irrespective of whether the call was a 2-party call or a conference call. Our implementation involved having a collaboration button which when pressed would send a collaboration request either to the other call party (for a 2-party call) or the conference server (for a conference call). This collaboration processes is shown in the next two diagrams.

Figure 8: 2-party Call Collaboration**Figure 9: Conference Call Collaboration****Example Scenario**

The following example shows a conference call where multiple users want to collaboratively examine sensor data (we will use temperature for this example) from the last 24 hours.

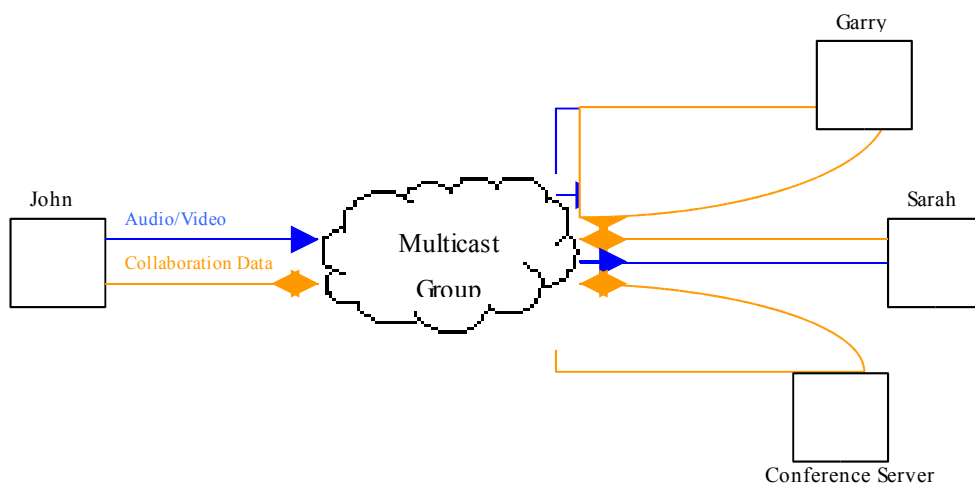
John dials the conference server (e.g. sip:ConferenceServer@domain.com) and is automatically connected. John selects the collaborate option and as he is the first user in the

conference he is asked by the conference server to specify what data to view. John selects the temperature sensor and selects the last 24 hours. John's web client is updated with a graph showing this sensor data. John circles a few parts of the graph which are of interest with his draw tool which are multicast to other participants of the call. Currently there are no other participants in the conference, but the conference server also listens for these multicast updates to store for any future conference participants.

Garry now dials and connects to the same conference server as John. John and Garry can now select if they want to send audio or video (if they have a web-cam), or whether they just want to listen to other users of the conference. Garry now selects the collaborate option and his screen is automatically updated with the same graph John is viewing, as well as the drawings John had made prior to Garry joining the conference. Any drawings Garry makes will be multicast to other participants of the call (John and the conference server).

Sarah now joins the conference and repeats the same process. We now have a three member conference scenario where each user can choose to send or just receive audio and video, as well as collaborate on data stored on a web server. As all this media is sent using multicast packets, this architecture can scale very well, especially if not all users need to be sending audio and video streams.

Figure 8: Media Stream Transmission



The example diagram (figure 8) shows the basic network infrastructure of the conference. In this example only one conference member is talking and the other users (2 in this example) are listening, but all users are collaboratively analyzing the data graph. Any updates being sent to other participants of the conference are also sent to the conference server.

Conclusions

A range of models is possible for designing multiparty conferencing for the NGN. A modeling framework that supports a top-down approach should be adopted (i.e. the design is approached primarily from the perspective of the conference application drivers such as media type, end-node profile, etc). An important aspect of modeling conferencing systems is to recognize the capabilities of emerging Internet protocols to decouple the signaling and media transfer functionality. It is possible to model at an even more granular level by differentiating between aspects of the signaling functionality (e.g. between registration, location and calling) and media transfer functionality (e.g. based on incoming and outgoing directions. Emerging Internet protocols such as SIP, SDP, RTP and RTCP offer some support in this regard but it may be necessary to design new protocols that can more effectively meet the requirements of more granular design models. While traditional conferencing has tended to use a completely centralized approach, future implementations will see a divergence in how signaling and media transfer are implemented. Conferencing in the NGN is likely to diverge on an even more granular basis. More work will be required to develop the modeling framework to reflect the multiplicity of permutations in the context of this granularity.

In the short term it seems that conference management (registration, security and location services) will maintain strong centralization characteristics while call signaling and media transfer will use a more distributed approach. The influence of routing protocol and related ideas associated with path determination in data networks, however, could see the signaling management become more distributed in the longer term. Although multicast delivery is ideal for scalable conferencing, the lack of widespread availability across the internet remains a limit to internet-based conferencing. In the interim, a hybrid unicast/multicast model will be best for media transmission and delivery with the central node acting as the root of the multicast tree for media delivery to participants.

SIP seems to be the preferred signaling protocol for NGN conferencing applications and is in a position to leverage existing IETF protocols such as RTP/RTCP while being extensible to add further functionality quickly. Although SIP can be implemented in a centralized and distributed fashion and using SDP can support calls with both unicast and multicast delivery of media. Java provides all the necessary API's for developing SIP telephony applications. In developing this system we have used the JAIN API's, the SIP reference implementation, Java's ability to transmit and receive multicast traffic, and a lot of the other standard java packages such as swing, net, awt, etc. The conference server architecture, using multicast rather than unicast

for the transmission of media, saves on both network bandwidth requirements and conference server processor requirements and allows for a more scalable system.

Looking Forward

One key area of research going forward will be to develop the framework for modeling multiparty conferencing systems to reflect the separation of signaling and media transfer and the improved granularity within each layer of functionality. Another will be to research emerging extensions to the SIP specification, such as the SIP SUBSCRIBE method and to identify potential for new extensions which would support more granular designs. A third focus of research will be to identify if an altogether new protocol with a more granular approach, (for example, one which considers application layer issues such as speaker/listener ratio, media type, etc), and which supports mobile ad hoc environments is needed for improved conferencing service creation.

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Problems with Internet and Library Usage for Secondary School Children

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Abstract

This research consisted of investigating seven hypotheses using the following components:

- 1. Observation of forty-three secondary school children using the Internet and the library to complete five tasks.*
- 2. An interview was held with all the participants in the study that was audio taped and subsequently transcribed.*
- 3. An on-line form was constructed so that the students could nominate their favourite educational web sites for each class subject.*

The participants were given five tasks and had to find the answers using two of the most common forms of information retrieval found in Irish schools, the Internet and the school library. Subsequently they were asked twenty questions about their opinions on aspects of the library and the Internet. Points of interest here included that the majority of participants felt that the Internet is faster, easier to use, and better overall than the library, even though it was proven not to be the case. It was also found that the participants nominated sites by domain name without actually investigating if the domain name had any reference to the subject in question.

The observation, interview and voting data was then analysed using SPSS to investigate the seven hypotheses. These findings were then reported, discussed and ideas for future study were recommended. Proposed technical and teaching solutions to problems uncovered in this research are also outlined.

The above findings have implications for search engine design, the curriculum of the Irish education system, and for teachers in how they use both the Internet and the library to their full potential.

1 - Introduction

1.1 Problems with Internet and Library use for school children

This thesis examines areas where the Internet is misused, underused or misunderstood by school children. It is not our aim to portray the Internet in a negative light but rather to:

- (a) Suggest possible technical solutions to some of these problems, and*
- (b) Suggest what schools should be teaching children about how to use the Internet so as to get the most out of it.*

The purpose of this research is to investigate seven hypotheses by using information gained from observation of information retrieval using both Internet and library resources. The outcome of this research has implications for curriculum development in Ireland, school policies on information retrieval, designers of search engines and most importantly the teachers responsible for using the Internet as an educational tool in class.

1.2 Hypotheses to be tested

Hypothesis 1: *Without proper guidance schoolchildren have difficulty using the Internet effectively as an information retrieval tool.*

Previous research has shown that adults and children encountered difficulties when using the Internet for information retrieval (Bilal and Kirby, 1998). In this area I intend to explore the validity of this statement using my own subjects and test process. Evidence was found to support this hypothesis.

Hypothesis 2: *Students are not critical enough of the information they find on the Internet.*

From past teaching experience it is a personal belief that students tend to be more impressed by the innovative multi-media experience and thus fail to question the authenticity of the information provided. Not enough conclusive evidence was found to support this hypothesis.

Hypothesis 3: *Investigation of two information sources a) the Internet and b) the book to determine which is better for secondary school usage.*

My aim is here to investigate if one medium is superior to the other in terms of information retrieval. How effective is information retrieval from the Internet compared to the traditional resources such as libraries? The results of this hypothesis were inconclusive, as not enough evidence was found to support it.

Hypothesis 4: *Use of the Internet in secondary schools is leading to an increase in plagiarism.*

Because of the increasingly paperless role of the computer based classroom, are the copy and paste functions leading to an increase in plagiarism? Do students realise the implications of

plagiarism and what can we as concerned educators do anything about it? Evidence was found to support this hypothesis.

Hypothesis 5: *Secondary school students believe that the content of a web site is directly related to its domain name.*

Does the domain name of a site matter, or is there a perception that a domain name is inherently linked to the content of a site? This hypothesis was supported by evidence found in this research.

Hypothesis 6: *Students are being overwhelmed by Information Technology and as a result automatically believe the Internet to be superior to print media for information retrieval.*

Today's secondary school students are currently part of a multi-media world of computer games, DVD, mobile phones, email, and the World Wide Web. Their perceptions of technology and their actual effectiveness in relation to information retrieval are a cause of concern. Do students believe that the Internet is better than the library for information retrieval just because it is technological and multi-media based? This hypothesis was supported by evidence found by this research.

Hypothesis 7: *There is a need for an information retrieval skills module to be introduced to the secondary school curriculum.*

The object of this hypothesis is to investigate whether or not there is an actual need to implement a specific programme for information retrieval skills as part of a secondary school syllabus. Examples might include library and Internet training. This hypothesis was supported by this research.

2 Literature Review

2.1 Trust & Relevancy issues

Watson (1998) analysed a group of students and their perceptions of the World Wide Web. It found that a very small number reported evaluating the content of information for accuracy and adequacy. These findings also were similar to Kafai and Bates (1997) whose study found that published information from all sources; both web and print were believed to be true by the students.

Hirsh (1999) found that only 2% of the participants mentioned authority as criteria when evaluating information from the Internet and generally did not question the accuracy or validity of the information they found from any electronic resource. Fidel et al (1999) also found that students in high school also did not question the accuracy of the information they found on the Internet. An interesting point here is the fact that half of the participants in the study believed that Microsoft was responsible for the information on the Internet and a quarter of them believed that Bill Gates was in control of the information on the Internet and directly monitored its use.

A finding from the Small and Ferreira (1994) study gives an insight into why children place a higher value on multimedia sources than traditional print sources. They found that students searching multimedia resources spent far more effort and time locating information than their colleagues searching print resources. Therefore the student's perception of information from multimedia resources was higher.

Kafai and Bates (1997) found that although students employed clear criteria on good and bad web pages, and in turn had a critical view of the web and had low expectations of its resources in comparison to other library resources, they considered the web very highly. This appears to be ironic in the sense that although the participants rated the library resource higher in terms of its effectiveness, the World Wide Web was still held in high regard.

This literature suggests that students do not properly evaluate the information they find and more importantly do not question the source of this information. A reason for this might be the age category of the participants in the various researches, as they were primarily in the 6 to 12 years old bracket. It could be said that these participants would not have the cognitive skills or life experience to properly criticise and evaluate information that they found. Indeed due to the multimedia side of the Internet they would automatically hold information found on this resource in higher regard.

With the web such a vast resource and the amount of information on it growing exponentially each year, it seems impossible to authenticate the information on it. Unregulated information raises questions about where the information originated, who produced it, and how accurate it is (Hernon, 1995).

2.2 Search Strategies

In his study Watson's (1998) participants revealed that to search successfully on the Internet, a focus or defined question is required. However previous research has proven that children rarely employ systematic search strategies and spend little time planning their searches (Marchionini 1989, 1995). It has also been proven that children who carry out unsuccessful searches are more likely to try and reduce or increase retrieval output as successful searchers do (Fidel, 1991; Hsieh-Yee, 1993).

Previous research has shown that children use keyword based search strategies for tasks that are well defined and browsing strategies for ill defined tasks (Borgman et al, 1995). Due to the cognitive nature of both of these strategies, keyword based strategies create a higher cognitive load due to its recall nature. Children will therefore favour browsing strategies with its recall nature. Browsing strategies according to the literature, have been shown to be a more effective search strategy when the task is ill defined (Marchionini, 1995). The web imposes a cognitive overload and is 'likely to exacerbate users feelings of being lost in hypertext, and cause them difficulties in navigating WWW subspaces' (Cockburn & Jones, 1996). Large and Behesti (1999) report that 'most information on the web has not been written with a young audience in mind and may impose a greater cognitive effort on the students part in comparison with books and CD-ROMs that have been specifically prepared with school students in mind'. This statement is quite significant for all the studies including this one as they deal with the information retrieval of school children.

Schacter et al (1998) also found that the vast majority of participants sought information by browsing techniques rather than keyword searches. Not one participant used Boolean searches or exact term searching. This high level of browsing may indicate that children are not carefully surveying or reading any of the information. One might also question whether a group of 9 to 12 year old children could be expected to formulate complex search queries. Although the study states that the participants had been using the Internet as an educational resource for the previous 5 months, it failed to say what training the participants had in using search engines and retrieving information in general.

These results i.e. the necessity for clear defined tasks in order for Internet searching to be successful and the less taxing option of browsing on the Internet would lead to the following question: Is the Internet being used to its full potential in school by both teachers and students alike?

2.3 Usability & Navigation issues

Hirsh (1999) found that students did not make use of advanced search features, did not record useful URL's and started each search anew by typing in search queries. This method of starting a new search was also found in Wallace and Kupperman's (1997) study. Children in this study had limited success with their searches, with 76% of their time spent using repetitive keyword searches, natural language in search engines and making incorrect use of Boolean logic.

Fidel et al (1999) found that students made extensive use of the back button to return to relevant sites. This study also revealed that students used landmarks in the search process. For some students this was the results page and the students felt it was an important safeguard, i.e. it was their comfort zone. Sometimes these landmarks were identified through graphical cues, such as animations and easily identifiable pictures. Wallace and Kupperman (1997) also found that students used the back button as their primary means of navigation, made repetitive use of keywords for searching and used natural language to query search engines.

As the computer now plays an integral part in most classrooms is it not time for computer instruction (computer applications) to feature as an integral subject on the Junior and Leaving Certificate syllabus?

2.4 Plagiarism

Participants in Fidel et al (1999) study copied the relevant information from the web page directly to the place they were completing the task given to them.

A participant in Large & Behesti (2000) believed that by re-typing information found on the Internet and not simply cutting and pasting, that he was conforming to acceptable practice. This would make it obvious that plagiarism seems to be more tempting from web pages than other sources. This would conform to Large, Behesti & Breuleux (1998), who stated 'the temptation of plagiarism is greater when the storage medium is electronic and the content suitable for transference, unedited, into the students project, as in the case, say, of a children's encyclopaedia on CD-ROM'.

Burdick (1998) said 'technology allows students to get information, and use it without even reading it, much less understanding it'. Students can combine or copy the words physically, without comprehending, assimilating, or combining the ideas intellectually.

This research would concur that children lack the motivation to locate and evaluate information. This might be due to the fact that not all people are comfortable with technology as means for information retrieval. Technology allows students to assimilate information without reading it properly, less understanding it. The ease with which students can copy and paste information by electronic means does not challenge them intellectually. This begs the question as to whether the end objective of information retrieval is being defeated, i.e. broadening one's knowledge whilst learning to question theories, processes and reasons.

2.5 Frustrations & Success

A common source of frustration experienced by children retrieving information from the Internet is slow connect times (Hirsh, 1999). Students in this study also reported satisfaction with their searches, with one student in particular finding 999 pages of Internet links to his favourite sports star. He interpreted this as meaning the Internet had the most information on the topic, even though it did not provide him with the specific information he was looking for. This would suggest a certain naivety on the part of the participants.

Participants in J.S. Watson's (1998) study recalled particular delight with regard to browsing the World Wide Web and of finding information; one particular comment 'not knowing what you want to find out' comes to mind here. Another student from this study said patience was a virtue with regard to searching on the Internet, as he truly believed that the information he required was on the Internet somewhere. Participants in this study also reported impatience with lost search time and confusion about how to find information successfully from the Internet. Some participants were overwhelmed with the amount of information produced by Internet searches.

As mentioned previously the information needs of children are different from adults, it is no surprise that spelling has been identified as a major source of errors in the information retrieval process (Eastman and Agostino, 1986). Fidel et al (1999) also found that spelling difficulties prevented more than 50% of the participants progressing a search during observations.

The above findings could have implications for all research using children of a certain age group and one would have to question the negative outcomes of most of the research. Perhaps different research tasks more suited to their age group would have given more positive results?

2.6 Traditional Library Use

The children in a study carried out by Edmonds, Moore and Balcom (1990) preferred using information retrieval methods using the card catalogue rather than the OPAC. They were

also more successful in their searches using this method. A reason for this may have been that the design of the OPAC in question was a touch screen and required users to pass through at least 8 screens to reach their search destination. One error along this path would ultimately result in an error overall.

Large & Behesti (2000) study concluded that a role remains for print materials, because they are targeted at a young audience and states that the web needs a more straightforward interface and more information aimed specifically at a young audience before it can threaten traditional methods of information retrieval. Previous research already mentioned in this chapter has supported this.

Hirsh (1999) examined the strategies of students when looking for information in the library. Students typically used the book cover, book title, table of contents and the index in the back of the book to help make decisions about how useful a book could be. They flicked quickly through the pages to see if any of the contents caught their eye. Children generally favoured books with titles that clearly contained their specific athletes name rather than general compilations of sports stars. Interestingly, participants in Watson's (1998) study reported that they valued books in different ways than the Internet. Findings here suggest that books are a more pleasurable experience for the reader, and hold them in higher esteem as a result.

Fidel et al (1999) study revealed that most students at the end of the search process turned to books to complete their given assignments. They knew that certain resources in the library would help them complete their projects and that the print resources would compliment what they had already searched for on the web. However most of the students agreed that to research information in the library required considerable more effort than on the Internet.

2.7 Internet as an Information Retrieval Resource

According to Bilal (2001) 'unlike on-line catalogues, CD-ROM multimedia encyclopaedias and traditional print resources, the web is dynamic, heterogeneous, lacks structure and has unique navigational properties'.

Yang and Moore (1996) and McKenzie (1996) have identified some of the disadvantages of educational hypermedia;

- Users can get lost in navigation
- Too much information is available and can overwhelm the user
- Too many decisions and mental steps have to be made resulting in cognitive overload

According to Large, Behesti and Breleux (1998), 'the web presents students with new opportunities but also new problems. It represents on one hand an endlessly rich source of images, sounds and texts on myriad topics, all of which can be accessed from a single location. On the other hand it raises a series of questions about this information, including its reliability, suitability and retrievability'.

Information seeking tasks that are open ended and loosely defined are well suited for children's Internet searching. For tasks that are well defined and highly specific, however, the Internet may not be the most efficient resource to assist children with their information needs (Schacter et al 1998).

Reasons for researching information retrieval from the Internet are varied and many. It is expanding at tremendous rate, is not controlled for content and is readily accessible. According to Schacter et al (1998) 'searching for information in a full text database comprised of 20 billion documents, where the structure of information and the use and degree of hypertext links to inter-relate documents vary according to who has designed the web site, introduces new variables not yet studied in information science'.

A general consensus of participants in Watson's (1998) study revealed that reading was carried out 'less thoroughly on the Internet'. Pictures were also found to be a motivating factor for reading, as pictures intrigue them to read the text for information. Interestingly one participant reported that they read the information very quickly on the Internet due to the cost factor; 'you don't pay by the hour with a book'. According to Watson (1998) 'the lure of visually exciting screens does not offer a substitute for exercising one's imagination from reading stand alone text, whereby one employ's comprehension skills far superior to simple decoding or taking information from the screen'.

3 - Research Methodology

The research took place mostly after school in the evenings and at the weekends. The participants in the study were taken mostly from the boarding section of the school. The reasons for this included the following:

- The researcher worked as a housemaster in the boarding school for the previous three years and knew the students well.
- There were a wide variety of nationalities to choose from, to give as wide a range of sample size as possible.

- The students were motivated to undertake the research as it involved an hour's break from study!
- The researcher resided in the school so access to the participants was never a problem.

The school library and computer laboratory were located ideally for the purposes of this research i.e. beside each other in the main residential area of the school.

3.1 Computer Laboratory setting

The computer laboratory in the school was installed in March 2000. It has everything that a computer room requires, 30 Pentium III multimedia workstations networked with a laser printer, teacher's workstation and a Cisco router controlling Internet access. A multimedia projector is also available for teacher demonstrations and each student has their own ID and password. Students also save their work on the network to their own individual folders, which only the student in question and the system administrator have access to. An ISDN line is used for Internet access. The web browser used on the workstations is Internet Explorer and Office 2000 is the main software package used by the students.

3.2 Library setting

A full time librarian and an assistant maintain the library. It is open during the day for study periods and also after school for students. The books are categorised according to the Dewey classification system and magazines and current newspapers are also stored for reference.

3.3 Research Task

This research consisted of a comparative study of library and Internet use of secondary school children by setting tasks and gathering data on how the user solved each task. The tasks were of a factual nature and due to the time constraints on this study a research task with open-ended questions were not carried out. Tasks were designed to ensure the participants could find the answers from both resources. The tasks were set and data was then gathered on how the user solved each task. The actual tasks given to the participants were:

Task 1: Find the name of the only English Pope?

This is a religion-based question and involved a lot of searching in both resources to find the answer.

Task 2: What is the French word for witch?

This is a dictionary based question.

Task 3: Who was the English footballer of the year in 1979?

This was mainly a sport based question, and was used primarily to increase the motivation of the participants, as they all had an avid interest in sport.

Task 4: In what city was Otto Von Bismarck born?

This was a historical question, with Bismarck being a famous historical figure.

Task 5: Find a map of Co. Carlow.

This was a geographical, image based question.

The questions were varied from student to student i.e. they were asked in no particular order. Both the Internet and library tasks were undertaken in a random fashion also i.e. they did not carry out the tasks in a set pattern.

3.4 The Internet research process

Each participant logged into the teachers PC at the top of the room. They were then given the five tasks and told that they could answer them in any order that they wished.

Observations were made of the student's use of the Internet by the researcher using special templates designed for the purpose. The researcher also had a stopwatch, which was reset after a task was completed. The main items of interest were the following:

- Amount of time spent completing task
- The type of search strategy i.e. natural language or Boolean
- The amount of keywords used in each search
- Did the participant scroll to the bottom of each web page?
- How the navigation features of Internet Explorer were utilised i.e. back and forward buttons
- Were spelling difficulties encountered
- Was the hit list constantly referred to
- Was the search a success

These observations were then transcribed immediately so that as little information was lost during the process. It was intended at the start of this research to conduct analysis on 15 questions but after a couple of trial runs it was found to be too time consuming so it was narrowed down to 5 questions. It was decided that a higher sample size would be more beneficial to investigating the hypotheses.

Each student was allowed a time of 30 minutes to conduct each search on the Web. They were told that it was not a test or anything whatsoever to do with school. They were also told that if the answer to a certain question could not be found, to move on to the next.

The students were not given any instruction whatsoever on what techniques to pursue their searches in either of the resources. They were given a completely free reign to carry out their own methods of information retrieval, and told to ask the researcher for help if they became confused at any stage.

3.5 The Library Research process

Similar to the Internet research process, each participant was timed on each task. The students were given the research tasks and told they had to find the answer to each task using the library as a resource. The researcher followed the student around the library, recording the data on a template designed for the purpose. Each participant was timed as in the Internet process on each task. The main items recorded were as follows:

- The time taken to complete a task
- The amount of books referenced during each task
- The features of the book that were utilised i.e. the cover, title, table of contents and the back index
- Was the card classification used to find a book
- Did the student wander from section to section in an unorganised manner
- Did the participant flick through the pages to find the answer to the task
- Was the search a success

Finally the students did not receive any instruction from the researcher in relation to information retrieval skills, whilst using the library or the Internet.

3.6 Interview Research Process

The students were then asked some questions about their experiences in an interview in order to identify their attitudes towards both resources as a means of information retrieval. These sessions were held after the tasks had been completed using both resources. These were audio taped and subsequently transcribed for analysis.

4 Analysis of data *From All 5 Tasks.*

To analyse the data as a complete section; the transform feature was used within SPSS. All the relevant data was computed to new variables e.g. (Internet search time 1+ Internet search time 2 + Internet search time 3 + Internet search time 4 + Internet search time 5) / 5 = Average Internet time.

This facility was used to compute the following new variables:

- Total spelling mistakes on Internet
- Overall success of Internet
- Overall success of library
- Total no of searches for Internet
- No of books in Library search
- Total times search button used
- No of times back button used
- No of times forward button used
- Boolean searches used
- No of keywords used
- Total amount of links
- Scroll to bottom of web page?
- Times book cover used
- Times book title referred to
- Times table of contents referred to
- Times back index referred
- Card classification referrals
- Average time on Internet
- Average time for Library

The summary statistics for these new variables are located in table 4.6.

- As can be seen from the table, the mean time for all Internet searches is 3 minutes 38 seconds, while the corresponding figure for the library is 3 minutes 9 seconds. This would suggest that the library is marginally faster overall than the Internet.
- The mean overall success of the Internet is 2.95 while the mean overall success of the library is 3.53. This would suggest that the overall success rates of the library are significantly better than the Internet search.
- The amount of searches in the Internet had a mean of 16.05, while the mean number of books in the library search was 9.35. This would suggest that the amount of effort taken by the library search overall is significantly less than the Internet.

Table 4.6 Statistics for all 5 tasks

	N	Minimum	Maximum	Mean	Std. Deviation
Total spelling mistakes on Internet	43	0	9	0.93	1.61
Overall success of Internet	43	0	5	2.95	1.33
Overall success of library	43	1	5	3.53	0.80
No of searches for Internet	43	5	49	16.05	8.57
No of books in Library search	43	5	16	9.35	2.44
Total times search button used	43	0	5	0.70	1.32
No of times back button used	43	0	46	12.35	10.10
No of times forward button used	43	0	22	1.44	3.87
Boolean searches used	43	0	5	0.77	1.36
No of keywords used	43	6	74	24.63	12.39
Total amount of links	43	4	56	23.00	11.96
Scroll to bottom of web page?	43	0	4	1.02	1.12
Times book cover used	43	0	3	0.72	1.03
Times book title referred to	43	3	5	4.40	0.69
Times table of contents referred to	43	0	7	2.33	1.46
Times back index referred	43	0	4	1.91	1.27
Card classification referrals	43	0	2	0.47	0.70
Average time on Internet	43	00:42	05:59	03:38	01:17
Average time for Library	43	01:39	05:26	03:09	00:48
Valid N (list wise)	43				

To investigate the above hypothesis, a paired samples t-test was conducted to provide proof that the above statements were true. (Table 4.7)

Table 4.7 Analysis of time, success and number of searches for the 5 tasks

	Paired Differences			t	do	Sig. (2-tailed)
	Mean	95% Confidence Interval of the Difference				
		Lower	Upper			
Average time on Internet - Average time for Library	0:00:28	0:00:03	0:00:54	2.257	42	.029
Overall success of Internet - Overall success of library	-.58	-1.03	-.13	-2.627	42	.012
No of searches for Internet - No of books in Library search	6.70	4.06	9.34	5.123	42	.000

A 95% confidence interval was constructed and the following information was obtained:

The t-test for the times compared gives a significance of .029. The null hypothesis that there is no difference overall between the time taken for the Internet search and the library search can be rejected, as .029 is less than .05. Thus the time taken for a library search is significantly less than an Internet search.

The t-test for the overall success rates compared gives a significance of .012. The null hypothesis that there is no difference overall between the success rates for the Internet search and the library search can be rejected, as .012 is less than .05. Thus the success rate for a library search is significantly better than an Internet search.

The t-test for the amount of searches in each gives a significance of 0. The null hypothesis that there is no difference overall between the amount of searches for the Internet search and the library search can be rejected, as 0 is less than .05. Thus the amount of searches for a library search is significantly less than an Internet search.

5 Other Survey Data

Another component of this research was the construction of an online web voting form. It was designed as part of the computer applications module that the researcher taught in the school. Its function was to enable the students to nominate their favourite educational web sites for each class subject and also their favourite search engines on the Internet. The data obtained from this part of the research was used to investigate the hypothesis that school children believe that the content of a web site is directly related to its domain name.

The voting form was hosted on the schools web site and was available for all users to access. The data was then sent to the researchers email address.

The Votes were entered into SPSS and gave the following results:

- One of the most popular votes for business was www.business.com
- The two top votes for German were www.german.com and www.germany.com.
- www.music.com was nominated for music.
- www.body.com was one of the top three nominations for biology.
- www.france.com was the most popular vote for French.
- www.irish.com was the second most popular vote for Irish.
- One of the joint second places in chemistry was www.chemistry.com.
- The two joint second places in Maths were www.maths.com and www.algebra.com
- www.history.com was one of the joint winners for History.
- www.english.com was voted the clear winner for English.
- www.art.com was the clear winner for Art.
- www.accounting.com was the clear winner for Accounting.
- One of the votes for Economics was www.leavingcert.economics.com.

These sites were then investigated as to their content and the following was discovered:

- www.german.com is in the German language and gives information on Internet security and firewalls. There is certainly no reference to leaving cert German!
- www.germany.com gave a page display error.
- www.business.com is called the "business search engine" and appears to be a good resource.
- www.music.com is more or less a general information site on most types of music. Its relevancy to leaving certificate music has to be questioned however.
- A page display error was given for www.body.com
- www.history.com is a film archive site, of no relevance to leaving certificate history.
- www.france.com appeared to be a general information site on tourism in France. Hotel and train information were available. It would be some help however as there were some good links to French historical figures and culture.
- www.irish.com links directly to www.getmusic.com, a music site.
- www.chemistry.com is a job recruitment site for the pharmaceutical industry.
- www.maths.com gave a page display error.
- www.algebra.com is an excellent site for maths.
- www.english.com is an educational site, however it is not yet fully functional.
- www.art.com was redirected to www.allwall.com, a site selling paintings.
- www.accounting.com is a recruitment site for the financial services industry.
- www.leavingcert.economics.com gave a page display error. When investigated further it was discovered that the domain name is still available for registration.

As can be clearly seen from the sites above, the participants place a lot of emphasis on domain names. Unfortunately most of the more popular English names are now being used for business, not educational purposes.

It has also to be said that either one or all of www.leavingcert.net, www.scoilnet.ie and www.brittanica.com featured high for each subject.

6 Data Support for hypotheses

Each of the 7 hypotheses listed in section 1 will now be examined in relation to the test results in order to determine whether they are founded or unfounded. This will be done by using the following evidence:

- Observations recorded while the participants searched the Internet and the library.

- Interview data.
- Web voting form data.

Table 6.1 Summary of section 4

Hypothesis One: *Without proper guidance schoolchildren have difficulty using the Internet effectively as an information retrieval tool.*

The participants in this research as previously stated had no specific training in information retrieval methods in either the Internet or the library. As can be seen from table 6.1, the library was faster in two of the tasks and had a higher success rate in three of the tasks.

	Faster	Higher Success Rate	Less Searches
Task 1		Internet (95%)	
Task 2	Library (99%)	Library (99%)	Library (99%)
Task 3	Library (95%)	Library (90%)	
Task 4	Internet (90%)		
Task 5		Library (95%)	
Overall	Library (95%)	Library (95%)	Library (95%)

In addition to this (see table 6.2) the use of the back button and the amount of spelling mistakes would suggest that the participants were not effective users of the Internet. This evidence would support the hypothesis that without proper guidance schoolchildren have difficulty using the Internet effectively as an information retrieval tool.

Table 6.2

	Back button (mean)	Spelling mistakes (mean)
Task 1	2.02	0.16
Task 2	2.95	0.12
Task 3	2.86	0.30
Task 4	1.88	0.09
Task 5	2.63	0.26
Overall	2.47	0.19

The following were observations noted during the research which further support this hypothesis:

- A spelling difficulty arose in this research, when a participant typed www.antarctica.com in the address bar (obviously a reference to www.encycarta.com) as he heard it was a good encyclopaedia site. It instead brought him to the homepage of an American beer company.
- The site map was widely misinterpreted in the hit results page. For example when "map of Carlow" was inputted into the search, the resulting hit results page gave some links with the words "site map" underneath. This was then clicked as a map of Carlow was expected. This was obviously the incorrect thing to do and would suggest that the participants lacked the dialogue of the Internet which adult users take for granted.
- One participant kept clicking on a certain section of hypertext. He explained that the hyperlinks were not working. The truth was that they were not hyperlinks in the first place and the participant did not know the difference between ordinary hypertext and a hyperlink.
- Many participants entered "Football" in the search engine while attempting task 3. The search should have been more specific as every type of football in the world was displayed, when English football or soccer would have been more appropriate, as it would have narrowed the hit list considerably.

Hypothesis Two: *Students are not critical enough of the information they find on the Internet.*

The participants in this research rarely scrolled to the bottom of the web pages they were viewing. On average this occurred once in every five pages. Also when the mean amount of pages visited (4.6) is divided into the mean time taken per search (3min 38 seconds), this gives a figure of 47 seconds spent on average per web page. This would indicate that the participants skimmed through the information on the Internet without allowing enough time to properly assimilate the information there.

It also emerged in the interview that 16.3% of the participants trusted the information found on the Internet more than the traditional print resources.

Furthermore, it was observed when participants were completing task 1 they typed in "English pope" into the search engine. This in turn gave links to Alexander Pope, the English poet. This was the answer provided by a lot of the participants, even though it was the incorrect answer.

The results of this hypothesis are deemed to be inconclusive, as not enough evidence was found to support it.

Hypothesis Three: *Investigation of two information sources a) the Internet and b) the book to determine which is better for secondary school usage.*

As can be seen from table 6.1, the Library has been proven to outperform the Internet in three of the tasks. The Internet outperforms the library on the other two. However closer investigation of task two would reveal a bias in favour of the print resource over its Web based counterpart. Dictionaries would be more familiar to schoolchildren in print format as opposed to the Web format. To state that one resource is better in general over the other would be incorrect, as both resources have advantages in certain areas. One could suggest that the library is better for dictionary based questions, although this would require further testing.

There is not enough evidence to support the hypothesis that one resource is better than the other as a whole.

Hypothesis Four: Use of the Internet in secondary schools is leading to an increase in plagiarism.

The interview statistics showed some interesting figures (see table 6.3,6.4,6.5).

Table 6.3

	Yes %	No %
Have/would you plagiarise from the Internet?	53.5	46.5
Have/would you plagiarise from a book?	44.2	55.8

Table 6.4

What are the advantages of websites?	%
Copy and paste information	4.7
More Information	14
Accessibility	14
Quicker	9.3

Table 6.5

What are the disadvantages of the library?	%
Too much manual work	41.9
Slow	25.6
Not enough information	9.3

A higher majority of participants stated that they would plagiarise from the Internet (53.5%) than from a book (44.2%). When asked what advantages the Internet had over books, 42% of the participants stated that it was easier to copy and paste, had more information, was more accessible and was quicker. These statements could indicate that the format of web pages is leading to an increase in plagiarism.

The students were further asked to comment on their views on the disadvantages of the library. The majority mentioned the manual nature of searching for information, slowness and lack of information. This would further support the argument that the format of the Internet is leading to an increase in plagiarism in secondary schools due to copy and paste functions and specific sites which encourage plagiarism e.g. www.schoolsucks.com.

Hypothesis Five: *Secondary school students believe that the content of a web site is directly related to its domain name.*

The data obtained from the web form as mentioned previously in chapter 5 gave some interesting results. Quite a high percentage of the participants in this part of the research linked an obvious domain name to the content of a site. It can be seen from table 6.6 that the participants in this research clearly believe that the domain name of a Web site is related to its actual content. As mentioned previously in chapter 5, the above domain names have absolutely nothing to do with the Leaving Certificate subject that they are matched with.

Table 6.6

Leaving Certificate Subject	Suggested Domain Name	Percentage
German	www.german.com	44.4
Music	www.music.com	11.1
Biology	www.body.com	20.0
History	www.history.com	16.7
Irish	www.irish.com	10.0
Chemistry	www.chemistry.com	16.7
Maths	www.maths.com	16.7
Art	www.art.com	42.9
Accounting	www.acounting.com	28.6
Economics	www.leavingcertconomics.com	14.3

The following observations were also noted which further support this hypothesis:

- Some of the participants entered www.englishpope.com and www.religion.com when attempting task1 without any positive results. This would indicate a lack of proper search techniques and the participants believed the domain name was the secret to success.
- www.carlow.ie and www.ireland-map was entered in the address bar to find a map of Carlow. This would also indicate that the name of the web site contained the answer to the task.

This would support the hypothesis that secondary school students believe that the content of a web site is directly related to its domain name.

Hypothesis Six: *Students are being overwhelmed by Information Technology and as a result automatically believe the Internet to be superior to print media for information retrieval.*

It can be clearly seen from table 6.7 above that the Internet was the resource most favoured by the participants in this research. These statistics are interesting in that although the majority of participants state that the Internet is easier to use, easier to read, better overall and faster, this research has shown this not to be the case. Referring back to table 6.1 the library at a 95% significance level, was shown to be significantly faster, took less searches and had a higher success rate than its Internet counterpart. This evidence would clearly support the hypothesis that students are being overwhelmed by information technology and as a result automatically believe the Internet to be superior to print media for information retrieval.

Table 6.7

	Yes	No
Which resource is easier to use?	Internet [72.1%]	
Which is easier to read?	Internet [58.1%]	
Which is better overall?	Internet [76.7]	
Which resource is faster?	Internet [88.4%]	
Which resource do you prefer to use?	Internet [79.1%]	
Which is more fun to use?	Internet [88.4%]	
Do you need special skills to use search engines on the Internet?	[32.6%]	[67.4%]

Hypothesis Seven: *There is a need for an information retrieval skills module to be introduced to the secondary school curriculum.*

A module in which students are taught how to use both the library and the Internet as resources for information retrieval is a proposal that could be considered for the Irish curriculum. Participants in this research were shown to have limited knowledge of the navigation features of Internet Explorer, rarely formulated an effective search query and only 10% of all searches using the library used the card classification index. These are all issues that suggest inefficiencies and ignorance in the use of these resources and the introduction of a module to teach correct methods to change perceptions about the library would address these. The perceptions that the participants had concerning the library can be found in tables 6.8 and 6.9.

Once the negative perceptions about books and the library can be addressed then both resources could be used more effectively in secondary schools.

Table 6.8

What are the disadvantages of the library?

	%
Old information	[20.9]
Dated	[7.0]
Slow	[25.6]
Manual nature	[41.9]
Not enough information	[9.3]

Table 6.9

Which is more fun to use?	Library [7%]
Do you read books?	No [32.6%]
Which resource do you prefer to use?	Library [18.6%]

7 Suggested Technical Solutions

This chapter involves proposing technical solutions to the problems uncovered by this research. Technical solutions will interest computer scientists and engineers, who are interested in the area of fixing problems and improving existing resources. It might also be suggested that the following ideas and features are relevant to problems uncovered in previous research for adult users also.

7.1 Proposed technical solutions to information retrieval problems related to secondary school children.

The participants in this study outlined some of the technical difficulties that they encountered with using the Internet as a form of information retrieval. They made the following recommendations:

1. Improve the success rates of existing search engines
2. Make the Internet faster
3. Remove irrelevant information
4. Improve usability
5. Less advertisements
6. Improve the area of natural language queries
7. Have search engines that do not give thousands of results for a query.

They were further asked to outline the disadvantages of the Internet. These included:

1. Slowness
2. Too much irrelevant information
3. Problems with search engines
4. Too many search results
5. Hardware instability
6. Advertisement issues.

The above issues can then be summarised into the following technical areas that the Internet needs to improve:

- Search engines
- Speed of Internet
- Internet content

7.1.1 Search Engines

Even though search engines designed for kids already exist, they also have their shortcomings (Bilal 2001). A possible solution to these might entail the design of a user-friendlier search engine designed for children's needs. This new system should make the search process as simple as possible to use and children should be used in usability tests during the development of the prototype. The following problem areas that were identified were as follows:

- Typing
- Spelling
- Vocabulary

- Search methods

If this search engine incorporated the following features then maximum success might be affected:

1. A spell checker beside the search bar.
2. A thesaurus to help explain complex words.
3. A help menu to explain how the search engine works.
4. A natural query option as well as keyword only queries
5. Information to be classified in a standard way i.e. the Dewey classification system for libraries is an example. Another possible improvement would be to structure the information categories in alphabetical order and use vocabulary specifically targeted at children.
6. Online prompts to be given.
7. Graphical cues should be used to guide children in the right direction.
8. The hit list should be set to a maximum figure as previous research has shown that most users only look at the first page of results. Participants in this research referred the hit list an average of .18 times per search. This would indicate that they were disillusioned with the huge amount of results when they entered a search.

7.1.2 Speed of Internet

1. The slow speed of the Internet was a common source of complaint both from the participants in this research and in previous studies as mentioned in chapter two. Schools should be provided with the proper financial assistance to install high-speed connections such as ISDN, DSL or satellite connections.
2. If students are using the Internet as a means of textual information retrieval they should be made aware that graphics greatly slow down the speed of the Internet. The graphical feature can easily be switched off in Internet Explorer and students should be taught how to carry out this procedure. (It is presumed Internet Explorer is the most common web browsing software available in schools).
3. There are numerous software downloads freely available from the Internet which claim to improve the speed of the Internet. The network administrator could test these as to their real effectiveness.

7.1.3 Internet Content

1. Web site designers should note that the home page of a site dedicated for children is very important, as children often evaluate a website on the first page that they see.

2. A feature could try to be incorporated by web browsers to eliminate all advertisements from web sites viewed. Some of these are already in existence i.e. Junkbuster and AdSubtract software products (CNN 2001).
3. The usability of children's sites should try and be improved, such as always having the search button on the home page (Nielsen 2001). Furthermore this feature should not be placed on the bottom of the home page, as it was observed that only 20% of searches involved the user scrolling to the bottom of a web page.

8 Suggested Teaching Solutions

This chapter involves proposing teaching solutions to the problems uncovered by this research. These solutions are in the view of this researcher logical and feasible to implement. These are of relevance to teachers, curriculum designers and educationalists in general. It might also be suggested that the following ideas and features are relevant to problems uncovered in previous research for adult users also.

1. Participants in this research were asked if they thought that special skills were necessary to use the Internet effectively. 77.4% replied no. This would indicate that students have little understanding of search strategies and methods. A module could be introduced in Computer Applications to teach the following topics:
 - i. How to formulate a proper search query.
 - ii. Search methods e.g. Boolean.
 - iii. The difference between a search engine and a search directory e.g. the differences between Google and Yahoo.
 - iv. How to use natural language queries effectively.
2. The Back button was the feature utilised most by the participants in this research. In one question it was used nineteen times during the search process. This would indicate that students are unfamiliar with the navigation features of Internet Explorer and this area could also be addressed in a computer applications module i.e. how to utilise the navigation features of Web browsers.
3. The amount of keywords used in the Internet searches varied in number from 1 to 33. Students should be taught how search engines actually work and how they use keywords to rate sites etc.

4. Teachers must be taught how to incorporate the Internet more effectively into the classroom. Useful educational sites and skills to teach the above issues should be incorporated here.

8.1 Schoolchildren do not evaluate information found on the Internet properly.

1. Students should be taught about manipulation in the media and shown how easy it is to put a website on the Internet. Anybody with a computer and Internet access can post a website, and they do not need to have the following to do so:

- Credentials
- Qualifications
- Identification
- Extensive resources

Students in secondary schools should have to design their own web sites and post them to the Internet. Once they have completed this procedure I believe from my experience in teaching computer applications that the students are amazed how easy the whole procedure is and as a result might evaluate in greater detail the information they find on the Internet.

2. Crank sites and sites which display false information could be outlined to validate these claims.

3. Assignments should be given by teachers that require the students to organise and structure the information found on the Internet.

4. Literacy skills should be promoted so that students read with more accuracy and detail. It was noticed in this research that the participants moved so fast between web pages that they actually missed the correct answers to some questions.

5. The online voting program that was incorporated into this research could be used by all schools so that teachers and students alike have a readily accessible database of sites from which to choose from when undertaking class assignments. This would eliminate wasting valuable computer contact time.

6. Children should be encouraged to take their time and not to aimlessly move from page to page like some of the participants in this research.

8.2 Students' perceptions that technology is the answer to everything.

1. In this research the participants were asked the following questions about use of the Internet and traditional print resources:

- Which resource do you prefer to use?
- Which resource do you consider to be better overall?
- Which is faster?
- Which is more fun to use?

The vast majority of participants replied the Internet as their answer to the above questions. An information retrieval module should be introduced in either primary or secondary schools to show students that the Internet is not better than the traditional print resources for everything. This research has shown that Questions two, three and five were answered more successfully by the books found in the school library. Assignments should be given so that students can realise for themselves what areas each resource is most suited to.

2. Increased financial resources should be made available to schools to help them update libraries and to encourage students to utilise them better.

8.3 Credibility issues of information retrieval.

1. In the post task interview, the participants in this research were asked if they had in the past plagiarised from either the Internet or a book. 53.5% of participants said they had using the Internet, while 44.2% said they had using a book. This would support the findings of Large and Behesti (1998) as mentioned previously in chapter 2. These findings indicate that students must be taught the serious implications of doing such acts and shown how to properly cite and reference material taken from electronic resources.

2. 17.3% of the participants in this research said in the interview that they trusted the information they found on the Internet more than the book. Even though this is not a significant figure, it would support the findings of previous studies (Schacter et al 1998; Small and Ferreira 1994). Students should be referred to sites that are not genuine and shown just how unreliable this information can be.

3. A related part of this research consisted of the construction of an on line voting form for students to nominate their favourite site for each subject that was available in the

school. As already discussed in chapter five, the students nominated sites even though they had absolutely no reference to school subjects e.g. www.music.com etc. Students must be shown that anyone with Web access and a credit card can register a domain name, and that these names have nothing to do with the actual content of the web site.

9 Further Work

The following areas are worthy of future research:

Hypothesis One: To further investigate hypothesis one, students could be taught a module on information retrieval using either the Internet or the library. Statistics could then be compared on the pre and post task effectiveness of this module.

The levels of anxieties that students and teachers have with technology are worth investigation, as this may have a detrimental effect on the life long learning habits of the current generation of secondary school children.

Hypothesis Two: The actual difficulties that people have with reading text in electronic environments is a topic worth of investigation, as the participants in this research skimmed from page to page without assimilating the information properly.

Hypothesis Three: The issue of graphics as an aid to the information retrieval process is worthy of investigation, as search engine designers could incorporate the results into a prototype aimed specifically at the younger generation.

The whole search process of children is worth investigation. How information is used and assessed, do children actually learn during the search process are topics which have not been covered in detail in previous research.

Hypothesis Four: A detailed survey could be carried out on students in secondary and third level to investigate their attitudes to plagiarism and are they aware of the serious consequences of doing so.

Another interesting area worthy of investigation would be to find out if students are being taught how to cite and reference material properly found in books and the Internet. One suspects that this is rarely taught in secondary schools.

Hypothesis Five: Since the participants in this research were taken from an all boys fee paying school, future studies in this area might consider taking the participants from different socio economic and gender backgrounds.

Hypothesis Six This hypothesis could be further investigated by carrying out more detailed research on why the domain name of a site is linked to its content.

Hypothesis Seven: The search strategies formulated by students is another topic worthy of further research. The effect of proper methods i.e. Boolean on search success could be incorporated here. This results of this hypothesis, if found to be positive, would greatly support the views outlined in this research that a proper module for information retrieval should be introduced into our schools.

A study on what topics impact children's success on information seeking using different resources would greatly help teachers and educationalists to utilise both the Internet and library to their full potential.

10 Conclusion & Recommendations

This study adds to previous ones that show that the Internet has enormous potential as an information retrieval tool for secondary school students. However for this to effectively happen users must be taught the relevant skills and teachers taught how to utilise the Internet and library resources effectively.

This study presented the findings of an original research project that investigated seven hypotheses while observing the searching behaviours of secondary school children in using the Internet and the library to answer five set tasks.

Evidence was found to support the following hypotheses:

- Without proper guidance schoolchildren have difficulty using the Internet effectively as an information retrieval tool.
- Use of the Internet in secondary schools is leading to an increase in plagiarism.
- Secondary school students believe that the content of a web site is directly related to its domain name.
- Students are being overwhelmed by Information Technology and as a result automatically believe the Internet to be superior to print media for information retrieval.
- There is a need for an information retrieval skills module to be introduced to the secondary school curriculum.

Not enough evidence was found to support the following hypotheses:

- Students are not critical enough of the information they find on the Internet.
- Investigation of two information sources a) the Internet and b) the book to determine which is better for secondary school usage.

The library was found to be faster, more efficient and more successful than its Internet counterpart as a means of information retrieval for children in this age group. Since only five tasks were completed these results are deemed inconclusive.

The Irish central statistics office (March 2001) produced a report that stated " The number of Irish households with access to the Web increased by more than 400 percent between 1998 and 2000. The results of the Central Statistics Office's survey found that 262,700 Irish homes had a computer connected to the Internet by the end of 2000, up from 61,100 in 1998. This translates to a home Internet penetration rate of 20.4 percent for the country." Furthermore 81% of these homes stated that the primary use of the computer was for educational purposes. Surely it must be a priority to incorporate proper and efficient usage of the Internet into secondary schools so that these students will not develop life long bad habits in the use of the Internet?

Since the Internet is available in most schools in Ireland and so much money has been spent on educational technology, more knowledge about how search engines actually work should be taught. Boolean searches, the difference between a search engine and search directory, efficient use of keyword searching are all areas that were highlighted in this research that need attention.

It should also be noted that in order for the students to be taught the correct and efficient means of information retrieval, teachers themselves need to given expertise in the area. So far a series of basic general computer skills has been available to teachers but the area of information retrieval has not yet been fully addressed.

This research has also proposed technical solutions to problems observed by the participants while the five tasks were completed. These solutions are of relevance to search engine designers, school administrators and web site designers especially.

Overall there is room for improvement in the use of both the Internet and the library. Both these resources have advantages over the other with regard to special topics. One of the most striking replies to one of the interview questions was that libraries would be obsolete in ten years time. This hopefully will never happen, and as this research has shown, the Internet still has a long way to go before it overcomes the library as a means of information retrieval. Teachers and pupils should be taught how to use both resources to their maximum potential and not disregard one to the neglect of the other. Both still have a vital role to play together as a resource in today's secondary schools.

10.1 Limitations of the Study

The participants in the research were all boys, and would not be representative of all pupils in secondary level education.

The facilities for information retrieval in the school in which the research was conducted were excellent. Not all schools would have such facilities especially the non-fee paying ones, and consequently would not be representative of secondary schools in general.

Only five tasks were set to the participants in this research. This in reality was not enough. An increased number of tasks would increase the validity of the hypotheses.

A software package designed to log the keystrokes and mouse movements would have been a more accurate way of obtaining the research data.

The fact that the researcher was both teaching and residing in the school may have influenced the participant's answers and performance. A researcher that was unknown to the participants may have eliminated any bias.

The participants may have performed better using both resources if they chose the topics themselves to search for information.

The actual query terms used by the participants were should have been recorded to gain an insight into their cognitive processes.

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SPACE – THE FINAL FRONTIER

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This paper ranges over a number of questions to do with the seemingly general sense of anxiety and discontent about life at this time, a time when we should be enjoying the embarrassment of riches heaped upon us in the West. Certainly, here in Ireland, we have experienced unprecedented wealth over the past ten years and yet you would be hard pressed to find a positive voice. Why is this? And how are we to turn this state of affairs around?

My own work, over a thirty-year period, has engaged with the social, cultural and arts world and so these musings reflect this background. Such work has brought me into contact with many different people and situations and it has touched on some fundamental issues to do with personal fulfilment and communal development. Here I wish to outline some of the problems as I see them and pose a number of solutions, which, at the very least, may frame a debate around these confusing and troubling issues.

Ireland is witnessing an unprecedented nation-wide building programme. Everywhere you look there are new apartment blocks, office buildings or shopping centres. This is not confined to Ireland, of course. All over Europe a forest of cranes rear skyward like exotic animals. The centre of Berlin is currently described as the largest building site on the continent. All of this construction raises an interesting and seemingly obvious question – what will this newly created space be used for? Or, more interestingly, what is the use of space?

When the twin towers were destroyed, a small but interesting statistic caught my eye. Only 10% of the towers constituted physical structure. The rest was, space. This I found fascinating because it suddenly struck me that most structures must have a similar ratio. Every enclosure is there to create space, to hold it for a purpose. If it does its job well, it creates the necessary space in proportion to the land it occupies and supports the purpose for which it is intended. A truism, you may say, but not always true.

I am thinking particularly of the civic building. It now seems to be the case that the façade of a building is more important than what is housed in the building. Take the spate of new galleries

³⁵ Sandy Fitzgerald was, until recently, Director of the City Arts Centre, Dublin. Prior to that he acted as Director of the Grapevine Arts Centre in Dublin, of which he was one of the founding members.

such as Tate Modern in London or the Guggenheim in Bilbao. These are 'landmark' structures that attract visitors because of what they look like on the outside not what they contain on the inside. And they have become the new 'must have' for aspiring city councils and Lord Mayors.

But this doesn't only apply to large-scale projects. For instance, both England and Ireland have a growing population of arts and cultural facilities. These Lottery/EU funded projects now rival the local shopping centre as part of any development plan. Yet, in many cases, their remit is unsure and their sustainability questionable. One may look no further than Dublin's Temple Bar to see this problem breaking the surface with the closure of Art House and Design Yard.

This preoccupation with façade rather than substance is, one could say, a sign of the times. Packaging has become the all-important element in selling or delivering anything, from Government policy to soap. And the packaging of space is no different.

But creating *meaningful* space is a different matter. And, I believe, it must start from the inside out, with the internal space, that place which houses all that we are as a living, breathing, human beings. There is a lot of talk these days about 'finding yourself' as if you inadvertently left yourself behind at the Post Office. In truth the idea of 'self' has been appropriated by marketing managers and advertisers to create, like the buildings, a personal façade of self. Our lives have been objectified to such an extent that we have neglected the subjective us, the real us, in favour of a more superficial way of living. We are objectifying our lives at an alarming rate and the loss of our sense of self and our connection with the world is deeply troubling, for us as individuals and as a community. And this investment and belief in the surface of things is reflected in planning, politics and the built environment.

But how have we lost such a vital connection? The answer is complex and to do with a strong motivation to escape the physical and psychological hardships of life. Since the beginning of recorded time human beings have sought to find escape from pain and suffering. As have all animals. No sentient being will turn down the opportunity for a moment's comfort. The difficulty arises when this desire goes out of balance with what is good for us. In theory we should know, instinctively, what will make us well or ill. And we do if given the chance. But our present day life style is not based on health and happiness but on shifting product. We no longer sustain ourselves by what we produce and no commercial producer has your health and well being in mind when developing new goods for the shop shelf. The bottom line is cash and how to entice you to hand it over in exchange for that little item you never knew you needed or, indeed, for the tasty but none too healthy treat.

While consumerism has always been with us, the difference now is that it aspires to buy us wholesale, body and soul. It has become the new religion. Slowly advancing over the course of the last century, the pace of consumerism has now reached staggering proportions. Driven by innovation and technological advance, we have become fixated with the possibilities for escape that consumerism offers. Escape has become the new leisure industry. In fact, it has become the industry and everything is geared to a continual assembly line of new, improved and advanced product.

One of the results of this lifestyle is that every minute of every day is filled with some distraction or other. Television, radio, music, Internet, mobile phones, cinema, music, video games, DVDs; the list is almost endless. Often these distractions can be experienced at same time! Visit almost any pub and you will find piped music, television and conversation all competing with each other. This, in turn, disconnects us, more and more, from a fundamental link with the natural world and ourselves and instills an ever-increasing need to buy, buy and buy.

With every waking minute filled with outside stimulus, our capacity to create any sort of inner space is almost non-existent. Finding ourselves is easy in that we are not lost. We are always there if we take a minute simply to connect. What happens then is called 'day dreaming', a much maligned and censored activity. Yet, daydreaming is the simplest and easiest form of meditation, therapy, healing, problem solving and living skill that we could employ. The reason is very simple. It facilitates the subconscious to do its work. Without getting bogged down in the realm physiology or cognitive science or, even, sleep study, which is more than this article allows, the subconscious can be described as that part of our metaphysical selves of which we are not aware on a day to day basis. As we go about our business our reality is rooted in habit and conscious decisions: I get up, I brush my teeth, I make tea. And our day continues thus. But alongside this, almost, automated behaviour there is a whole other process going on that is informing our decisions and assisting us in our life. During sleep this deep well spring of knowledge comes to the fore and literally realigns us, helping to solve problems, create new possibilities, and heal our body and mind. Just because we wake doesn't mean that our subconscious sleeps. It is just dominated by our waking reality, our much more conservative, timid, and often, none too clever, waking reality. If we gave ourselves the chance of allowing this most potent of personal tools, this intelligence, to come through and assist us, the benefits would be enormous.

We all suffer from this deficit. Children most of all as parents and teachers are heard to say 'stop day dreaming'. Yet, this is probably the most beneficial learning experience of all. A business consultant once told me that the most important job of any chief executive is to stare out the window. His reasoning was that during these periods of 'dream time' the executive was forming ideas for the future of the company. And business only survives on new ideas.

And this brings me onto the results of dreaming. Allowing the subconscious to do its work always results in ideas. They will come bubbling up like a fresh spring. And this is where we really begin to run into opposition, quite often self-imposed. While daydreaming is seen as a waste of time, ideas are positively dangerous. The first thing we learn in school is that our ideas are not worth anything. There are better ideas, tried and tested ideas, much more useful ideas. After years of not having our ideas validated, we self censor or are censored, which, in turn, leads us to buying our dreams and ideas off the shelf and so, we become passive consumers with little stake in our future and a feeling that we are inadequate and useless.

At the heart of all this is the concept of creating space for a purpose. Understanding that we need time for the creation of inner space and that we need to do work in the construction of that space, clearing the site, so to speak, in order to reconnect with our real selves. Without trying to proffer any sort of conspiracy theory, the current status quo benefits the powerful and the wealthy. They succeed in taking (or perhaps we, in our desire to escape, give up) our dreams, repackaging them, and sell them back to us. We repress our own creativity and bury original ideas. How could our meagre efforts possibly be better than the shiny new video game or slick television programme? And where would we get the time anyway, exhausted as we are from commuting in all that traffic and trying to answer our text and e-mail messages before getting some 'relaxation' in front of the box?

But, if we don't rehouse our dreams, in a personal and communal way, then the façade of living will continue to fail us on any meaningful level and the public manifestation of the communal dream, the civic space where we are meant to collectively appreciate and develop as a group, will mean nothing more than an architectural statement, a nice package, an empty promise, to be passively consumed. Is it not time to clear some space?

In future research I will look at some possible ways to clear this space, the first step towards taking some power back in creating our won future.



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