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Editorial

It gives me great pleasure to introduce you to this, the first edition of the ITB Journal, the academic journal of the Institute of Technology Blanchardstown. It uniquely offers the opportunity for the members of ITB, visitors and guest contributors to 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.

We have a range of papers covering a diversity of subjects. Ruth Harris talks about computer assisted language learning, Brian Nolan looks at a linguistic analysis of the situation types in modern Irish, Terence Sheridan discusses modern accounting practices relating to purchased goodwill. Ray Manley offers a glimpse of the future with a paper on fuzzy logic and neural networks. Fergus Maughan talks about the use of automatically guided vehicles in a flexible manufacturing environment. An interesting paper on XML is given by Geraldine Gray and David Kerwick. Narratology, as an emerging multifaceted method of study encompassing linguistic forms to present genres, is discussed by Fr. Paddy Boyle. We also have a number of interesting book reviews.

Papers can be dropped in for the next edition of ITB Journal to the college now at the address below. Alternatively, papers can be submitted in MS-Word format via email to brian.nolan@itb.ie

We hope that you enjoy the range of topics in this edition of the ITB Journal.

Brian Nolan
Editor
ITB Journal
Institute of Technology Blanchardstown
Blanchardstown Road North
Blanchardstown
Dublin 15

Are CALL packages disregarding the research on dealing with authentic materials?

By Ruth Harris ITB Blanchardstown, Dublin, Ireland.

Abstract

Since the advent of the communicative method, authentic materials have been seen as an important source of input for second language acquisition. However they have been noticeably absent from CALL packages. This paper looks at the implications of the research on reading, and explores which areas of work on authentic materials can be successfully done using CALL, and areas which are best left to a classroom, groupwork or semi-autonomous environment. A model of an integrated approach proposes ways of maximising the potential of each, providing new challenges for the teacher and student alike.

Text of article

CALL has been hailed as one of the most significant means of enhancing language learning and a revolution in terms of teaching methods and learner strategies. There has been much debate on the future role of the teacher, given the fact that CALL appears to be taking over many of the teacher's functions. Computers can emulate their traditional role by providing instruction, then drilling and finally testing. Software designers even seek to simulate the native speaker, particularly in the design of multi-media packages where they try to create an interface which allows the student to interact with an electronic native speaker. The goal of the linguist and the computer industry appears to be to package this concept and produce stand-alone learning materials which will be more effective for the learner and more cost-effective for the institution; many educational establishments find language teaching expensive in terms of manpower, due to the need for a low student-teacher ratio and a high number of contact hours.

It is undeniable that CALL can be used very effectively in a range of language learning situations. Many packages focus on grammar-type drills, due to the strength of the theory that feedback promotes learning. Research has shown however, that without practice, students will fail to transfer what they have learned to the area of performance, what Widdowson (1985) calls "the internalization of systemic knowledge as a communicative resource". Intensive grammatical re-enforcement courses, using CALL or other means may promote learning in the short term, but the students' "interlanguage" at a spoken level and to some extent at a written level will lag behind their supposed proficiency in grammatical aspects of the language. The computer has brought excellent translation tools in the form of on-line dictionaries and specialised glossaries. Word-processing packages with spell-checks and data-bases

can be used to good effect, and multi-media packages are providing an up-graded language laboratory, even incorporating voice recognition features.

The limitations of CALL

However, there are language learning fields which do not benefit from CALL. To try to re-package all language skills in this way would be to disregard much of the excellent pedagogical research carried out during the seventies, eighties and nineties. Many researchers, in fact, would agree that there has not been as much innovation as one might have hoped. Vivian Cook (1988) remarks "While teachers today commonly expect students to learn by understanding meaningful messages, or by communicating information to one another, CALL programmes mostly assume that they learn by drilling or by consciously mastering grammatical rules." Almost ten years later Watts (1997) remarks in the area of CD-ROM design "In an evaluation of widely used language learning materials on CD-ROM, it was found that while most used a wide range of media sources - color stills, video clips, music, speech - the content tended to follow drill-based approaches and employ a restricted range of exercises and activities such as filling in blanks, sentence completion and answering multiple choice questions"

Authentic reading materials

In this context, I would cite particularly the use of authentic texts - both for the development of reading skills and as an opportunity for language acquisition - as opposed to the packaged units of language which so often form the basis of texts in CALL programmes. The justification for using authentic materials is set out by Little et al. (1988) in claiming that "First, because they have been written for a communicative purpose, they are more interesting than texts that have been invented to illustrate the usage of some feature of the target language; learners are thus likely to find them more motivating than invented texts. Second, because they revolve around content rather than form, authentic texts are more likely to have acquisition-promoting content than invented texts". He further argues that "authentic texts are a substitute for the community of native speakers within which "naturalisitic" language acquisition occurs".

To date, packages which deal with reading texts tend to re-produce the types of exercises which could be done equally well on paper. It is important to make a distinction between packages which try to create a discipline for the disorganised student, and those which actually facilitate language acquisition. In the former case, the novelty factor may be considerable, whereas in the latter case the increased learning will motivate the student to continue to work on the programme. A text fed into the computer, followed by boxes in which the student writes answers to comprehension questions, may at least initially work better than the same exercise on paper, but it does not in itself have any extra acquisition promoting characteristics.

Adaptation of authentic texts for CALL

Many software packages fail to respect the authenticity of texts and often adapt or alter them. Firstly, there can be alteration of form. Due to the size of the computer screen, and the larger case needed for electronic clarity, texts are often shortened if not simplified. Headings become banal and parallel information in the form of supplementary photographs, graphs and other visual images often removed. Recent upgrades such as WIDA's which allows for the attachment of these, represent not just an aesthetic improvement, but a real step towards safeguarding the authenticity of the text. Grellet (1980) remarks "Authenticity means nothing of the original text is changed and also that its presentation and layout are retained... the picture, the size of the headline, the use of bold-type face, all contribute to conveying the message to the reader". Secondly, there can also be alteration of content - primarily due to the need to shorten the text, the teacher / designer may decide to eliminate unnecessary details such as reformulations and repetitions. Grellet remarks "Paradoxically, simplifying a text often results in increased difficulty because the system of references, repetition and redundancy as well as the discourse indicators one relies on when reading are often removed or at least significantly altered." A further complication may arise if the person editing the text is not a native speaker. Conscious that the student may be working alone on the materials, the teacher may decide to eliminate difficult phrases or words or bring the text closer to the mother tongue of the students.

Some researchers such as Davies (1984) would argue that simplified texts are in their own way authentic, as they also have been written with a prupose, and are a necessary precursor to working with authentic texts, and cites research by Lautamatti suggesting that simplified texts and authentic texts are ends of the same continuum. However both researchers agree that it is preferable to write an account of what is in a text, as this is still an authentic text of sorts, than to juggle with the elements of an existing text.

Skills involved in reading

The research on reading identifies three types of processing skills. Bottom-up skills focus largely on decoding the graphemes and are essential to effective reading. "Lower-level skills are skills to be mastered as a necessary means to taking the guesswork out of reading comprehension" (Eskey 1988). Top-down skills, as defined by Goodman (1967) in coining the term "a psycho-linguistic guessing game" to describe the reading process, involve prediction, confirmation and interpretation of the text "Any text, either spoken or written, does not in itself carry meaning...a text only provides directions for listeners or readers as to how they should retrieve or construct meaning from our own previously acquired knowledge" (Carrell & Eisterhold 1986). Interactive processing involves both types of skills "Simply stated, reading involves both an array of lower-level rapid, automatic identification skills and an array of higher-level comprehension / interpretation skills" (Grabe 1991)

Designing CALL exercises to support lower level processing

Bottom-up processing focuses therefore on vocabulary, syntax and automatic recognition. A lot of problems in L2 reading arise from students having inadequate basic word recognition skills. Lack of vocabulary and unfamiliarity with grammatical structures can prevent the reader from acquiring automaticity. It is relatively easy to design CALL exercises to help develop these skills - matching terms, synonyms, antonyms; associating words with definitions, grouping semantically associated words, putting things in the correct order, creating sentences, grammar drills or transformational sentences. Nyns (1988) suggests timed reading to increase reading speed and thus promote automaticity.

CALL exercises for higher-level processing

Top-down processing however, is much more difficult to adapt to CALL. Important elements of top-down processing involve the reader predicting, confirming, and correcting as he goes along. In the eighties, schema theory attempted to explain how concepts are created in our minds by grouping words together. e.g. club, green may conjure up a number of possible images, but the addition of "hole" confirms that golf is the topic. These schemata need to be "triggered". The triggering depends on our background knowledge of the topic and our correct understanding of each of the clues provided. A very considerable problem of cultural differences is apparent in L2 reading, where an ESL student may have difficulty seeing the connection between shamrock, beer, 17 March.

In the area of CALL applications, it is vital to provide introductory texts, help texts, supplementary audio and video clips, to help set the context of the text and to trigger the appropriate schemata. However, this can only be interactive to a degree, and there is no guarantee that the supplementary materials are triggering the correct schemata. A writing exercise prior to a reading text (Zamel 1992, Devitt 1997) could be appropriate, but again the problem of feedback occurs. A storyboard type exercise prepared by the teacher could be effective, however the student will again be working on a text rather than creating or expressing his or her own views. A writing exercise alone might not be of any real benefit unless the student gets feedback; a spell-check or grammar check may give feedback on errors, but will do little to confirm the student is on the right track.

Appropriate exercises for higher skills are difficult to design. Most packages will only accept an identical answer to the one keyed in by the teacher, therefore open-ended questions are virtually impossible to accommodate. Nyns (1988) suggests a programme which would recognise key words of vocabulary, and give a correct response if the sentence contained these words. This seems fundamentally flawed, as the presence or absence of "not" could alter the whole meaning of the sentence. Some of the matching exercises used for basic word activities could be adapted to key concepts, but inevitably the teacher / designer is providing the information, the student merely selecting.

Language acquistion and the negotiation of meaning

From a language acquisition point of view, one of the main ways in which students learn language is through the negotiation of meaning, which is a form of interaction which allows the student to acquire new structures. "This term has been used to characterise the modification and restructuring of interaction that occurs when learners and their interlocutors anticipate, perceive, or experience difficulties in message comprehensibility. As they work linguistically to achieve the needed comprehensibility, whether repeating a message verbatim, adjusting its syntax, changing its words, or modifying its form in a host of other ways" (Pica 1994) The theory behind negotiation of meaning refers to the learning of the L2 evolving out of communicative use rather than the other way around (Hatch 1978). Pica observed that spontaneous negotiation was more effective than pre-modifying input in an effort to anticipate the repetitions and reformulations needed to help the student understand. This would lead one to believe that the devices we would build into a CALL program would not be as effective as person to person interaction. Furthermore, Pica discovered that students learnt a lot merely observing spontaneous negotiation between a student and native speaker / teacher. In other words, the classroom or small group set-up is an ideal language learning situation and not easily replicated in an artificial environment.

CALL exercises adapted to the negotiation of meaning

With CALL we could attempt to re-produce this type of interaction, by providing hints to the meaning of words and phrases. Most packages will give the shape of the word or the first letter of a word, but what is needed is more communicative interaction. These hints could be in the form of cryptic clues, synonyms, gapped sentences giving the word in a different context, or ultimately the translation in the L1. At least at the end of the session the student will have learned the meaning of the word instead of just being given the word without comment as often happens in CALL exercises. The quality of the hints will determine the inter-active nature of the program. "Hard luck, try again" may be interactive on some level but will do little to promote the acquisition of language. The preparation time for the teacher would be considerable, but each package could be re-used several times and eventually form the basis for autonomous tasks.

Design Implications

The design implications must focus therefore on appropriate pre-reading activities, aids to processing the actual text, and finally useful post-reading activities. The *Think and Talk* package by Berlitz has a final speaking exercise which instructs the student thus: "You now have three minutes to record your own voice. Use as much language as you can remember from the last unit". This will certainly not do the student any harm, but is hardly a good use of the interactive features of a computer. A well-

designed classroom activity could be far more effective. The grid following lays out the possible activities in a classroom situation or an equivalent CALL situation. In many cases the classroom situation could be replaced by group work in an autonomous or semi-autonomous environment, perhaps with access to a native speaker, rather than a teacher. The shaded areas indicate the activity which I would consider to be better for the student either because of its interactive nature or acquisition promoting features. The tiering of activities to include CALL and non-CALL work would ultimately provide a very comprehensive approach to text-work with a focus on each of the skills.

The result would be a multi-functional integrated system which, rather than making the language teacher redundant and the student totally independent and isolated, would provide new challenges for the language teacher in the preparation and design of materials, and for the student to develop autonomous learning strategies in a semi-controlled environment.

Activity	**Classroom or autonomous group work**	**Feedback**	**CALL**	**Feedback**
1. Pre-reading Schema triggering	Background text / video / discussion Cultural information	yes	Background text / video / cultural information	unknown and difficult to quantify
2. Pre-reading vocabulary development	Brainstorming Organising vocabulary in semantic maps	yes	Matching terms, grouping words semantically, word association	yes
3. Pre-reading writing exercise	Creating a text using vocabulary above, predicting content of target text	yes (no immediate correction)	Writing exercise using WP package with L2 spellcheck or reconstructing storyboard created by the teacher	some on forms, but little on meaning
4. Reading	Silent reading	no	Silent reading timed to promote automaticity	yes
5. Lower level processing/ decoding	Decoding with dictionary or oral interaction and negotiation of meaning	some yes	Hypertext with hints and translations or glossaries	yes
6. Higher level processing	Open ended questions inferences, analysis	yes	Open-ended questions with vocab recognition feature	inaccurate

	more negotiation of meaning		Inferencing key words Written answers	not immediate
7. Form focused exercises	written or oral work on forms in text with exercises	some	Exercises on forms encountered in text	yes
8. Post-reading oral exercise	Follow-up discussion / debate on issues raised	yes	Speak and record opinions on topic	none
9. Post-reading written exercise	Developmental writing exercise	yes (but not immediate)	Written exercise on WP with spell check	yes

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PURCHASED GOODWILL AND ITS ACCOUNTING TREATMENT

Terence Sheridan

ITB Blanchardstown, Dublin, Ireland.

When a company decides to purchase another company or enterprise, the consideration paid will, in many cases, exceed the total of the separate valuation of each of the assets and liabilities of the company or enterprise being purchased. The extent of the premium paid is sometimes dependent on the growth potential of the company in question. In other cases, the premium is linked to the possibilities for cost-cutting when synergies between the existing and new companies are exploited. Occasionally, the fact that a company has an established reputation or an established customer base will result in a considerable premium being paid by the acquirer. The premium paid is referred to as Goodwill and the accounting treatment of this premium has been the centre of an accounting controversy for some time.

Until recently, the standard practice on purchased goodwill was dictated by Statement of Standard Accounting Practice (SSAP) 22, *Accounting for Goodwill*, which was issued by the Accounting Standards Committee (ASC) in July 1989. Two practice treatments were allowed.

The first and preferred treatment was to eliminate the purchased goodwill from the accounts immediately by debiting or reducing revenue reserves. [1] The main rationale for this accounting approach was that, since goodwill is not normally treated as an asset in the balance sheet, it would be incorrect to account for goodwill as an asset just because it was purchased. When this method is used, goodwill does not appear as an asset in the balance sheet and the profit figure in subsequent years is not affected.

The second treatment is to consider the purchased goodwill as an asset on the balance sheet since this is an item for which you have paid. The goodwill is then systematically amortised through the profit and loss account over its useful economic life.[2] In this case, profit is reduced in subsequent years by the amortisation charge (which is similar to a depreciation expense).

Not surprisingly, most companies in Ireland and, in particular, the United Kingdom (where there is considerably more take-over activity and, hence, more situations where goodwill accounting arises) decided on the option which would not reduce profit in subsequent years. A survey was carried out by the Department of Accounting and Finance of Lancaster University in order to examine the treatment of purchased goodwill in the financial statements of the larger companies. Immediate write-off to reserves was the goodwill treatment most widely used by respondents (80.3%). Only 11.4% of respondents

[1] SSAP 22, paragraph 39.

specified capitalisation and gradual amortisation. The results of this survey have been supported by similar studies of reporting practice.[3] The favourable effect on reported future earnings undoubtedly contributed to this preference for the write-off method.

The Accounting Standards Board issued a Working Paper on Goodwill and Intangible Assets in June of 1995. Subsequently, the ASB issued Financial Reporting Exposure Draft (FRED) 12 on the same topic and, finally, in December 1997, the ASB issued Financial Reporting Standard (FRS) 10, *Goodwill and Intangible Assets*. This new standard applies to all financial statements with accounting periods ending on or after 23 December 1998.

The most fundamental change proposed in FRS 10 is that purchased goodwill and intangible assets (assuming that they can be measured sufficiently reliably for recognition) should be treated as assets in the balance sheet.[4] While this treatment was optional with SSAP 22, the majority of companies opted for the "preferred" method of immediate write-off to reserves. This classification of purchased goodwill as an asset is consistent with the generally accepted accounting practice in most other European countries, Japan, the United States and with IAS 22, the international accounting standard on business combinations. In addition, a number of econometric studies using US data have shown that the book value of a company corresponds more closely to its market value when purchased goodwill is treated as an asset and is amortised systematically over its useful life. In other words, the market (in the US) tends to view purchased goodwill as an asset when valuing a company. If similar studies were carried out using US data, a corresponding finding would probably be the result. It is appropriate, therefore, to abandon the write-off to reserves method of accounting for purchased goodwill.

The procedures for amortising purchased goodwill in the new standard are complex and controversial. The requirements for amortisation depend on the nature of goodwill and the main elements are as follows :

where the asset is believed to have a useful economic life of 20 years or less, it should be amortised over its useful economic life;

where the asset is believed to have a useful life in excess of 20 years but not an indefinite life, it should be amortised over its useful life and annual impairment reviews should be performed;

where it is considered that the assets has an indefinite life, it should not be amortised but an annual impairment review should be carried out.[5]

The impairment review is carried out in accordance with FRS 11 : *Impairment of Fixed Assets and Goodwill*. This involves comparing the amount at which purchased goodwill is stated in the balance sheet with its recoverable amount (i.e. its value to the business).

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[2] SSAP 22, paragraph 41.
[3] c.f. Tonkin, DJ and Skerratt, LCL, ed., *Financial Reporting 1992-1993 : A Survey of UK Reporting Practice*, (London : ICAEW, 1993), 203 *et seq*.
[4] FRS 10, paragraphs 7–10.

The most controversial element of these proposals is the calculation of the recoverable amount in the case of purchased goodwill. This will be necessary in cases where the useful life of purchased goodwill is expected to be greater than 20 years. It involves the calculation of the present value of future cash flows expected to be generated by purchased goodwill. This is to be achieved by dividing the company into income-generating units, estimating the future cash flows of each unit, discounting the estimated future cash flows to calculate the present value of each unit and then comparing the present value of the unit with the carrying values of its constituent assets and liabilities. To the extent that the carrying value of the income-generating unit exceeds its value in use, the unit is impaired. Concerns have been expressed regarding these amortisation proposals for the following reasons :

The proposals give management considerable latitude in establishing a recoverable amount for purchased goodwill. Discounting calculations are extremely sensitive to changes in discount percentages and changes in the estimates of future cash flows. It is conceivable that these calculation will be manipulated in order to produce the most favourable valuation from the company's perspective;
The figures used in discounting calculations are subjective and are very difficult to verify objectively. This could pose some difficulty for auditors;

The proposals are at variance with the accounting treatment in most other European countries, Japan and the US where a systematic approach is taken.

A questionable concept in the accounting standard is the notion that purchased goodwill may have an indefinite life and does not have to be amortised on a systematic basis. This proposal is at variance with the standard accounting practice for purchased goodwill in most other European countries, Japan, the US and with the international standard IAS 22 where goodwill has a finite life of between 5 and 40 years.[6] More importantly, econometric studies on the value of goodwill seem to support the fact that goodwill has a finite life. Using US data (where purchased goodwill has a maximum life of 40 years), researcher have found that for some companies, reported goodwill overstates economic goodwill; for many others, reported goodwill understates economic goodwill. On balance, it was not possible to reject the hypothesis that the goodwill asset is given an equal valuation weighting to other assets. Therefore, it seems appropriate to have a finite life of approximately 40 years for purchased goodwill.

A feature of the current standard is that the inconsistency of accounting treatment between companies which acquire intangible assets externally and those that develop them internally remains. Intangible assets procured through take-over activity are considered capable of recognition while those generated from within the organisation are not. However, in many cases, expenditure on internal intangible assets

[5] FRS 10, paragraphs 15-17.
[6] The accounting standard in the US permits a maximum useful life for goodwill of 40 years. IAS 22 permits a maximum amortisation period of 20 years.

such as Research and Development and advertising is as easily identifiable as the cost incurred during a take-over and the benefits to be achieved from such expenditure no less certain than those of purchased intangibles.

Another feature of FRS 10 is the valuation of intangible assets, a valuation which, owing to the nature of the asset, is an arbitrary one. It is impossible in most cases to separate the value of a brand from that of the rest of the business. Any valid assessment of a brand's future profitability involves many inherently subjective judgements about marketing factors such as competitive market position, overall market prospects and the quality and value of marketing support. In short, most valuations of intangible assets will be subjective in nature and will not be liable to objective verification, a feature which may pose some problems for auditors.

Fuzzy Logic and Neural Networks - a glimpse of the future.

By Raymond Manley,

School of Informatics and Engineering. ITB Blanchardstown, Dublin, Ireland

Introduction

During the nineties I was interested and involved in the areas mentioned above. The practical application of my interest was in my masters thesis and in the design and delivery of a similarly named subject on the B.Eng. degree course in Product Design Engineering at Dundalk IT. My original interest was sparked in the area by the notion that engineers and scientists were starting to look at problems from a more 'human' perspective.

Since the Newtonian split each of the disciplines of human behaviour have more or less headed off in their own direction. Before this time we had people like Leonard de Vinci who could paint, design the first helicopter and probably wrote some philosophic and theological works as well. Thus, nowadays, engineers tend to stick to engineering in a narrow way and so on for other disciplines with the result that perhaps some of the narrower implementations of areas such as computers stem from a lack of a 'bigger picture'.

With my involvement in teaching digital logic on engineering courses over the years, it was not too difficult to see the organisation of computers and digital logic as existing only in terms of Boolean logic. Here we limit ourselves to two possible logic states a 1 and a 0, yes or no. This is still the case with all computers. However, this does appear quiet limiting given that we can appreciate as humans that our thought processes are infinitely more complex than a yes/no reasoning. (even for those professions where we think it exists!). So it was with interest that I started reading about two areas where efforts were being made to bring our human thought process into the engineering realm. Fuzzy logic allows a decision making process like our own and neural networks provide systems that can learn what to do in certain situations in a manner mimicking our own neural structures.

So to look to the future we may be seeing a trend where by the bigger picture and the reintegration of various disciplines will come about as art, medicine, the sciences and engineering come closer in the pursuit of more advanced and useful technological advances. If our technology is more integrated according to a human model it follows that it would more likely be more in tune with our way of doing things and thus be more appropriate. It is hard to envisage computers trotting along in a 100 years time still restricted to binary logic which originated in finding a system that was simple to build at the time.

The rest of this article is a reediting of various pieces of work from the last decade. The first is an article I wrote for the journal of the Institution of Engineers of Ireland in November 1998 and will be

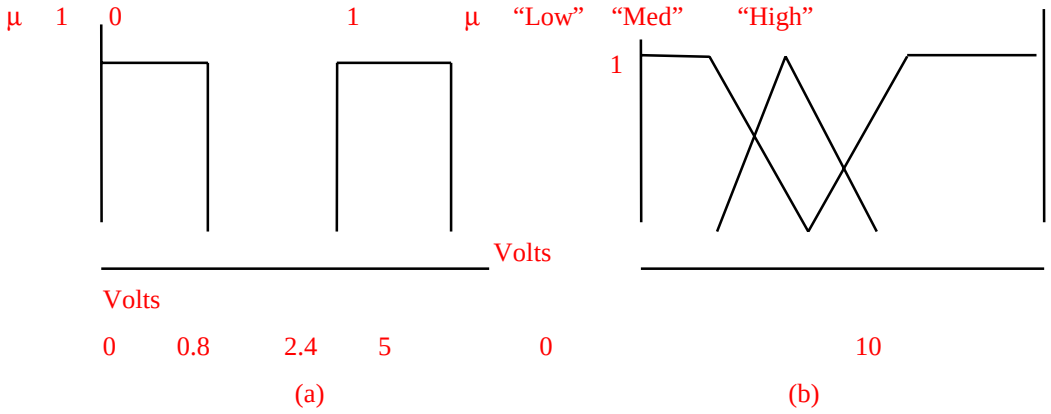
somewhat dated at this stage. The other two pieces offer an introduction to fuzzy set theory in some more detail and also an introduction to neural networks to give a flavour of these two areas. In terms of what may exist in the future, you can use your imagination in the quiet contentment that it won't be mimicked by machines - well just yet.

Fuzzy Logic Made Clear !

These words, 'fuzzy logic', are becoming more a part of everyday speech as they start to appear in the specifications of a whole range of consumer products from washing machines to cameras. Most people usually refer to it in some joking manner but what is it all about? Hopefully it will be a little less 'fuzzy' at the end of this article!

Origins of Fuzzy Logic

In 1965 Lofti Zadeh[1] published his paper on fuzzy set theory , putting it forward as a way of more closely realising the human thought process. Many systems developed to aid human activities have been based on definitive , yes/no, type decision making processes. An example is the way all computers are based on the binary logic system where only two possible and separate logic levels are allowed, a logic 1 or logic 0. However, we know from everyday experience that humans think in terms of vague linguistic categories, for example, the weather is fairly good today. "Fairly good" represents a vague category that can be represented by a fuzzy set which allows values to belong to the set by a varying degree from 0 up to 1. The grade of membership is not a probability , it is a measure of the compatibility of an object with the concept represented by the fuzzy set.



(a) Traditional binary logic shown as two non overlapping sets with all values in each set having maximum grade of membership.

(b) Three fuzzy sets shown with overlap. The varying degree of memberships allows us to be vague about whether a value belongs to each of these sets.

Since Zadeh proposed his theory many areas of applications have been considered to assess the suitability of applying fuzzy set theory. Areas include fuzzy logic and approximate reasoning, expert systems, pattern recognition, fuzzy decision making in economics and medicine and fuzzy control. [2] However, it is in the area of fuzzy logic control that most success has been achieved.

Fuzzy Logic Control

Traditional control theory requires that a mathematical model of the process to be controlled be available. Using Laplace and Z transform techniques control systems are designed to control processes from factories to spacecraft. Digital computers have come to be used in control applications with larger and more powerful microprocessors being used. Now it is being found that there are limitations to our traditional control methods.

In some applications no precise mathematical model can be constructed to model the process or such a model proves to be too complex because of the highly non-linear characteristics of the process. Also, where models do exist, i.e. linearization of non-linear problems, the cost of DSP (Digital signal processing) is too high for many consumer applications.

Thus, in recent years, the focus is changing to look at alternative methods of control where control can be achieved at lower costs and without recourse to complex mathematical models. In applying themselves to this problem many researchers, such as Mamdani [3], noticed that in control problems where no automatic electronic control was traditionally available, the control was provided by human operators who used their skill, tacit knowledge and experience of the system to produce an acceptable result.

This led to renewed interest in fuzzy set theory which Zadeh had developed in the 1960's. Using fuzzy logic it becomes possible to quantify with fuzzy sets the vague linguistic categories that a skilled operator uses in their control of a process. For example a certain range of input values could be assigned to a fuzzy set labelled " LOW", individual values in this fuzzy set can belong to it by a varying degree from 0 to 1.

The resulting controllers allow expert knowledge to be built into them without having to describe the process mathematically. This allows problems to be addressed that in the past were too complicated.

First Use of Fuzzy Logic Control

The first real example of the possibilities of using fuzzy logic for control applications was presented by Mamdani[3] in 1974 with the control of a model steam engine. Mamdani showed that Zadeh's approach provided a convenient way of expressing the linguistic rules of a human controller in a form easily processed by computer. This allowed a complex, non-linear dynamic plant to be controlled with a simpler control strategy which would be more viable in practical situations.

Application of fuzzy logic control to an industrial process was first achieved in 1982 with the control of a cement kiln in Denmark [4] and 1988 [5], a highly non-linear process and one which traditionally could only be controlled by a skilled operator as a good mathematical model was not available to allow conventional control. These early examples of fuzzy control were applied to problems where a good base of operator knowledge could easily be transferred into the IF..THEN rules of the fuzzy logic controller.

Fuzzy Logic finds Acceptance in Japan

Despite a promising start, acceptance of fuzzy logic control was slow. This no doubt was due in part to the negative connotations of the word 'fuzzy' in the English language denoting something imprecise and unreliable. However, fuzzy logic control had a better reception in Japan where the word 'fuzzy' was just seen as a label and the technology was investigated on its own merits. Thus many of the early uses of this new control method were to be found in Japan.

The Sendai Subway Automatic Operations Controller, possibly the best known example of fuzzy control, was introduced in 1986 and the strategies of experienced operators were implemented in fuzzy rules. The system claims smoother braking at stations and speed control, however some commentators [6] question the standard of conventional controller that the fuzzy logic controller was compared with.

Similar reactions have been reported [7], which explains the slowness of acceptance of fuzzy logic control outside of Japan. However, the number of applications has increased from 8 in 1986 to 1,500 in 1993 [4]. Since 1990, many Japanese home appliances from washing machines to video cameras contain fuzzy logic control to give cost-effective control of such parameters as focusing and sharpness in cameras. [8]. Fuzzy control was introduced to cruise control in Japanese cars in 1991. Western countries tried hard to catch up on Japan at the start of the nineties and during NASA space shuttle flights in 1992/1993, temperature control of some experiments, where the temperature needed to be kept within 0.1 ^{O}C over a range of 1 to 40, was achieved using fuzzy control.

As the interest in fuzzy logic control continues to grow, many control situations are being re-investigated to see if improvements can be achieved over existing methods. The area of controlling non-linear systems has been mentioned. Another aspect of fuzzy logic control being investigated is the improvement in control action where noise, load or parameter changes occur.[9] Yet another area is where consumer products are required with greater control requirements and with a faster development cycle to meet market demands. With this last point in mind, fuzzy logic control, and its related area of neural networks, have been included in the new B.Eng. in Product Design Engineering at the Regional Technical College, Dundalk.

Summary

In summary, the use of fuzzy logic controllers has proven successful and practical in a range of commercial applications, particularly where non-linear systems or systems which are subject to noisy, erroneous information are involved and where no easy mathematical models are to be found. With increasing uses in consumer products, fuzzy logic is set to become a more accepted design method.

Fuzzy Set Theory

Fuzzy Sets - a definition

A **fuzzy set** differs from a crisp set in that the elements of such a set can have a varying degree of membership dependant on how strongly they match the set membership criteria.

For example, for a fuzzy set labelled " Tall Men", a height of 5ft would not have as strong a membership as a height of 7ft.

Definition:

Thus a fuzzy set can be defined as a set of ordered pairs where each element is assigned a membership value between 0 and 1.

The fuzzy set "Tall Men" could thus be described as:

TM = { (4,0.2) , (5,0.7) , (6,0.8), (7,1) }

This grading of membership mirrors the vagueness that characterises human thought processes.
If asked, could a 6ft man be included in a group labelled "Tall Men", a person would most likely respond that a 6ft person was 'fairly tall'. This vagueness (or fuzziness as Zadeh called it) is reflected in the fuzzy set by the fact that 6ft has a membership weighting of 0.8 i.e. 80% true.

Important distinction with Probability Theory

The grade of membership is not a probability, it is a measure of the compatibility of an object with the concept represented by the fuzzy set.

Fuzzy Sets - examples

A classical or crisp set can be defined as a grouping of elements which either belong to or do not belong to that particular set. The set can be described by listing the elements of the set or by stating the conditions for membership.

Ex 1 (a):

A set **A** is defined as:

$A = \{x \mid x \leq 6\} \quad x \in X \quad ,$

Where X contains all possible integers.

or $A = \{ 0,1,2,3,4,5,6\}$

A fuzzy set can be defined as a group of ordered pairs denoting the element and it's degree of membership. The set can be described by listing the ordered pairs or stating the conditions of membership of the fuzzy set.

Ex 1 (b):

If X is a collection of elements , then a fuzzy set A is defined as:

$$A = \{ x, \mu_A(x) \} \quad x \in X$$

where $\mu_A(x)$ is known as the degree of membership (or degree of truth) of x in fuzzy set A, which maps X into the membership space of all values between 0 and 1.

Ex 1 (c):

If , in a garage, all cars are classified by engine size in litres then

E = { 1, 1.2, 1.3,1.4, 1.6, 1.8, 1.9, 2,2.5,2.8 } is the crisp set of all available engine sizes.

A fuzzy set to describe 'comfortable size cars' could be defined as follows;

C = { (1.3,0.3), (1.3,0.7), (1.4,0.9), (1.6,1), (1.8,0.8), (1.9, 0.4), (2,0.3)}

In general fuzzy sets will be denoted as ordered pairs of the element followed by it's degree of membership of the set.

A fuzzy set can also be defined by a function determining the degree of membership of its elements.

Ex 1 (d):

A fuzzy set B = ' real numbers close to 15' can be described as :

$$B = \{ x, \mu_B(x) \mid \mu_B(x) = ((1+(x-15)^2)^{-1} \}$$

Fuzzy Sets - graphical representation

Fuzzy sets when used in engineering are more usually represented graphically. Example 1(d) can be described graphically by plotting element values versus membership values as follows:

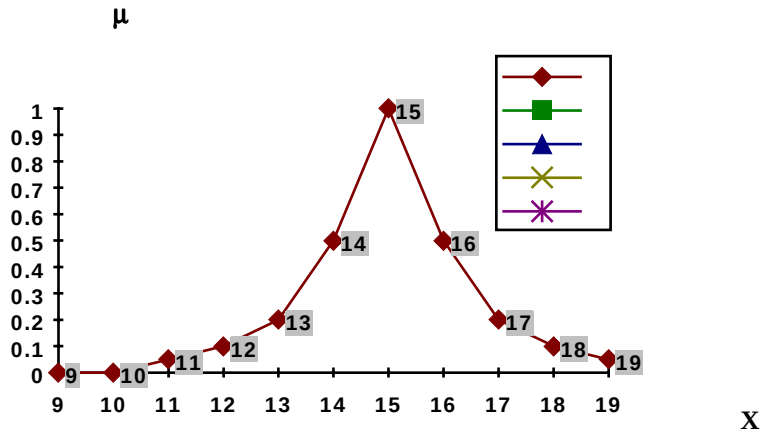


Figure 1

This example illustrates two important points about fuzzy sets. Firstly, a fuzzy set usually has associated with it a vague linguistic term which describes it in human terms. i.e. ' real numbers close to 15' or 'fairly warm' etc. Secondly, fuzzy sets can be described graphically to show how the membership function varies with element value. This graphical representation can be used when designing systems to show what values belong to which fuzzy set and to show the overlap between sets.

NB: The overlap is used to give smooth control or decision changes as input variables change, i.e. no abrupt changes from one set of conditions to another which would cause a step response in the controlled plant. An example is shown in Fig 2,

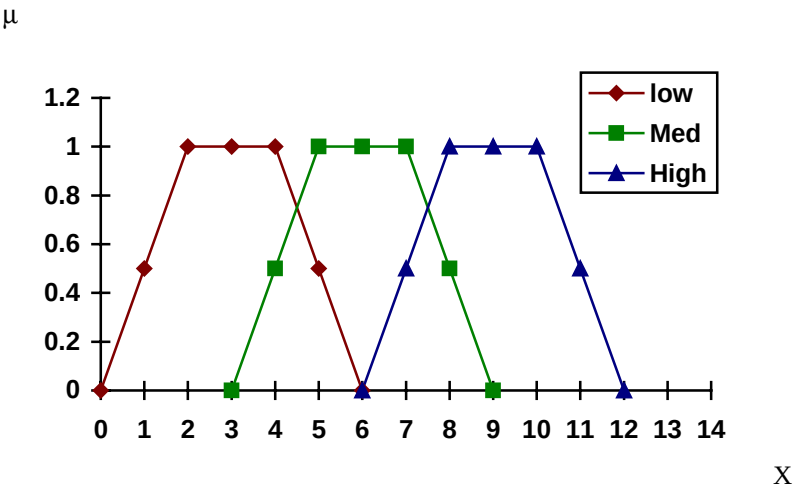


Figure 2

Research has shown that for most situations where fuzzy sets are used, the shape of the fuzzy set is always convex as shown in Figures 1 and 2.

Non-convex sets can lead to instability in certain situations and erroneous results in such areas as decision making and expert systems.

A test can be carried out on a fuzzy set to ensure that it is convex by comparing the elements to fit the following criteria.

$$\mu_A\ (\lambda x_1 + (1-\lambda)x_2) \geq \text{MIN}\ (\mu_A(x_1)\ ,\ \mu_A(x_2))\ \ x_1,x_2 \in X\ ,\ \lambda\ \in [0,1]$$

Perform this check on the fuzzy set below:

fuzzy set B = ' real numbers close to 15' can be described as :

$$B = \{\ x, \mu_B(x)\ \mid\ \mu_B(x) = ((1+(x-15)^2)^{-1}\ \}$$

Basic Set-Theoretic Operations on Fuzzy Sets

Just as we defined new crisp sets by applying set-theoretic operations we can apply such operations to fuzzy sets to create a new set. For example the intersection of two crisp sets gave a new set which was the set of all elements that both original sets had in common. How does this work with fuzzy sets?

The Intersection of two fuzzy sets

The MIN operator governs the intersection of two fuzzy sets.

Definition:

$C = A \cap B$, is defined pointwise by the function:

$$\mu_C\ (x)\ = \min\ (\ \mu_A\ (x), \mu_B\ (x)\ )\ \ \ x\ \in\ X$$

i.e. the lowest value of membership function is mapped into the fuzzy set C for that element.

This can be shown graphically by the following example.

Ex 1 (e): Example of the MIN operator.

Let C = { (1.2,0.3) , (1.3,0.7) , (1.4,0.9) , (1.6,1) , (1.8,0.8) , (1.9,0.4) , (2, 0.3)}

be the set of 'comfortable size car' from Ex 1 (c).

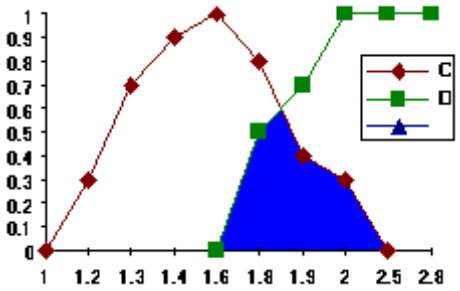
and D be the set of 'cars with large engines' defined as:

D = { (1.8,0.5) , (1.9.0.7) , (2,1) , (2.5,1) , (2.8,1) }

Then F = C ∩ D = { (1.8,0.5) , (1.9,0.4) , (2,0.3) }

The fuzzy set F describes 'comfortable size cars with a large engine' or it could be described as 'comfortable size cars and with a large engine'. The intersection is shown graphically below as a shaded area.

μ



Litres.

Figure 3

Intersection of two fuzzy sets.

So in fuzzy sets, an "AND" function describes the area that both sets have in common i.e. intersection.

The union of Two fuzzy sets

The union of two fuzzy sets and is governed by the MAX operator.

Definition:

$C = A \cup B$ is pointwise defined by the function:

$\mu_C(x) = \max(\mu_A(x), \mu_B(x)) \quad x \in X$

i.e.. the highest value of membership is mapped into the fuzzy set C for that element.

Ex 1 (f): An example of the MAX operator.

Using the same fuzzy sets C and D as in Ex 1 (e) , then

G = C ∪ D

G = { (1.2,0.3) , (1.3,0.7) , (1.4,0.9) , (1.6,1) , (1.8,0.8) , (1.9,0.7) , (2,1) , (2.5,1) , (2.8,1) }

The fuzzy set G now describes ' comfortable size cars or cars with a large engine'.

The union of sets C and D is shown graphically below as the shaded area.

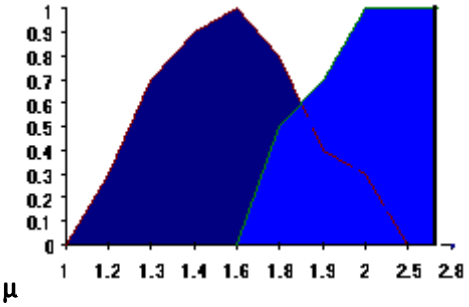


Figure 4

Union of two fuzzy sets

So, in fuzzy sets an "OR" function describes the area which meets the requirements of both sets to the highest degree of truth.

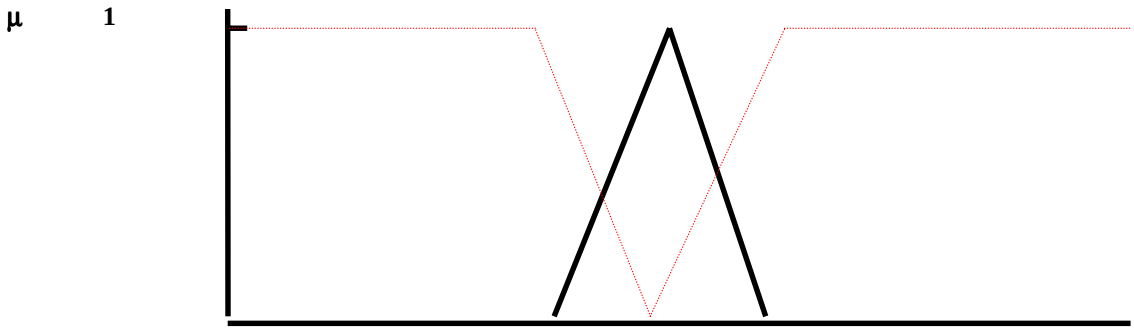
The Complement of a Fuzzy Set

The complement of a fuzzy set defines the degree of truth of all elements that are not compatible with the concept represented by the fuzzy set e.g. NOT A.

Definition:

$$\mu_{\overline{A}}(x) = 1 - \mu_A(x) \quad x \in X$$

Graphically, this can be represented as all the area that is not part of the fuzzy set.



It is useful in clearly representing what is NOT membership of a fuzzy set in fuzzy control rules.

Other Operations on Fuzzy Sets

Algebraic Sum

Definition:

The algebraic sum of two fuzzy sets A and B is defined as :

$$C = A + B, \quad C = \{ x, \mu_{A+B}(x) \mid x \in X$$

where $\mu_{A+B}(x) = \mu_A(x) + \mu_B(x) - \mu_A(x).\ \mu_B(x).$

Bounded Sum

Definition:

The bounded sum of two fuzzy sets A and B , $C = A \oplus B$, is defined as :

$$C = \{ x, \mu_{A \oplus B}(x) \mid x \in X$$

where $\mu_{A \oplus B}(x) = \min \{1, \mu_A(x) + \mu_B(x)\}$

Bounded Difference

Definition:

The bounded difference of two fuzzy sets A and B , $C = A \bigcirc B$, is defined as:

$$C = \{(x, \mu_{A \bigcirc B}(x)) \mid x \in X\}$$

where $\mu_{A \bigcirc B}(x) = \max \{ 0, \mu_A(x) + \mu_B(x) - 1\}$

Algebraic Product

Definition:

The algebraic product of two fuzzy sets A and B , C = A•B, is defined as:

$$C = \{ (x, \mu_A(x). \mu_B(x)) \mid x \in X\}$$

Ex 1 (g): An example of the other operators.

These operators are illustrated for the following example for fuzzy sets A and B.

A = { (2,0.4) , (3,0.7) , (4,1) , (5,0.6)}
B = { (3,0.5) , (4,0.8) , (5,1) , (6,0.6)}

A + B = { (2,0.4) , (3,0.85) , (4,1) , (5,1) , (6,0.6) }
A ⊕ B = { (2,0.4) , (3,1) , (4,1) , (5,1) , (6.0.6) }
A ○ B = { (3,0.2) , (4,0.8) , (5,0.6) }
A•B = { (3,0.35) , (4,0.8) , (5,0.6) }

NB: It should be noted that where an element has no ordered pair in a fuzzy set , it's existence with a membership function of 0 is implied.

These operators have been used to model the intersection and union of fuzzy sets and have provided alternatives to the MIN/MAX operators. Their use is dependent on the particular application and their adaptability to it. However, certain operators who exhibit common properties are often grouped together.

Fuzzy Logic and Bivalent Logic

How do these operators relate to the traditional binary logic operations?

Fuzzy Union and the OR Function

In traditional logic equations the OR operator returns the value of input that has the highest value i.e. a logic 1 on any input of an OR function ensures that the output is a logic 1.

The fuzzy union returns the value which meets the requirements of both sets to the highest degree of truth and is governed by the MAX operator.

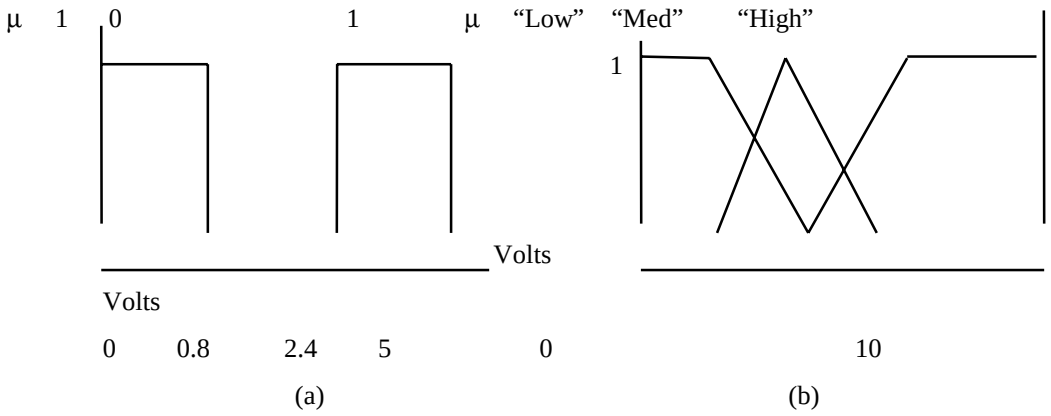
Fuzzy Intersection and the AND Function

In the bivalent logical AND operation the lowest value , 0 , controls the output condition. So if one of the inputs is logic 0 , the output is logic 0.

The same idea is covered in fuzzy set theory by the intersection of two fuzzy sets, which returns the value which meets the requirements of both sets to the lowest degree of truth and is governed by the MIN operator.

Bivalent Logic vs. Fuzzy Logic

If we were to compare graphically traditional bivalent logic with fuzzy logic , they would look as follows.



Traditional binary logic shown as two non-overlapping sets with all values in each set having maximum grade of membership.

(a) i.e. it is a particular case of fuzzy set theory.

(b) Three fuzzy sets shown with overlap. The varying degree of memberships allows us to be vague about whether a value belongs to each of these sets.

Neural Networks

Introduction

What are neural networks?

What are they used for?

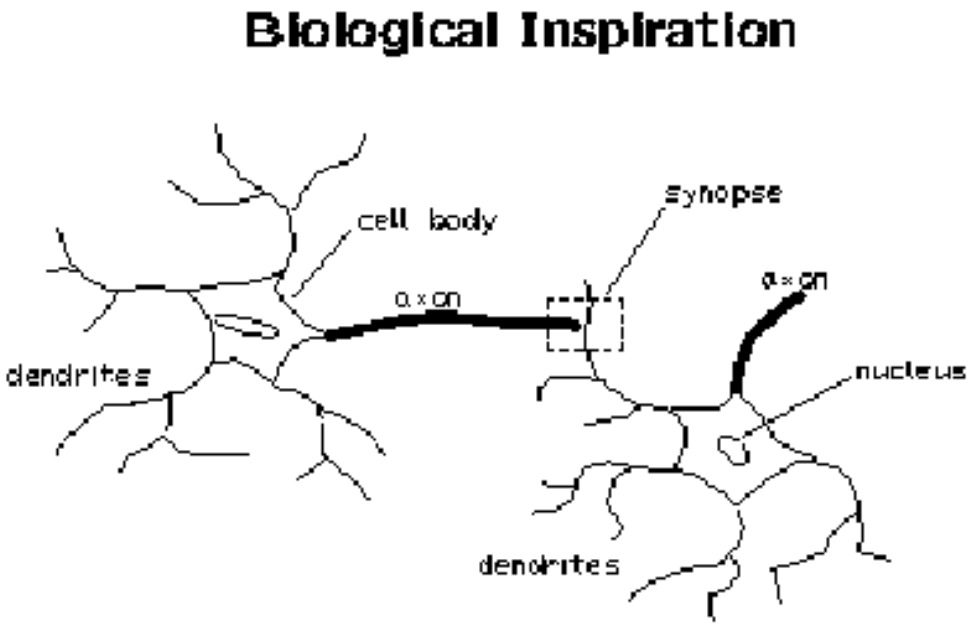
How do they operate?

What different types are there?

How are they related to fuzzy logic?

Human Brain

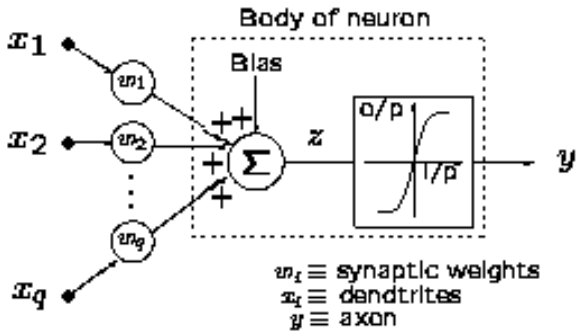
The human brain represents the best computational "machine". The brain consists of many neurons which when working together performs tasks way beyond what computers can do. Scientists since the 1940's have been fascinated with creating a machine that would work like the human brain neurons.



Characteristics of Biological Neurons.

- A typical brain contains between 10^{10} and 10^{12} neurons.
- Neurons are connected to each other in a complex spatial arrangement to and from the central nervous system.
- The cell body is typically a few microns in diameter.
- The 'hair like' dendrites are tens of microns in length and receive incoming signals.
- The axon is the neuron output and is 1mm to 1m in length. It can branch at its extremity, allowing it to connect with a number of other neurons.
- A single neuron may be directly connected to hundreds or even tens of thousands of other neurons.
- Signals are transmitted by electromechanical means.
- Pulse propagation speed ranges from 5 to 125 m/s .
- A delay of 1ms exists for pulses to traverse the synapse, via the generation of chemical substances called '*neurotransmitters*'.
- It is thought that, due to increased cell activity, metabolic growth takes place at the synaptic junction, which can increase its area and hence its 'weight'. (So practice does pay off!)
- If the 'sum' of the signals received by a neuron exceeds a threshold, the neuron 'fires'.
- Neurons can fire over a wide range of frequencies but always fire with the same amplitude.
- After carrying a pulse, an axon fiber is in a state of complete non-excitability for the duration of the 'refractory period', about 10ms.
- Information is frequency encoded on the emitted signals.

A Model of an Artificial Neuron.



ANN mimic of biological neuron

The following diagram is the common model used to mimic a brain's neuron.

Formula:

$Y = f\left(\sum_{i=1} w_i x_i + w0\right)$

The inputs, X*i*, are analogous to the dendrites, *y* to the axon and *wi* to the synaptic weights.

These models are a much simplified version of a real neuron.

These ANNs are joined together to form ***networks*** which can then perform tasks.

Brief History of ANN Development

Origins

1943 McCullough-Pitts neuron

1949 Hebbian learning

The First Golden Age

1958 von Neumann's input

1958 Introduction of Perceptron (Rosenblatt, Block, Min- sky & Papert

1960 Widrow-Hoff learning rule (Delta rule, LMS) and Ada- line

The Quiet Years

1972 Kohonen - associative memory neural nets.

1977 Anderson - associative memory nets.

1967-88 Grossberg - 146 publications with math. and bio- logical treatment

'Renewed enthusiasm'

1983 Bolzmann machine

1985 Carpenter - adaptive resonance theory (ART)

1986 Backpropagation training rule (Werbos, McClelland & Rummelhart)

1987 Hopfield networks (associative memory nets)

1987 VLSI and optical implementations of ANNs

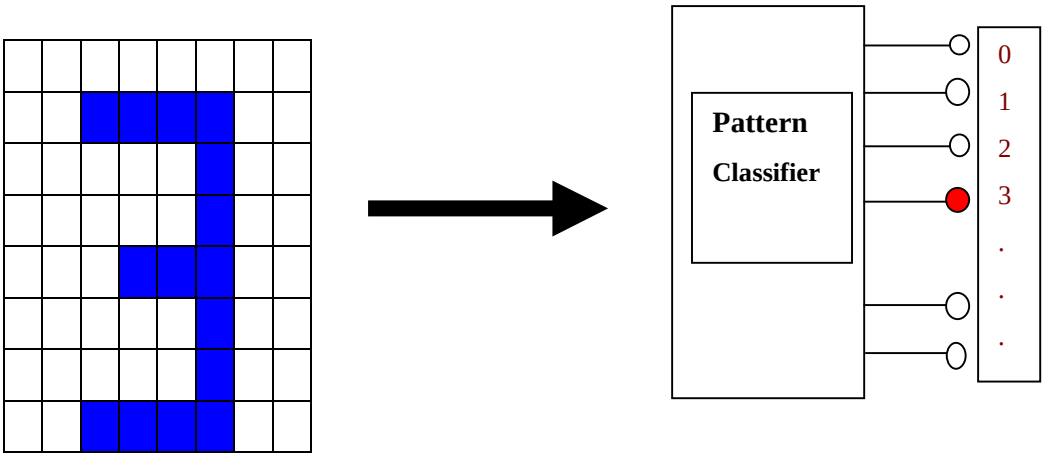
1988 Fukushima - neocognitron

What does a neural network do?

The function of a neural network is to produce an output pattern when presented with an input pattern.

Pattern Classification

Your brain is interpreting these words and letters as patterns, which is easier as they are typed. Trying to interpret hand written text is a pattern recognition problem that is hard but can be implemented using an ANN. Using an electronic memory to build a pattern recogniser for say 10 classes to recognise the numbers from 0-9 is not feasible.



There are 64 inputs (8x8) so there are $2^{64} = 1.8 \times 10^{19}$ different input patterns.

So a memory with 1.8×10^{19} locations would be needed.

Each location must be 10 bits to represent the 10 different output values.

This would require something like 170 million 1Gbyte chips!

If 1 pattern is processed each second it would take 600,000,000,000 years to program! Not feasible.

How is a neural network better?

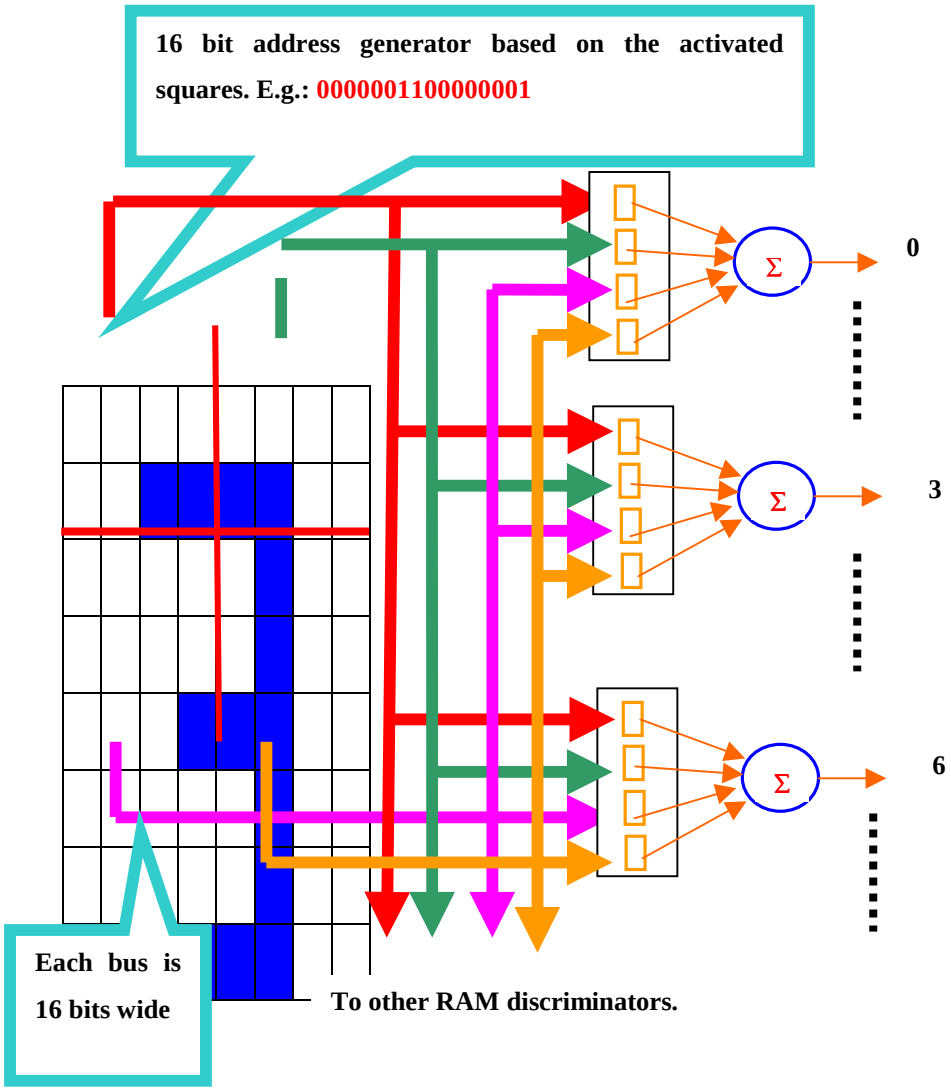
An ANN is better because it can:

- Learn from a small number of input patterns
- Generalise from the examples it has been shown
- Be small enough to be physically realisable.

Ram Discriminators

These are an example of a system that can recognise patterns, learns by example and can generalise. However, they are implemented using Boolean logic circuits and are thus known as Boolean Neural Networks. They allow the last example to be realisable.

Let's take our 8x8 image for classifying numbers 0-9.



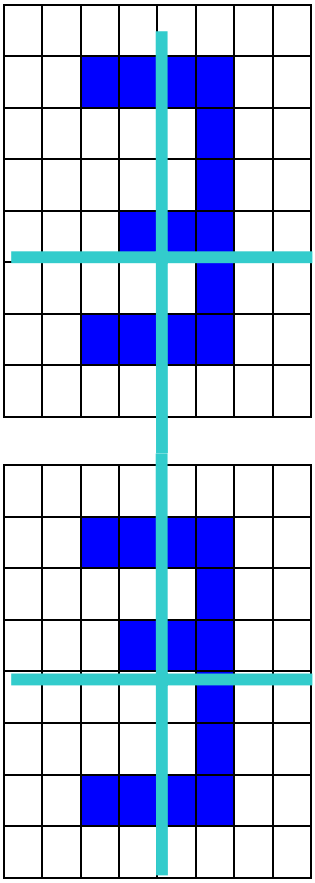
Process for the above example.

- We break the image into 4 quadrants.
- Each quadrant has 16 pixels which address a RAM memory device. Therefore, each RAM needs 2^{16} = 64K locations.
- Instead of storing 10 bits, we now only store 1 bit but have 10 different RAM chips.
- Before 2^{64} locations with 10 bits were needed. Now we only need 10 sets of $4x2^{16}$ locations i.e. 70 billion times smaller!
- The outputs of all 4 RAMs are connected to a summing junction, so if all RAMs produce a 1 we get a maximum output of 4.
- Training is by showing the system a pattern such as 3. Then place a 1 in the 4 memory locations addressed in the '3' discriminator. The memory devices in the other discriminators are unchanged.
- If the system is shown several examples of the number 3, each example puts 1s in different memory locations.
- Now, if a pattern is shown to the system that matches one of these, that discriminator will give a maximum output, 4. Others should be less than the maximum.

An interesting feature of this system is that it can **generalise.**

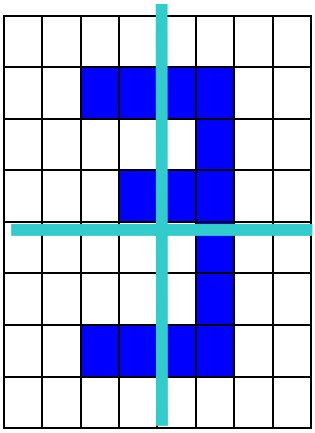
An example:

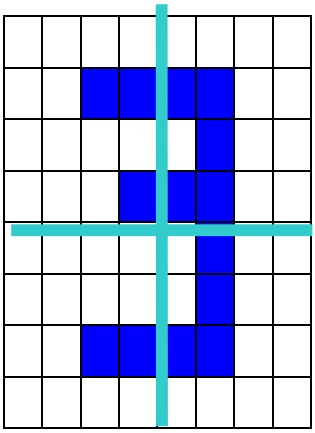
Let's say the following two patterns are used to train for a 3.

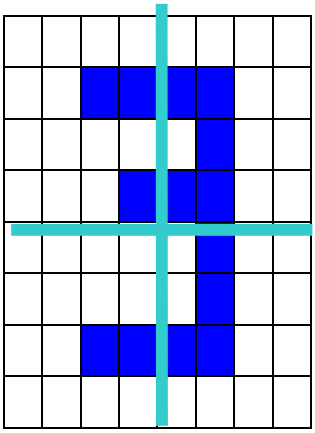


Even though we have only shown the system two patterns, there are 16 patterns that would give a maximum of 4 from the '3' discriminator. 14 of whom it never saw before i.e. it can generalise.

Here are 3 of those 14 other possibilities. They do look closer to a 3 than any other number so it is right that they should be classified as '3's.







So this is an example of a Pattern Classifier which can be *trained* and can *generalise*.

Biologically Inspired Neural Networks

Most of the different neural networks, apart from Boolean ones, are descended in some way from the McCulloch-Pitts neuron (1943).

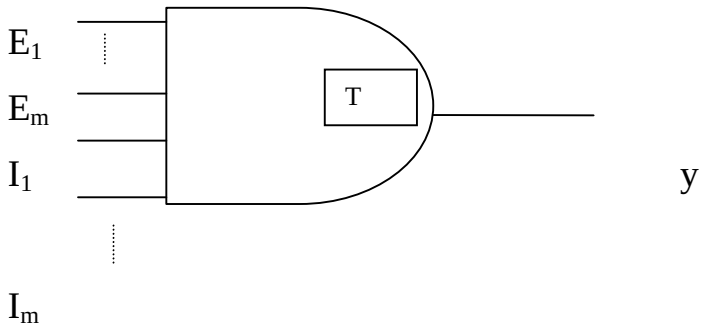


Figure 1 McCulloch-Pitts neuron (1943)

Figure 1 shows the basic idea behind the original neuron. It has excitory and inhibitory inputs. If any of the inhibitory inputs are active, the neuron won't fire. If none are and if the sum of the excitatory is greater than the threshold, we get an output. Mathematically:

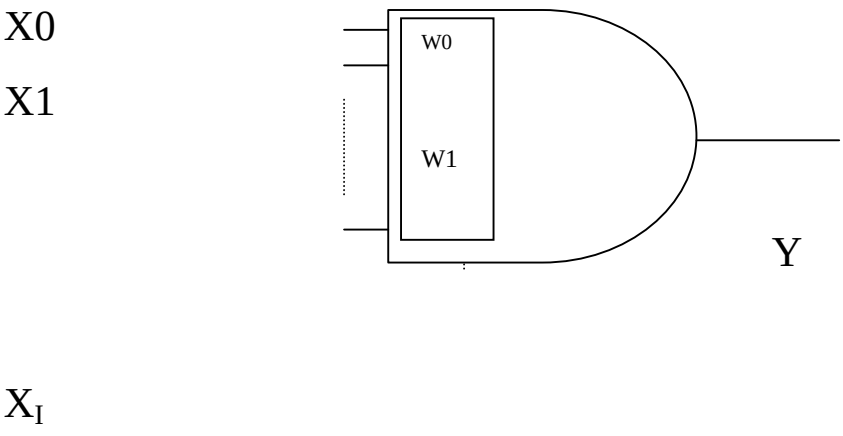
$$Y = 1 \text{ if } \sum_{i=1} I_i = 0 \text{ and } \sum_{j=1} Ej \geq T$$

$$Y = 0 \text{ otherwise.}$$

The problem with this early neuron model was that it lacked the ability to learn or generalise. Various modifications were made to it over the years including making the inhibitory inputs negative and adding weightings to the inputs. One of the earliest useful neuron models was the ADALINE. ADAptive LINear Elements developed by Windrow and Hoff(1960).

ADALINE

Figure 2 shows the basic Adaline model.



Each input can have a value of +1 or –1. Each input has a weight associated with it which is a real number and can be positive or negative.

Figure 3 Alternate Adeline Representation

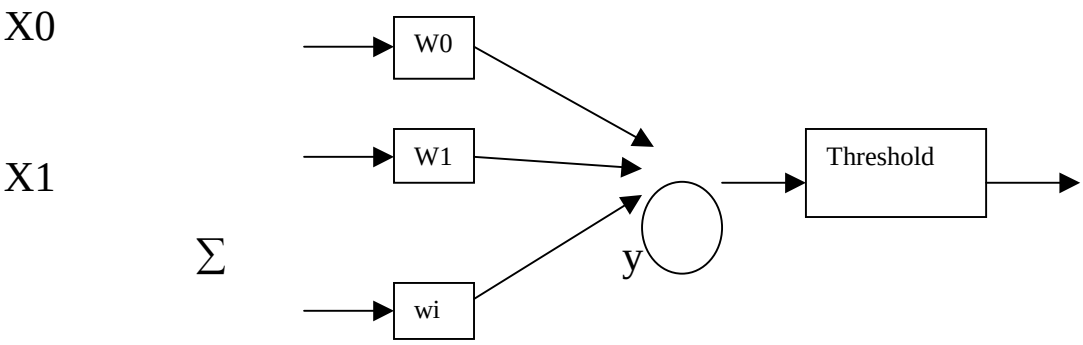


Figure 3

It can also be represented as Figure 3 above. When a pattern is presented to the input, the weighted sum, called the net input, *net*, is found by multiplying the inputs with their corresponding w2eights and adding all the products together.

$net = \sum_{i=0} w_i x_i$

The additional input and weight, x0 and w0, provide a constant offset with x0 permanently set to +1.

This replaces the threshold that was used in the McCullough-Pitts neuron.

The value, *net*, is transformed into the output, y, by a non-linear output function. This function gives a +1 if the weighted sum is > 0. If sum ≤ 0 then the output is –1.

This is known as a Hard-Limeter.

Training this and other neural networks involves finding values for the weights.

Representing the No. 3 Problem with ADALINE

10 Neurons are required, one for each numeral.

When a "3" appears at the input of the 3 neuron, it should fire.

The diagram below shows whites represented by a –1 and blacks by a +1.

-1	-1	-1	-1	-1	-1	-1	-1
-1	-1	**+1**	**+1**	**+1**	**+1**	-1	-1
-1	-1	-1	-1	-1	**+1**	-1	-1
-1	-1	-1	**+1**	**+1**	**+1**	-1	-1
-1	-1	1-1	-1	-1	**+1**	-1	-1
-1	-1	-1	-1	-1	**+1**	-1	-1
-1	-1	**+1**	**+1**	**+1**	**+1**	-1	-1
-1	-1	-1	-1	-1	-1	-1	-1

One way to train a neural network to recognise this pattern as a 3 is to assign values to the weights so that for white cells it is –1 and for black cells the weight is +1.

So the value of *net* will be 64 when presented with a perfect 3

If the offset, w0, is set to –63, then the weighted sum becomes 64-63 = 1. This being >0 we get a +1 when passed through the hard-limiter.

If another pattern is presented the weighted sum will be at most –1 and possibly as low as –127, so the hard-limiter will give a –1 for all other patterns.

What if a pattern of 3 with 1 bit different appears?

With 1 bit different we get (63x+1) + (1x-1) = 62

With an offset, w0, set to 63 we get a sum of –1 which is less than 0 so that the hard-limiter will give a –1 out. It is rejected.

If the offset is adjusted to 61 then *net* sum for the corrupted 3 becomes +1 and it is accepted. All patterns with one corrupted pixel will be accepted.

Thus adjusting the weights adjusts the sensitivity of the neuron.

Different Learning Methods

When a neural network such as ADALINE is in its learning phase there are 3 things that have to be taken into account:

- The inputs that are applied are chosen from a training set where the desired response of the system to these inputs is known.
- The actual output generated when an input pattern is applied is compared with the desired output and used to calculate an error.
- The weights are adjusted to reduce the error.

This kind of training is called **supervised learning.**

Conclusion

The above examples give a flavour and an introduction to the areas of fuzzy set theory/logic and an example of basic neural network The area of fuzzy logic controllers which uses fuzzy set theory in a particular way to control electromechanical devices, such as a washing machine, is not covered. In the area of neural networks many other examples could be looked at to cover areas such as weighting, self-learning and indeed other models of neural networks. Anyone interested can contact me for more!

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AGV CONTROLLED FMS

[1]Fergus G. Maughan,

[1] School of Informatics and Engineering, ITB Blanchardstown, Dublin, Ireland.

Keywords: Automatically Guided Vehicle, Flexible Manufacturing Systems, CIM, LAN

ABSTRACT

One of the key factors that prevent the implementation of Flexible Manufacturing Systems (FMS) is the elaborate cost associated with the control software. In a FMS there is often a wide range of equipment such as personal computers Programmable Logical Controllers (PLCs), CNC Machines or robots, each of these having their own "intelligence" and library of data. Providing a means of communication between these individual controllers has traditionally been achieved using a Local Area Network (LAN). This proves more expensive when traditional manual operated machines have to be integrated into the system. The model described in this paper provides an alternative to the conventional use of a LAN in a FMS environment. In the design solution an Automatically Guided Vehicle (AGV) is used as both the materials handling unit and the communications line linking each station to the host controller. Communications between the AGV and peripheral equipment is achieved using a standard infrared data link, eliminating hard-wiring and network protocols.

A simulation model has been developed to demonstrate the feasibility of such a system, using industrial data. The software package Witness is used to develop the simulation model. The objective from developing this simulation model is to test whether an AGV is capable of meeting the demands of such a scenario. The research undertaken aims to test this by modeling an existing factory layout. Using this layout and captured machining times and part routes, from the factory database, the feasibility of such AGV controlled production system is established. The model shows that such a system is plausible in a scenario where machine times are high and the distance between machines is large.

1. INTRODUCTION

Computer Integrated Manufacturing (CIM) incorporating the flexible manufacturing concept has not yet provided the expected benefits for small to medium volume discrete parts manufacturing operations. Typically, these flexible computerised systems come in over budget and yet do not provide the promised flexibility [1].This can be directly attributed to the high cost of control software development for integrated systems. In recent years, as a result of worldwide industrial competition, there has been an increased interest in Flexible Manufacturing Systems (FMS). With a rapidly changing market there is a need for manufacturers to change their production systems from systems that are capable of producing a wide variety of products at a relative low cost to those of mass production. It is therefore necessary for production systems to change from, job shop operations, which have high flexibility at high cost, to flexible manufacturing system which also have high flexibility but at a low cost. [2]

Flexible Manufacturing Systems (FMS) are generally composed of CNC machines (Computer Numeric Control), automatic tool changing facilities and automatic materials handling units. Integrating these machines and facilities generally involves the use of complex software as a control system. Providing a

means of communication between a series of these individual controllers and the host controller has traditionally been achieved using a Local Area Network (LAN). The complexity of successful integration of each work station using a LAN results in a relatively high cost system.

Traditional shop floor systems incorporate some form of control system such as, hierarchical control, centralised control, hierarchical control, or hybrid control,[1][2][3]. Due to the high cost of converting all machines to CNC control and implementing a full scale networked Flexible Manufacturing System with an expensive complex control systems it is necessary to develop a low cost control system for implementing a Flexible Manufacturing System to the shop floor. Kathryn *et al.* [4] defines an FMS as,

> *"...an integrated, computer controlled complex of automated materials handling devices and numerically controlled machine tools that can simultaneously process medium-sized volumes of a variety of parts..."* Chen *et. al.,* describes a Flexible Manufacturing Systems as, *"...a class of highly automated systems which consist of (1) numerically controlled (NC, CNC, NC) machining tools, (2) an automated materials handling system (MHS) that moves parts and sometimes tools through the system, and (3) an overall computer control network that coordinates the machine tools, the material handling, and the parts..."* [5]

However these philosophies, which describe Flexible Manufacturing Systems, neglected to include the human intervention in FMS. In order for small to medium sized Irish firms to adapt to Flexible Manufacturing Systems, stand-alone manually operated machines will have to be incorporated into the flexible manufacturing concept. This may be achieved by the use of manually operated machines which use a human link the FMS system. The operators receive their instructions from the FMS host in the form of a print out sheet or a instruction from a user interface. Each time the operator performs an operation on a batch of parts it informs the host, as to update the hosts scheduling algorithms, by placing the pallet of parts into an *out station* at the machining station. In the described system an AGV is used as the transport medium. The AGV used is a single load vehicle and acts as the sole materials transportation unit. The operator is not permitted to transport pallets manually. It is also noted that all parts are introduced into the FMS by the AGV and all parts are removed from the system by the AGV. The AGV used has been both developed and simulated at the University of Limerick for demonstration purposes in a working environment. The AGV uses reflective tape laid in a loop layout on the shop floor as a guidance system.

2. CONTROL SYSTEM ARCHITECTURE

As Wysk *et al.*[6] described, planning has been attributed to the selecting of tasks that the manufacturing system will perform, scheduling as identifying a good sequence for these planned tasks based on some performance criteria and execution as performing the scheduled tasks through the direct

interfaces with the physical equipment. These specific functions will be performed by the AGV on board computer.

There are two main components in the FMS controller, each customised to support the configuration of the FMS system. These components being the, system host controller and the AGV controller. The system host controller's primary function will be to link the AGV to the CIM system. Job instructions are loaded from the stationary host-controller to the AGV on-board computer through an infra red data link. At the user interface of the host controller user information is transmitted in the form of a Manufacturing Work Order. A copy of the Manufacturing Work Order is stored on the AGVs on board computer which is updated as the batch of parts progress through the production system and also stored on the host controller for future reference.

The AGV controller contains a database of Manufacturing Work Orders with the associated CNC machine code and drawings for each individual batch. It is not necessary for the AGV controller to be aware of the capabilities if each individual machine. The AGV simply identifies the required machining station from the Manufacturing Work Order and delivers the pallet of grouped parts to the appropriate destination. The AGV identified each particular station by my means of a binary address embedded on the floor of the machine shop.

The execution system of the AGV controller as described by Maughan *et al.*,[7] consists of two levels of hierarchical control consisting of the instructor and the transporter. The instructor, which determines where a particular part must be delivered to, depending on its Manufacturing Work Order, instructs the AGV to begin transportation.

It should be remembered that each pallet of parts has a unique Manufacturing Work Order number associated to it whether the pallet carries one part or a number of parts. On completion of machining the operator placed the parts back on the pallet where the AGV treats them again as a part group.

3. OPERATING PROCEDURE

When Manufacturing Work Order files are generated they may be transferred to the AGV on board computer my either of two methods being, through the infra red data transmission link or by copying the from a diskette. The relevant CNC programs and CAD drawings are also transferred in this manner. On initial assessment of the Manufacturing Work Order and machine file data, the AGV controller can identify the following relevant manufacturing information,

1) Pending Jobs (i.e. jobs started, but put on hold)
2) Work In Progress (Jobs being worked on)
3) Status of each Machine (busy / idle)
4) Estimated finish time for the pallet or batch of parts

5) Where pending jobs need delivered to
6) Due date (Necessary if scheduling using EDD rule)

Once the AGV receives Manufacturing Work Order information it operates on a "stand alone" basis until its knowledge needs updating or editing. A schematic of the shop floor layout is shown in Figure 1.

When the AGV is switched to "run mode" a digital Manufacturing Work Order is selected from the AGV database. The criteria for selection of particular Manufacturing Work Order depends on the AGVs task allocation decision rules which may be shortest processing time (SPT), longest processing time (LPT), first come first serve (FCFS) earliest due date (EDD) etc.. The parts processed in the FMS are scheduled in real-time mode as opposed to off-line techniques. (See Chen *et al.*[5] for off-line planning and scheduling problems of Flexible Manufacturing Systems). When scheduling using real-time, decisions are made at the occurrence of a discrete event, which may be the completion of an operation, the failure of a machine or particular tool, the entry of a part group to the system etc.. The use of a real-time approach is a more suitable approach to a model that uses skilled operators under minimal supervision.

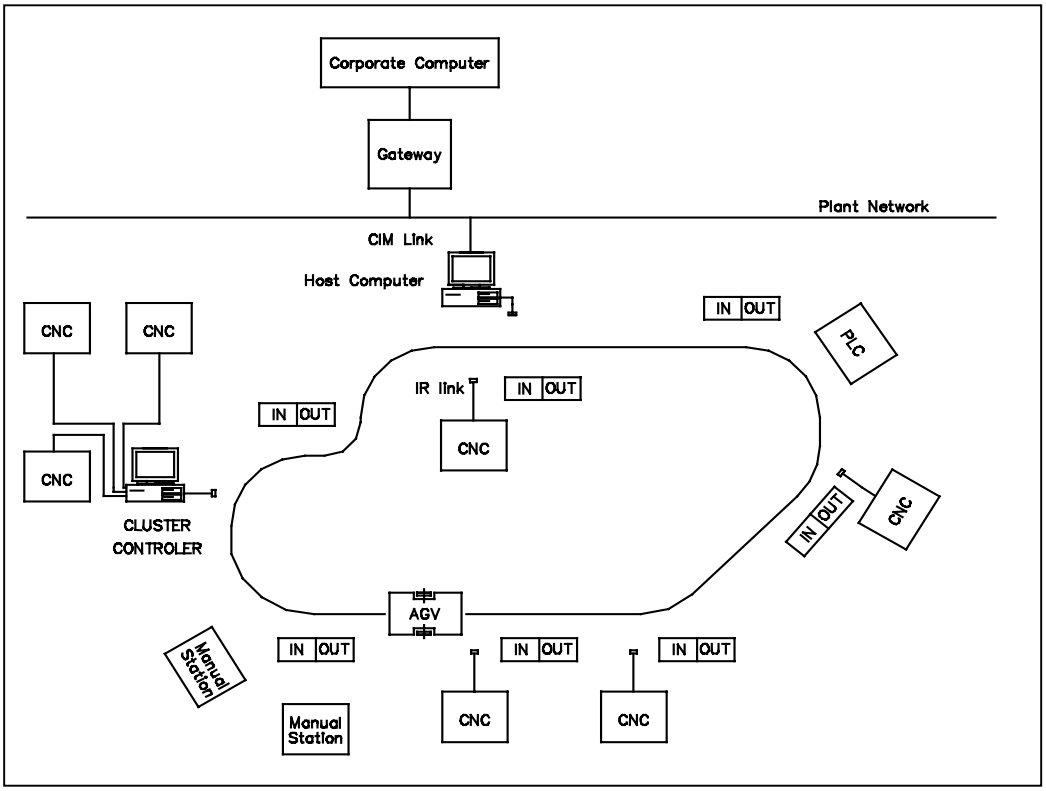

Figure 1: FMS Layout

The AGV on receiving a start instruction identifies the job contained on a pallet located at the load station of the FMS. When the job is identified the relevant Manufacturing Work Order is selected. The Manufacturing Work Order is identified by use of the bar-code on the pallet. The AGV identifies the first work station the pallet of parts is to be delivered to from the digital Manufacturing Work Order . When the pallet is delivered to the work center, the pallet is logged as being busy. The operator on completion of the work on the pallet of parts, places the pallet into the out station of the machining station. The AGV can then identify that the work has been successfully completed and re-allocate the pallet to the next required machining station.

The AGV, on identification of a pallet at the out station of a work center buffer, scans the relevant digital Manufacturing Work Order and identifies the next work station in the sequence of manufacturing operations.

As the AGV travels through the FMS, when executing a transportation function, the status of each buffer station is logged. There are four states that the AGV can identify. These being,

1. in station vacant : *allows a pallet to be assigned to the work center*
2. in station engaged : *pallet has been assigned to the work center*
3. out station vacant : *futile knowledge*
4. out station engaged : *pallet is requiring transportation and assignation to a work center*

4. Development of the Simulation model using Witness

The loading of parts/pallets into the FMS was set to be 1.75 hours (105 minutes.) between each orders release. This was achieved by generating a part release file, which released pallets into the system at the required time interval. This interval was set at 105 minutes sampling from a negative exponential distribution with a mean of 105 and a standard deviation of 10.

The initial system model comprised twenty-eight pieces of equipment distributed over eight work centres. The data represented in the tables below were taken from actual machining times retrieved from a local machine shop database [8]. The first model simulated was the representation of this machine shop using the machining times and frequencies of the five manufactured parts and also using the distances the machines are apart. The part routing and frequencies are shown in Table 6.1 below.

Table 1 Component routing and frequencies

Part No.	OP 1	OP 2	OP 3	OP 4	OP 5	OP 6	OP 7	Ops	Frequency
8S498247	1	3	4	2	5			7	0.10
8S498514	2	1	3	4	6	5		8	0.15
8S498538	2	7	4	6	4	5		6	0.50
8S498544	2	4	6	3	1	5	8	7	0.10
8S498554	5	2	6	3	4	8		6	0.15

The processing times for a particular component at a particular work centre are presented in Table 2. The expected inter-arrival time between components was 1.75 hours. A FIFO queuing discipline was assumed with no job having priority over another. The distance each machine is from its preceding machine was set between 5 and 20 meters..

Table 2: Machining times per part at each Work-Centre (Minutes)

	WORK CENTER							
Part No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
8S498247	222.0	73.0	417.0	271.0	281.0			
8S498514	222.0	73.0	208.0	271.0	292.0	445.0		
8S498538		73.0		270.0	292.0	445.0	327.0	
8S498544	222.0	73.0	417.0	271.0	281.0	445.0		
8S498554		73.0	208.0	273.0	281.0	445.0		540.0

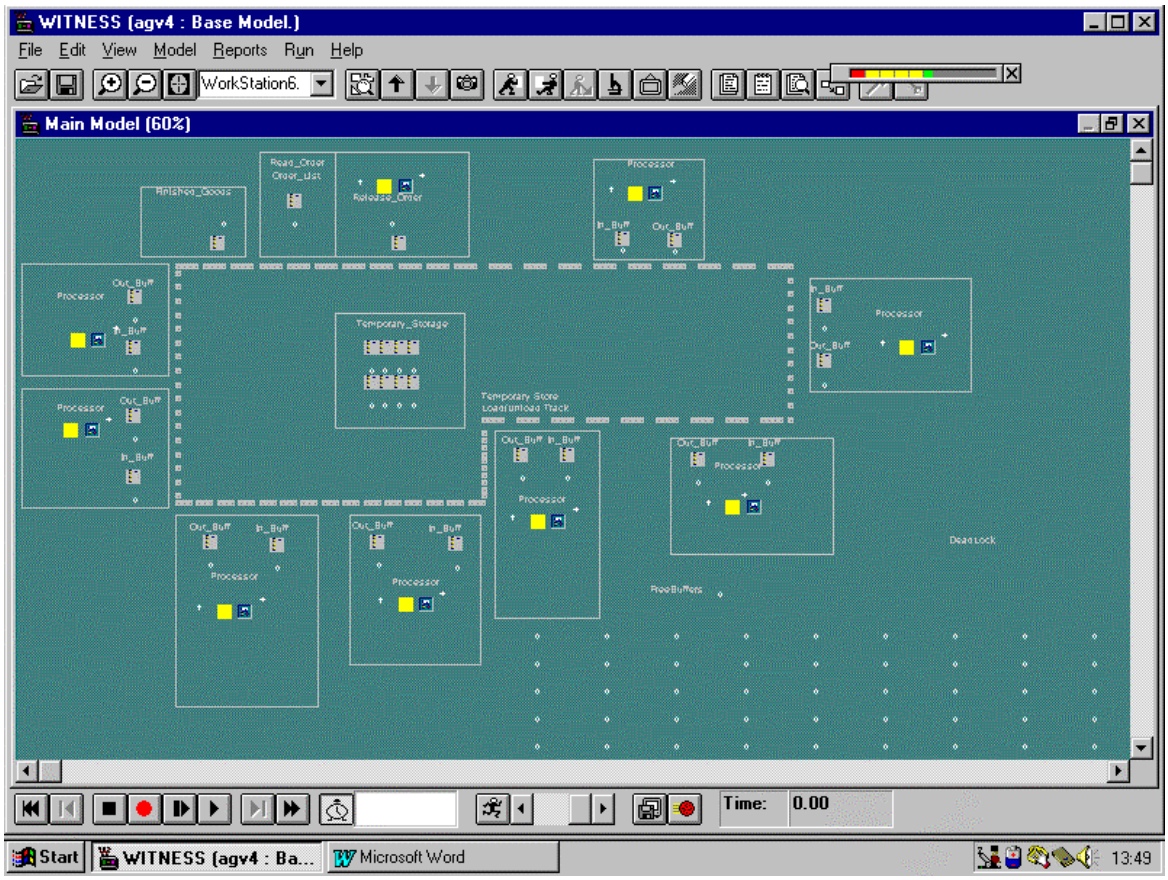

Figure 2: The modeled layout showing the temporary storage area.

Deadlock avoidance was achieved by the use of a temporary storage area. If a pallet is waiting on the *out buffer* of a work-centre and the required *in buffer* is full, the AGV moves the pallet requiring transportation to this dedicated area. Figure 2 shows the location of the temporary storage area located in the centre of the AGV track.

Each work centre has an in and out buffer which mate with the AGV during material exchange. The load time of the AGV was set to 30 seconds and the unloading time to 1 minute to accommodate any program downloads that may be requires Setup up times were modeled as a constant time per part change. That is, each time a new part type enters a work centre a setup time is associated to it prior to machining. Breakdown times were modeled from a log normal distribution with a mean time between breakdowns of 10000, with a standard deviation of 15 hours. The repair time was set to 60 minutes for each breakdown.

5. Results simulation model

It was proven from the model that using the AGV as the sole transport medium within a FMS environment could work. Table 6.4 below shows the percentage of time each work-centre and the AGV was idle, busy or blocked. The system flowed continuously without deadlocking. The model was executed 5 times using the factory data. It can be seen that there is a zero amount of backlog. This indicated that the consumption capacity of the work centres is not being exceeded by the arrival time of the production orders. Saturation occurs when there is a constant backlog of pallets queued at the release order buffer.

Table 3: Average values over five cycles

Average values over 5 cycles

	% Idle	**% Busy**	**% Blocked**
WC 1	60	35	5
WC 2	61	35	4
WC 3	31	67	2
WC 4	42.3	54	3.7
WC 5	42	54	4
WC 6	39	56	5
WC 7	46	54	0
WC 8	63	37	0

No of pallets processed:	**965**
Model run time:	**10 weeks**
Average processing time per pallet:	**920 min**
Backlog-log of orders at release order buff:	**0**

These results prove that the concept of using an AGV as the sole transport mode in an FMS is viable. The AGVs response time to demands for transportation by bidding pallets is sufficient not to cause a backlog of orders.

The main reason for success is the high machining times per pallet of parts and the relatively short distances between machines which keeps the transportation time low. The short travel time between work centres also reduces the knowledge update lag time of the AGV.

Optimisation of real life model

A screening experiment was conducted to see which factors affect the capability of the system. It was the intent of the screening experiment to identify a combination of variables where the AGV controled system deadlocks or operates in an inefficient fashion. One such combination of variables, which would cause the system to fail, would be the use of short machining times such as 10 minutes with transportation times between work centres at 2 minutes.

Using the throughput as a measure of performance is not accurate, since the average machining times for a product mix can vary significantly. For example, comparing the throughput from an experiment with average machining times set at 10 minutes against machine times of 500 minutes, would not be a accurate measure of performance. It was therefore necessary to conduct grouped experiments with the machining time fixed. This allowed throughput to be used as a performance measure.

Five variables were identified for screening as follows.

1. Travel time (load times and un-load times)
2. Machining time (Including setups)
3. Capacity of temporary storage
4. Breakdown frequency
5. Pallet arrival time

The values for throughput from Table 6.6 were analysed using SPSS software. An ANOVA was chosen for data analysis. It was concluded from the results of the ANOVA that there are two factors that are statistically significant, i.e. they have the greatest influence on the throughput. These factors are machine time and travel time. A full factorial array was developed for these variables at three levels. It was also noted that reducing the pallet arrival time significantly, below the average machining time, starved the system of product. This resulted in reduced throughput and lower machine efficiency. Increasing the pallet arrival time saturated the system, with product queuing at the release order buffer. This resulted in higher machine efficiency but at the expense of increased WIP reducing the overall average pallet throughput time.

Summary of results

Two simulation experiments were conducted. Firstly a model was developed replicating a real system which is currently operational. Real data including machining times, part routes, part arrival time and part frequency was used.

The model was executed for a run time to simulate 10 weeks production. The average processing time per pallet of parts was 920 minutes. The AGV response time to transportation function was sufficient as not to cause the system to deadlock or to create an unrecoverable backlog of parts.

The second simulation experiment involved identifying the factors in the system which if changed would contribute to the effectiveness or ineffectiveness of the system. This was achieved by running the experiment at different levels and analysing the output. It was noticed that machining time and transportation time had the greatest effect.

6. CONCLUSION

With the AGV controller operating on a "stand alone" basis with Manufacturing Work Order on board, allows greater maneuverability of the system, for example the FMS control hardware and software could be relocated in a different section of the plant to accommodate seasonal demands.

This system offers the advantage of the ability of operators to interact with the AGV without upsetting its actions. The problem of conflict between the two controllers, the AGV controller and the host computer, can be prevented by the use of *in and out buffers* at each work center. The FMS host computer could be linked to a central database for use as a Shop Floor Data Collection System while also acting as the host for the FMS, with machining times at each work station being logged by the AGV and by the host computer.

The solution described of integrating operators with the single AGV would also be similar to that of a FMS containing more than one AGV. The AGVs, communicating through a infrared data link , could be updated of the others actions.

Should it be desired to add more machines to the system, the software changes necessary are minimal. It is not necessary to shut down the system to adopt these changes of implementing extra machines. A new machine file need only be generated off line, listing the machines binary address and its machining capabilities, and copied into the host controller database. When a machine is being removed from the manufacturing system, the machine file is simply moved from the working directory of the host controller to a temporary directory to prevent the machine file being selected as a destination for future task allocation.

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Towards a Study of Situation Types of Irish

By Brian Nolan,

School of Informatics and Engineering. ITB Blanchardstown, Dublin, Ireland

1 Introduction

In this paper we analyse the structure of situation types as found in Irish. We translate these situation types into a logical metalanguage, giving the logical structure of each type. We do this to differentiate, for Irish, the aktionsarten distinctions of state, activity, achievement and accomplishment as they are found within the language.

The motivation of this paper is therefore to describe the aktionsart of modern Irish and to determine the logical structure that underpins these situation types. Undertaking an analysis of situation types in terms of logical structure will enable us to provide a suitable treatment of important language phenomena including:

a) Differentiating between the copula and the substantive verb, while focusing on the substantive.
b) Capturing the use of prepositions with state and location.
c) Differentiating between the predications of verb and verbal adjective.
d) Finding the means by which possession, as against ownership, may be recorded as a state or property.
e) Understanding the use and deployment of the verbal noun.
f) Differentiating between perfectivity and imperfectivity in activities.
g) Finding a suitable means by which we treat code mass nouns, sufficient to our purposes in analysing the telic/atelic aktionsart properties in relation to Irish. The compositional blend of mass noun and verb in the construction effectively delivers the appropriate aktionsarten reading. Any solution to this must therefore make reference to the inner structure of these mass nouns. We therefore need some means of recording the structural properties of nouns, whether count or mass. Logical structure representation assists with this.

We start with a brief clarification of some terminology that will be used within the analysis. We follow this with a brief description of various diagnostic tests useful in determining the particular aktionsart classification in different sentences and situations. We examine in turn the aktionsart distinctions of state, activity, accomplishment and achievement. We explore the influence of durative, manner, pace and point adverbials on the interpretation of aktionsart situation types along with the role played by prepositions, verbal adjectives and verbal nouns.

2 The Four Basic Aktionsarten Distinctions

The distinctions in aktionsart were originally proposed by Vendler (1967) in which he argued that verbs, and other predicating elements, could be classified in terms of their inherent temporal properties. Vendler proposed four basic classes: states, achievements, accomplishments and activities. The four Vendler classes can be defined in terms of whether the action denoted by the verb in the clause is static or not, punctual or not, and telic or not. The distribution of these qualities over the aktionsart classes is indicated following.

(1)

State	static	non-telic	non-punctual
Activity	non-static	non-telic	non-punctual
Accomplishment	non-static	telic	non-punctual
Achievement	non-static	telic	punctual

States are static non-dynamic situations involving the location, state or condition of a participant, or an external experience of a participant. These states are characterised by having no inherent terminating point. Activities or actions are defined as dynamic states of affairs in which a participant does something. An action is inherently unbounded. Accomplishments are states of affairs that involve a bounded process of change that takes place over time. Typically these encode a change of location, state, condition, or internal experience of a participant. These accomplishment processes have an inherent termination point. Achievements are states of affairs which seem to happen instantaneously, being conceptualised as immediate events. This category is inchoative in nature, and has an inherent termination point. Telicity has to do with whether a verb depicts an activity of some kind with an inherent termination point, or not. States and activities lack inherent terminal points and are therefore atelic, or non-telic. Punctuality distinguishes telic events with internal duration from those that lack it.

The four basic aktionsarten distinctions can be represented in logical structures according to the table below. Following convention, predicates are presented in **bold** typface followed by a prime, whereas variable elements are presented in normal typeface. The elements in bold+prime (**pred'**) are part of the vocabulary of the metalanguage used in semantic decomposition.

(2)

Verb Class	**Logical Structure**
State	**predicate'** (x) or (x,y)
Activity	**do'** (x, [**predicate** (x) or (x, y)])
Achievement	INGR **predicate'** (x) or (x,y)
Accomplishment	BECOME **predicate'** (x) or (x,y)

3 Tests on the Aktionsart Type of a Verb

How do we know what is the aktionsart type of a verb? The literature suggests a number of diagnostics (Vendler 1967, Dowty 1979, Pustejovsky 1995). For our purposes we may adopt a series of tests based on those identified in VanValin & LaPolla (1997:94*ff*) and summarised in the table below.

Diagnostic	***States***	***Achievement***	***Accomplishment***	***Activities***
1. Occurs with progressive *Tá* X_{NP} *ag* Y_{VN} "X is Y-ing"			**yes**	**yes**
2. Occurs with dynamic action adverbs like *go bríomhar*, "vigorously", etc.				**yes**
3. Occurs with manner and pace adverbs like *go tapadh* "quickly", *go mall* "slowly", etc.			**yes**	**yes**
4. Occurs with durative adverbials such as *ar feadh* __ "for __"	**yes**		n/a (yes)	**yes**
5. Occurs with frame adverbials such as *i* __ "in __"			**yes**	
6. Occurs with adverbials such as *ionann* "almost", *dóbair* "nearly"		**yes**	**yes**	**yes**

In general, these states of affairs (state, achievement, accomplishment and activity) differ with respect to issues such as: how many participants are involved, whether there is a terminal point, and whether the state of affairs is spontaneous or caused. The important issue of termination point relates to whether a state of affairs describing an activity of some kind inherently comes to a conclusion. An inherent termination point is to be found with the verbal action denoted by *ag tirimú* "drying" while that denoted by *ag casadh* "turning" does not. Achievement events have an inherent termination point. It is, however, possible for an otherwise discrete achievement event to occur in an iterative manner and, in this context, the continuous occurrence will not have a coded termination point. States do not have an inherent termination point in that there is nothing in the nature of being, say, *ar an mbord* "on a table" that implies that these situations will terminate. An activity or action is also inherently unbounded while accomplishment processes do have an inherent termination point. We can summarise these as:

Aktionsart	*Quality*	*Termination coding*
state	static, non dynamic	no inherent termination point
achievement event	happen instantly	inherent termination point
accomplishment process	involve change over time	inherent termination point
activity/action	dynamic, participant does something	no inherent termination point

1.4 States

States are static non-dynamic situations involving the location, state, condition, or external experience of a participant, characterised by having no inherent terminating point. In Irish, states are primarily recorded by use of the verb "to be". Irish, however, has two verbs of "to be" – the copula and the substantive. An Irish speaker will use the copula for classification, identification, and expression of ownership with the preposition *le* "with", or to indicate an emphasis. Ownership in Irish is expressed somewhat differently from possession. Expression of possession makes use of the substantive verb. The expression of ownership involves the use of the copula together with the preposition *le* "with. We use a different metalanguage operator in the logical structure representation for the copula as against that used for the substantive verb. This allows us to simply differentiate in logical structure between these two verbs of "to be". An example of the underlying logical structure of a copula sentence is shown in (3), with (4) indicating a substantive verb example. Another important difference between the two verbs of "to be" is that the copula indicates a permanent state, whereas the substantive indicates a more transitory or temporary condition. Example (4) denotes the state as a location.

(3) *Is le Tara an leabhair*
is:COP-PRES with:PP Tara:N the:DET book:N
Tara owns the book.

is'(an leabhair, [**le'**(Tara)])
is'(x, [**le'**(y)])

(11) *Tá an leabhair ar an mbord*
is:SUBV the: DET book:N on:PP the: DET table:N
The book is on the table.

be'(an leabhair, [**ar'**(an mbord)])
be'(*x*, [**ar'**(*y*)])

The expression of a state as a position, as against state as a location, is described by use of the preposition *le* "with":

(5) *Tá Aisling le Oisín*
is:SUBV Aisling:N with:PP Oisín:N
Aisling is with Óisin

be'(Aisling, [**le'**(Oisín)])
be'(x, [**le'**(y)])

Many sentences in Irish use a verbal adjective form to denote the coding of a state or condition. This verbal adjective bears a strong relationship to the nature of the verbal action from which it originates, i.e. *an fuinneog briste* "the broken window". It is a feature of Irish that all verbs have a verbal adjective or a nominal modifier form. We record these in logical structure by use of the template **be'**(x_1,[**pred'**(x_1)]). The only exception to verbs having a verbal adjective in this way are the verbs of "to be", the copula and substantive. The verbal adjective will always be coded in the second or rightmost variable slot within the **be'** operator. We can therefore appeal to the generalisation as we require.

State

(6) *Tá Maire tuirseach*
is:SUBV-PRES Maire:N tired:ADJ
Maire is tired.

be' (Maire, [**tuirseach'**(Maire)])
be' (x, [**tuirseach'**(x)])

We can note that the template **be'**(x_1, [**pred'**(x_1)]) gramaticalises the **pred'** in this construction to a verbal adjective. Both variables must be co-indexed and elaborated by the same entity instance.

Condition

(7) *Tá an fuinneog briste*
is:SUBV-PRES the: DET window:N broken:VA
The window is broken.

be'(an fuinneog, [**bris'**(an fuinneog)])
be'(x, [**bris'**(x)])

This representation captures the verbal adjective. We can therefore expect to find this generalisation, using this underlying template, whenever a verbal adjective is used within Irish.

4.1 Possession as a State or Property

At this point we need to address the issue of how we record possession as a state or property, as against ownership, in logical structure. We have seen that the substantive verb is used with a preposition such as *ar* "on" to express the location and used with the coding of states. To indicate possession, the preposition *ag* "at" is used. Examples (8 and 9) illustrate. We use (**P$_{time}$**) to represent some appropriate point on the time line, known to the speaker and hearer.

State as Location

(8) *Bhí an ríomhaire **ar** an tábla*
is:SUB-PAST the: DET computer:N on:PP the: DET table:N
The computer was on the table.

be' (an ríomhaire, [**ar'**(an bord)])
be' (x, [**ar'**(y)])

State as Possession

(9) Bhí cupla carr **ag** Séan an úd
is:SUBV-PAST couple:ADJ cars:N at:PP Seán:N the:DET time:N
Sean had a couple of cars at that time.

an_úd'(**P$_{time}$**, **be'**(cupla carr, [**ag'**(Séan)])
an_úd'(**P$_{time}$**, **be'**(x, [**ag'**(y)])

We have already noted that the substantive verb is used to express existence, position, state or condition. The example sentence in (10) treats the possessive state as a location to "be in", that state being possessed by the indexed 3rd singular male actor. An additional difficulty we need to deal with next is how do we record possession in logical structure while retaining the generalisations found with the substantive construction using prepositional phrases (PPs) and state/locations. We have already encountered ownership in the copula construction. Possession is differentiated from ownership, with ownership being considered as more permanent a property, hence the copula usage (11). Our representation captures this.

Substantive use for possession

(10) *Tá sé ina fhear*
is:SUBV-PRES him:PN in:PP+his:PN man:N
He is a man.

be'(sé$_1$, [**in'(**[**a'(**[**fear'**(sé$_1$)])])])
be'(x$_1$, [**in'(**[**a'(**[**pred'**(x$_1$)])])])

Copula use for ownership

(11) *Is* *fear* *é*
is:COP-PRES man:N him:PN
He is a man.

is' ($é_1$, [**fear'**($é_1$)])
is' (x_1, [**fear'**(x_1)])

5 Activities

Activities or actions are defined as dynamic states of affairs in which a participant does something. An action is inherently unbounded. An activity does not encode any information relating to a start or end state. Activities are usually denoted in Irish through the use of the verbal noun. These are the means by which progressive activities are recorded in the language. The example in (12) makes use of the substantive verb and progressive form. The progressive which takes the form of a verbal noun is introduced by its canonical marker, the preposition *ag* "at". The progressive allows for change to be recorded on the actor who is engaged in the action.

(12) *Tá* *Sadhbh* *ag* *canadh*
is:SUBV-PRES Sadhbh:N at:PP singing:VN
Sadhbh is singing.

do'(Sadhbh, [**be'**(Sadhbh, [**ag'**[**canadh'**(Sadhbh, 0)]])])
do'(x, [**be'**(x, [**ag'**[**canadh'** (x, 0)]])])

An issue presents itself here. How do we differentiate in logical structure between perfectivity (12) and imperfectivity (13) in activities, for Irish? From the examples in (12, 13), it is clear that the essence is captured in the following logical structure templates, indicated in (14) and (15).

(13). *Canann* *Sadhbh*
sing:V-PRES Sadhbh:N
Sadhbh sings

do'(Sadhbh, [**canann'**(Sadhbh, 0)])
do'(x, [**canann'** (x, 0)])

(14) perfective

do'(x, **be'**(…, [**ag'** (**pred'** (x)]))

(15). imperfective

do'(x, [**pred'**(x)])

Progressives encode perfectivity. A perfective process portrays a situation as changing through time. Example (12) above records the recognition of being in the state/condition of *being in a situation that is changing through time*. This is an important characteristic of Irish and is diagnostic of the use of prepositions with states in the language. Evidence for this can be taken from the fact that the verbal noun in Irish is atemporal and preceded by the preposition *ag* "at", i.e., it is a verbal process converted into a nominal. The required tense and agreement of the activity is recorded directly on the substantive verb as the verbal noun, as a nominal cannot encode this information. The substantive verb can encode all tenses, including the present tense, in this perfective construction. Some languages, for instance English, do not allow the use of the perfective in simple present tense (Langacker 1991:85). Irish allows the use of the present tense in a progressive construction encoding perfectivity with the particular stative quality noted above. [A detailed discussion of the perfect in modern Irish is to be found in O Sé (1992) and Green (1979)].

Imperfectives, on the other hand, are to be found in the simple present, but not with the progressive. An imperfective process describes the extension through time of a stable situation. Imperfectives therefore describe the continuation through time of a static configuration. A similarity between the perfective/imperfective (active/static) contrast for verbs and the count/mass distinction for nouns has been observed (Langacker 1991b, Mourelatos 1981). Langacker records this similarity as follows:

(16) Imperfective and Perfective processes (adapted from Langacker (1991:87)

> The component states of an imperfective process are construed as all being effectively identical. An imperfective process is indefinitely expansible or contractible in that any series of component states is itself a valid instance of the category.
> A perfective process is specifically bounded in time within the scope of predication. Replicability (repetitive aspect) is possible for perfective processes.

(17) Mass and Count nouns (adapted from Langacker (1991:87)

> The region profiled by a mass noun is construed as being internally homogenous. A mass is indefinitely expansible or contractible in that any subpart is itself a valid instance of itself. The region profiled by a count noun is specifically bounded within the scope of predication in its primary domain. Replicability (pluralisation) is possible for count nouns.

In example (13) we do not specify what Sadhbh was actually singing, but use "0" as a macrorole placeholder in logical structure to indicate that an argument could be included here. This indicates that this verb is a two-place predicate. Example (18) is a one-place predicate with only one macrorole and, as such, does not have a y argument in its logical structure. Example (20) is again a two place predicate with two macroroles and, in this instance, with both the x and y arguments elaborated.

(18) *Tá mé ag rith*
is:SUBV-PRES I:PN at:PP running:VN
I am running.

do'(mé , **be'**(mé, [**ag'(**[**rith'**(mé)])]))
do'(x, **be'**(x, [**ag'(**[**rith'**(x)])]))

(19) *Tá Eamonn ag ól*
is:SUBV-PRES Eamonn:N at:PP drinking:VN
Eamonn is drinking beer.

do'(Eamonn, **be'**(Eamonn, [**ag'(**[**ól'**(Eamonn, 0)])]))
do'(x, **be'**(x, [**ag'(**[**ól'**(x, 0)])]))

In example (20) we indicate that "Eamonn is drinking beer" and record this in logical structure with the appropriate variables. The nominal *beoir* "beer" is recorded as the undergoer of the action. We can contrast this with the prior example and its coding of this variable position with a "0", indicating the absence of an undergoer. In regard to example (20), *beoir* "beer" is a mass noun in undergoer position which mandates an aktionsarten interpretation of activity. We will discuss this phenomenon relating to mass nouns more fully when we addressed the logical structure of accomplishments, in the next section.

(20) *Tá Eamonn ag ól beoir*
is:SUBV-PRES Eamonn:N at:PP drinking:VN beer:N
Eamonn is drinking beer.

do'(Eamonn, **be'**(Eamonn, [**ag'(**[**ól'**(Eamonn, beoir)])]))
do'(x, **be'**(x, [**ag'(**[**ól'**(x, y)])]))

We have addressed the logical structure underlying the event structure of activities of Irish. In the next section we turn our attention to the aktionsart of accomplishments.

6 Accomplishments

Accomplishments are states of affairs involving a bounded process of change that takes place over time. Typically these encode a change of location, state, condition, or internal experience of a participant. These accomplishment processes have an inherent termination point. We have seen from the previous section on activities that examples, such as the sentence in (21) below, denote an activity, in this instance, of indefinite length. The activity in (21) with the one place predicate verb *siúil* "walk" has no temporal durative termination. In (22) it is shown with a clear logical termination (i.e. *go dtí an siopa* "to the shop") and receives an aktionsart interpretation of accomplishment.

Activity

(21) *Siúlann* *Aisling*
walk:V-PRES Aisling:N
Aisling walks.

do'(Aisling, [**Siúlann'**(Aisling)])
do'(x, [**siúl'**(x)])

Accomplishment

(22) *Siúlann* *Aisling* *go* *dtí* *an* *siopa*
walk:V-PRES Aisling:N to:PP until:PP the:DET shop:N
Aisling walks to the shop.

do'(Aisling, [**Siúlann'**(Aisling)]) & [BECOME **be'**(Aisling, [**go dtí'**(an siopa)])]
do'(x, [**Siúlann'**(x)]) & [BECOME **be'**(x, [**go dtí'**(y)])]

The logical structure fragment … & [BECOME **be'**(Aisling, [**go dtí'**(an siopa)])] encodes the logical termination point of the activity and indicates that the appropriate aktionsarten reading is that of an accomplishment. Its logical structure representation illustrates the logical termination endpoint of the activity thereby allowing for an accomplishment aktionsart interpretation.

In contrast to a logical termination point, a temporal durative termination point is coded in Irish by use of durative adverbs. Durative adverb phrases frequently include a spatial preposition and are used to encode a definite and specific time duration into an event frame, after which time the action terminates. Such durative adverbs would be considered complex in their prepositional use and encode the sense of "on+until". The durative adverbial *ar feadh* "on+until" codes extent in time. Interestingly, extent in space can also be coded with this construction.

(23) *Ritheann Tara ar feadh uair*
run:V-PRES Tara:N on:PP until:PP hour:N
Tara runs for an hour.

ar'([**feadh'**(uair)], **do'**(Tara, [**ritheann'**(Tara)]))
ar'([**feadh'**($\mathbf{t_{extent\_in\_time}}$)], **do'**(x, [**ritheann'**(x)]))

We can see that this codes into the event frame both an *extent in time* coupled with a *termination trigger* on the action. In this specific instance, the trigger is a time related termination trigger coding extent in time. We find something similar with example (24) but here the trigger is distance related and denoting *extent in space*.

(24) *Rith Sorcha ar feadh dhá mile*
run:V-PAST Sorcha:N on:PP until:PP two:NUM mile:N
Tara ran for two miles.

ar'([**feadh'**(dá mile)], (**do'**(Sorcha, [**rith'**(Sorcha)]))
ar'([**feadh'** ($\mathbf{d_{extent\_in\_space}}$)], (**do'**(x, [**rith'**(x)])))

An adverb of position can additionally be utilised by the Irish speaker to indicate a termination on an otherwise unbounded activity.

(25) *Rith sí istigh*
run:V-PAST she:PN inside:ADV
She ran inside.

do'(sí, [**rith'**(sí)]) & [BECOME **be'**(sí, [**istigh'**(sí)])]
do'(x, [**rith'** (x)]) & [BECOME **be'**(x, [**istigh'** (x)])]

The action terminates under an accomplishment interpretation once *istigh* "inside" is reached.

6.1 Mass Nominals

Nominals (Pustejovsky 1995) are held to have internal structure that can be described under a number of headings, which, taken together uniquely described the entity denoted, what it is made of, the type of role(s) and behaviour that it can expect to exhibit. This is the basis of qualia theory. The headings used to capture this information are: constitutive, formal, telic, and agentive. The manner in which they relate together is indicated in (26).

(26) *Qualia theory*

a. *Constitutive role*:	The relation between an object and its constitients, or proper parts.
1.	material
2.	weight
3.	parts and components
b. *Formal role*:	that which distinguishes the object within a larger domain
1.	orientation
2.	magnitude
3.	shape
4.	dimensionality
5.	colour
6.	position
c. *Telic role*:	purpose and function of the object
1.	purpose that an agent has in performing an act
2.	built-in function or aim that specifies certain activities
d. *Agentive role*:	factors involved in the origin or "bringing about" of an object
1.	creator
2.	artifact
3.	natural kind
4.	causal chain

The theory requires that the lexical entry for a noun contain a set of qualia $\{Q_C, Q_F, Q_T, Q_A\}$, which represent its primary semantic properties, much like a logical structure represents the semantic properties of a verb. We get a complete semantic representation for a clause when we combine the two, as in example (27).

(27) a. *Oscail an doras* "The door opened".

b BECOME (**oscail'**(**an doras'**(x), $\{Q_C, Q_F, Q_T, Q_A\}$))

We will let M represent the sort or type of a mass nominal, such as *uisce* "water" or *beoir* "beer". For purposes of this example we will let U represent the particular mass nominal *uisce*. We will allow x and y to represent portions of *uisce*. For the constitutive role of *uisce* "water" we might therefore have the following:

(28) Constitutive: ***uisce*** $(x) \wedge U.M \wedge (x \subseteq U) \wedge (y \subseteq U) \wedge (x.U \equiv y.U)$

$\bullet\ (x \subseteq y) \vee (y \subseteq x) \wedge (\,|\, x.U \,|\, < \geq \,|\, y.U \,|\,)$

We can read this as follows. We represent *uisce* "water" by the symbol U, a mass noun of type M. Both x and y are portions of *uisce* "water" U and are therefore the same substance. The portion x may be subsumed in y or the portion y may be subsumed in x. The cardinality or amount of portion x can be less than, greater than, or equal to the amount of portion y. For the telic role we might have:

(29) Telic: **be'**($|x| \geq 1$) & **do'**(actor, [**pred'**(actor, x) & [BECOME **be'**($|x| = 0$)]

The telic role can be understood to mean that 1) a pre-state exists with respect to x such that the amount/cardinality of x is non-zero; 2) some activity predicate characterised by [**do'**(actor, **pred'**[actor, x) operates on x.; 3) a result of the action of the previously mentioned predicate is that the amount of x is now equal to zero.

(30) *D'ól* *Eamonn* *an* *uisce*
PVP+drink:V-PAST Eamonn:N the:DET water:N
Eamonn drank the water

do'(Eamonn, [**ól'**(Eamonn, (uisce(x), {Q_c, Q_f, Q_t, Q_a}))])
& [BECOME **be'**(uisce(x), {Q_c, Q_f, Q_t, Q_a})]

This is then interpreted in aktionsart as telic and as an accomplishment.

Example (31) uses the solution suggested by VanValin & LaPolla (1997) to this problem of mass vs. count nouns in informing the interpretation of event structure. That is, they appeal to the category of the verb under discussion (see Levin 1993 for discussion of verb categorisation for English), and use this category as a means of denoting the endpoint termination trigger. In this example, the verb *ith* "eat" is a verb of consumption and therefore, the endpoint trigger for the termination of the action is represented by the logical operators BECOME **consumed'(y)**. The activity reading does not have these logical operators in its representation. This then is how such utterances are differentiated in logical structure in this framework. We can illustrate the accomplishment/activity readings with the following example pairs.

Accomplishment

(31) *D'ith* *sé* *pláta* *spaigiti* *i* *deich* *nóiméad*
PVP+eat:V-PAST he:PN plate:N spaghetti:N in:PP ten:NUM minutes:N
He ate a plate of spaghetti in ten minutes.

i'(deich nomaid, [**do'**(sé, [**ith'**(sé, pláta spaigiti)]
& BECOME **consumed'**(pláta spaigiti))])
i'(t, [**do'**(x, [**ith'** (x, y)] & BECOME **consumed'**(y))])

Activity

(32) *D'ith sé spaigiti ar feadh deich nóiméad*
PVP+eat:V-PAST he:PN spaghetti:N on:PP until:ADV ten:NUM minutes:N
He ate spaghetti for ten minutes.

ar'(feadh'(deich nomaid, [**do'**(sé, [**ith'** (sé, spaigiti)])]))
ar'(feadh'(deich nomaid, [**do'**(x, [**ith'** (x, y)])]))

Accomplishment

(33) *D'ól sé an beoir in uair*
PVP+drink:V-PAST he:PN the:DET beer:N in:PP hour:N
He drank the beer in an hour.

in'(uair, [**do'**(sé, [**ól'**(sé, an beoir)]) & [BECOME **consumed'**(an beoir)]])
in'(uair, [**do'**(x, [**drink'**(x, y)]) & [BECOME **consumed'**(y)]])

Activity

(34) *D'ól sé beoir ar feadh uair*
PVP+drink:V-PAST he:PN beer:N on:PP until:ADV hour:N
He drank beer for an hour.

ar'(feadh'(uair, [**do'**(sé, [**ól'**(sé, beoir)])]))
ar'(feadh'(uair, [**do'**(x, [**ól'**(x, y)])]))

These accomplishment examples clearly appeal to the verb category i.e verbs of consumption, as a means to allow logical structure to represent telicity via BECOME **consumed'**(x). In languages such as English, the use of the definite article is often used as a diagnostic of whether a nominal is a mass or count noun. This is somewhat more complex with regard to Irish owing to the simple fact that Irish does not have an explicit indefinite article. The definite article is *an* "the" (singular) and *na* "the" (plural). Absence of the definite article to the left of noun implies that the noun is indefinite by default. The influence of quantised (count) vs. non quantised (mass) participants on the aktionsarten (where quantised → telic and non-quantised → atelic) provides evidence for Irish, as indeed for other languages, that a compositional approach to aktionsart is necessary. This becomes clear from our examination of the semantic representation in logical structure. Of importance to us is the fact that the participant must be overt, explicitly recorded, and elaborated in the logical structure as a macrorole variable. It is only when that macrorole variable in logical structure is elaborated that it is available for interpretation for aktionsart in event structure. This then is an indication that valency is a factor of no small importance in understanding event structure.

7 Achievements

Achievements seem to happen instantaneously, being conceptualised as immediate events. This category is inchoative in nature, and has an inherent termination point. Frequently we see an alternation between causative and achievement.

Achievement

(35) *Bhris an gloine*
broke:V-PAST the:DET glass:N
The glass broke.

INGR **bris'**(an gloine)
INGR **bris'** (x)

Causative

(36) *Bhris Caoimhín an gloine*
broke:V-PAST Kevin:N the:DET glass:N
Kevin broke the glass.

do'(Caoimhín, 0) & CAUSE [INGR **bris'**(an gloine)]
do'(x, 0) & CAUSE [INGR **bris'**(y)]

Achievement verbs can be given an iterative aktionsart by the use of an adverbial qualifier with a scope over the whole utterance indicating that the whole action is repeated upon the occurrence of the event trigger. In the example below the trigger for the continuous repetition of the (causative) achievement action is *gach oiche* "every night".

(37) *Chuir Caoimhín an madra amach gach oiche*
put:V-PAST Caoimhín:N the:DET dog:N out:ADV every:ADV night:N
Kevin put the dog out every night.

gach'(oiche, [**do'**(Caoimhín, [**cuir**(Caoimhín, an madra)
& CAUSE [INGR **amach'**(an madra)]])])
gach'($\mathbf{t_{iterate}}$, [**do'**(x, [**cuir**(x, y) & CAUSE [INGR **amach'**(y)]])])

8 Summary

In this study of the situation types we explored the logical structure underlying the aktionsart classifications of Irish. We looked at states, activities, accomplishments and achievements. For states, we differentiated between the copula and the substantive verb by use a separate operator. The widespread use of the preposition & state/location in logical structure was explicitly captured and this revealed a number of useful generalisations. We also differentiated between the predications of verb and verbal adjective in logical structure and identified the underlying lexicalisation pattern. We discussed the state of possession (with the substantive verb), as against ownership (with the copula) and recorded both in logical structure.

The verbal noun plays a large part in Irish constructions and the logical structure representation underlying this was revealed as: **be'**(x, [**ag'** (**v**'(x))]). When we had uncovered the logical structure of the verbal noun, and therefore the progressive, we used this to describe the difference between perfectivity and imperfectivity in activities. The fragment for perfectives is: **do'**(x, **be'**(…, [**ag'** (**pred'** (x)])), as against **do'**(x, [**pred'**(x)]) for imperfectives. We identified two means by which a mass noun may be coded in logical structure in composition with the matrix verb of the construction so as to deliver the appropriate aktionsarten reading. The first utilised qualia theory and the second appealed to the verb category. In this paper, we represented each of the aktionsart classes in a logical structure. A by-product of using a metalanguage involving logical structure to describe these situation types is that the generalisations underpinning these constructions become visible to inspection, as we have seen.

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XML for Business to Business Data Exchange

By Geraldine Gray & David Kerwick,
School of Informatics and Engineering, ITB Blanchardstown, Dublin, Ireland

Abstract

This paper examines to use of XML for business to business data exchange. Starting with creating an XML document from an existing data source and transmitting that document, we explain some of the supporting standards for XML which facilitate automated processing and transformation of an XML document. Finally we look at the advantages of using XML, and why it is expected to revolutionise electronic data interchange.

Introduction to XML

The Extensible Markup Language (XML), which is a subset of SGML[7], was developed by the World Wide Web Consortium (W3C) to provide a freely available, widely transportable methodology for controlled data interchange. XML was designed principally for the exchange of information in the form of computer documents over the Internet.[4], [7]. An XML document contains data, and tags which describe that data. The tags are syntactically similar to HTML tags, however unlike HTML, XML tags are not pre-defined. When creating a document, you decide what tags are required in a document, and what each tag will be called. This allows an XML document structure to mirror the equivalent business documents. Figure 1: XML Document.

```
<? XML version="1.0"  ?>
<!DOCTYPE prescription SYSTEM "prescription.dtd">
 <prescription>
        <date> 14th May 1999 </date>
        <doctor>
                <name> Joe Bloggs </name>
                <address> Dublin 1 </address>
        </doctor>
        <medication>
                <product> Elicon 250g</ product >
                <quantity>  1 </quantity>
        </medication>
</prescription>
```

Figure 1: XML Document - medical prescription

[7] HTML, the language currently used to create web pages, is also a subset of SGML.

XML is very strict in regards to how it is formed, The following rules dictate the composition of a syntactically correct XML document [3] :

- The document must be surrounded by a single outermost root element or document.
- As with HTML, a start tag can have attributes, however no attribute can appear more than once in the same start-tag.
- Tags must be properly nested and all tags must have matching pairs.
- An XML document can make reference to constant declarations, called parameter entities. These must be declared before they can be used.
- You can also use binary entities to reference images or files, provided you have declared them as **entity** or **entities**. They cannot be referenced in the content.
- All entities, elements, and attributes are case sensitive.
- String attribute values cannot contain references to external resources.

The XML family of standards

The XML standard itself is quite simple. There is however a family of standards supporting XML, some not yet available, which are complex, and cover a range of IT disciplines [1] . This paper will cover some of these standards, and where they fit in a business to business data interchange solution.

Creating an XML document

The first step in data interchange is to extract the data from an existing data source, be it RDBMS, legacy system or flat files, and use it to populate an XML document. This step can be implemented in a range of development environments. Each data item would be read from source, wrapped in the appropriate tag and outputted to a text file creating the XML document.

Alternatively, this step may involve converting an existing EDI message into an XML document. XML Solutions Corporation have developed a suit of software to convert from the X12 standard to XML and are currently developing software to convert EDIFACT messages to XML [10]

Defining the document content

To automate the processing of an XML document, it must conform to some pre-determined structure. There are two methods for defining the content of an XML document, using a DTD (Document Type Declaration) or using an XML schema.

A DTD, which can be embedded in the XML document, or created separately and referenced in the XML document, imposes a structure on an XML document by defining:

- the tags that are to be included in the document,
- whether a tag is mandatory or optional,
- which tags will be embedded in other tags,
- the tags that can be repeated in the document, and
- what data elements will be enclosed in each tag.

Trading partners would agree on the structure of the DTD. All transmitted XML documents would then conform to the DTD structure. An XML parser (discussed in section 2.5.1 below) can validate the XML document against the DTD to ensure it contains the correct information. Figure 2 DTD.

```
<?xml version="1.0"?>
<!DOCTYPE prescription [
<!ELEMENT date(#PCDATA)>
<!ELEMENT doctor(name,address)>
  <!ELEMENT name (#PCDATA)>
  <!ELEMENT address(#PCDATA)>
<!ELEMENT medication(product,quantity)>
  <!ELEMENT product (#PCDATA)>
  <!ELEMENT quantity(#PCDATA)>
]>
```

Figure 2 DTD.

This DTD specifies that a prescription tag must contain a date, doctor and medication tag. A doctor tag must enclose a name and address tag. The medication tag must contain product and quantity tags. Name, address, product and quantity tags contain character data.

DTD can also inherit a definition from another other DTD. So you can define each entity required by an application, and then import these definitions (external entities) into the Document Type Declaration. This allows for code reuse, and easy maintenance of the entity definitions.

DTDs are the official W3C standard for enforcing the structure of an XML document, however DTDs have the following limitations:

- A limited set of pre-definined data types
- DTD is a separate language from XML, and so involves an additional learning curve.

An alternative to using a DTD is to use an XML schema, which is written in XML syntax. A schema encompases the same functionality as a DTD, but has a richer set of data types, and has additional features including the ability to represent relationships between data elements. The W3C standard for schemas is not yet complete, however they are gaining increasing support in the industry [2], [6]. Figure 3 below gives an example of an XML schema for the medical prescription in Figure 1.

```
<?xml version="1.0"?>
<s:schema>
      <elementType id=”name”>
            <string/>
      </elementType>

      <elementType id=”address”>
            <string/>
      </elementType>

      <elementType id=”doctor”>
            <element type=”#name”/>
            <element type=”#address”/>
      </elementType>

      <elementType id=”product”>
            <string/>
      </elementType>

      <elementType id=”quantity”>
            <string/>
      </elementType>

      <elementType id=”medication”>
            <element type=”#product”/>
            <element type=”#quantity”/>
      </elementType>

      <elementType id=”prescription”>
            <element type=”#doctor”/>
            <element type=”#medication”/>
      </elementType>

</s:schema >
```

Figure 3 Schema for the prescription

Standardising XML document content for business documents

One of the initial problems with EDI was that everybody was using different message formats meaning that separate messages had to be produced for each trading partner. To overcome this the EDIFACT and X12 standards were developed to standardise message content. As yet there is no equivalent standard for XML document content. However there are repositories of XML schemas for a number of business documents which in time could form the basis for a standard. The purpose of the repository is to generate a consensus on document content for business transactions. The two main repositories of XML schemas are xml.org from a consortium of companies, and Biztalk from Microsoft. See XML.com have a more complete list of repositories. [5].

Document transmission

An XML document can be transmitted using the HTTP[8] protocol. Documents can be pushed from source, or pulled from their destination using standard HTTP methods.

For a more robust, secure and fault tolerant solution, a number of middleware products now support XML including BEA's WEBLOGIC[11] and webMethods B2B[12].

Automated processing of XML documents

There are a family of standards to support the automatic processing of XML documents. DOM and SAX are the two main programming interfaces to process XML documents, while XSLT which is at recommendation stage, covers how to transform data in an XML document to other formats. In this section we shall explain these three standards, and also look at XML parsers, which process the XML document. Most XML parsers include implementations of the DOM and SAX standards.

XML parsers

An XML parser (or processor) reads through an XML document to check that it is both syntactically correct according to the rules described in section 1 above, and that it's content conforms to the corresponding DTD if one exists.

XML parsers are available free. Tests done in September 1999 rated the following as the top for parsers: [10]

Sun ``Java Project X"
IBM XML4j
Oracle XML Parser
Microsoft MSXML in Java

Document Object Model (DOM)

The Document Object Model is an official W3C standard, originally used with Dynamic HTML, but now adapted for XML[2]. Like all official standards DOM is quite large and powerful. A DOM parser converts the XML document into a tree structure, called a DOM tree as shown in Figure 4 below, and provides a

[8] Hyper Text Transfer Protocol used to transmit data over the Internet. It consists of a set of rules that define how web servers and browsers communicate with each other over a TCP/IP connection.

range of methods for processing the DOM tree. Methods include traversing the tree, retrieving particular data items, and adding, updating and deleting data items.

The following example will shows two alternative methods of processing the data in a DOM tree. These examples were written in Java. Both are based on the prescription document in **Figure 1: XML Document**

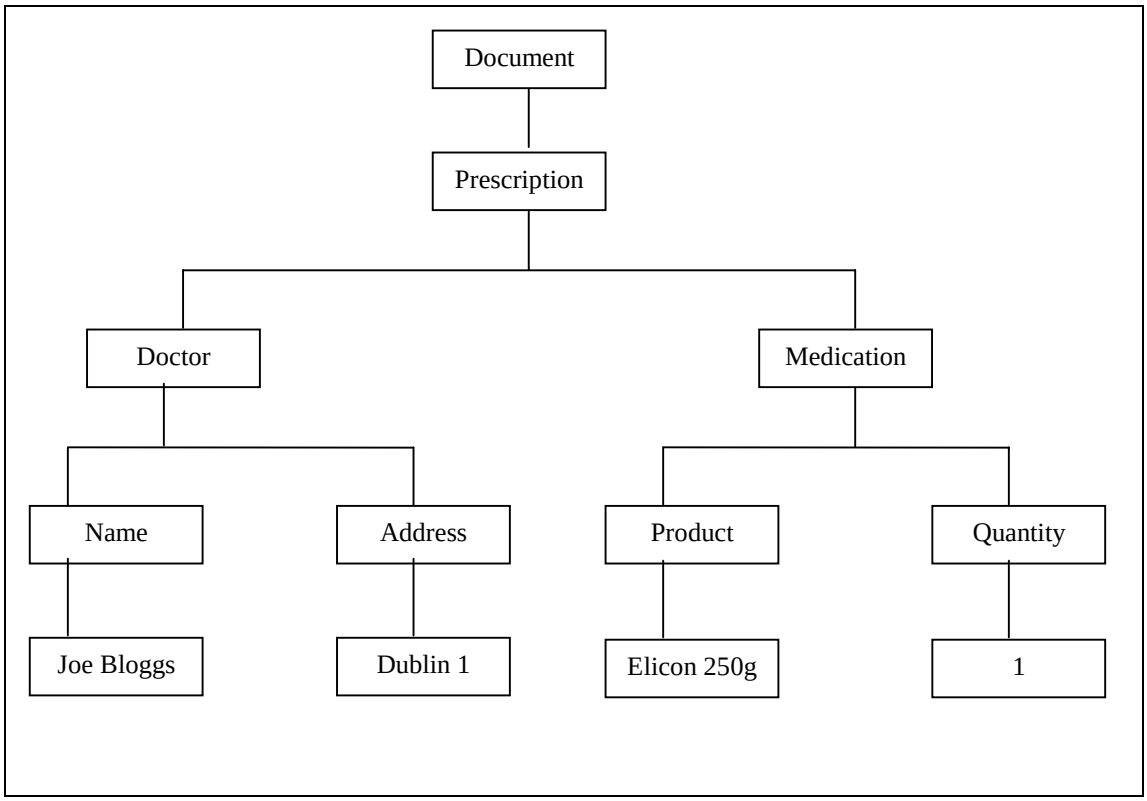

Figure 4 DOM tree for a prescription

Example1: Traversing the tree

This example illustrates methods which allow you to move between nodes on the tree. Starting at the root note (prescription), the code moves to the product being subscribed, and prints it[9].

[9] Note: This code assumes no carriage return or white spaces in the XML document. The DOM standard does not make allowances for carriage return characters and spacing used to format an XML document. If the XML was written as per Figure 1, the prescription node would actually have 5 children:

1. Carriage return and spaces
2. <doctor>
3. Carriage return and spaces
4. <medication>
5. Carriage return and spaces

```
root = ((Document)node).getDocumentElement();
prescription = root.getFirstChild();
doctor = prescription.getFirstChild();
medication = doctor.getNextSibling();
product = doctor.getFirstChild();
productText = product.getFirstChild();
System.out.print("Product is: " + "\"" +
productText.getNodeValue() + "\"");
```

Example2: Searching the tree

An alternative method of processing data in a DOM tree is to search for tags by name. A fragment of this code is given below.

```
Node medication, product, productText;
root = ((Document)node).getDocumentElement();

      //converts the node to an Element
Element rootElement = (Element)root;

      //return a list of the children of this element which
      //have the tag name medication
NodeList findMedication =
rootElement.getElementsByTagName("medication");

      //the medication node will be the first one in the list
      // as it is the only one
medication = findMedication.item(0);

      //converts the node to an Element
Element medicationElement = (Element) medication;

      //return a list of the children of this element which
      //have the tag name “product”
NodeList findProduct =
      medicationElement.getElementsByTagName("product");

product = findProduct.item(0);

      //moves into the text portion of the product node
productText = product.getFirstChild();
      //prints out the value stored in the product tag
System.out.print("Product is: " + "\"" +
            productText.getNodeValue() + "\"");
```

This code is more flexible as it will work regardless of the white spaces used or if other elements are added into the XML document. Is does require that the tag names of the two elements used, medication and product, are not changed.

One of the drawbacks of DOM is the amount of space required to create the DOM tree for large XML documents. For example searching an XML document of 100,000 element for just one element still requires the overhead of creating a tree for the 100,000 elements.

SAX:

The Simple API for XML is a defacto standard created by the XML-dev mailing list. SAX is an event driven model developed to overcome the DOM overhead for simple processing.

As an XML document is parsed a number of events are triggered. An application can be coded to listens for particular events and then execute the corresponding code for that event. This has a very low memory overhead and is much more efficient than DOM for the search example above. But as the name suggests this is a simple API and so does not support the same level of functionality provided by DOM.

Continuing from the DOM examples above, the approach to finding the product name in the medical prescription document is quite different with SAX. SAX parsers work on the principle of 'listeners', which are activated when the action they are listening for gets triggered.

The example below listens for two events, the start of elements and character data. The listeners for this are

startElement(String name, AttributeList attrs) and

characters(char ch[], int start, int length)

The startElement method will be fired when the parser reads the

1. prescription tag
2. doctor tag
3. medication tag
4. name tag
5. address tag
6. product tag
7. quantity tag

and the characters method will be fired when the parser reads

1. John Doe
2. Dublin 1
3. Elicon 250g
4. 1

Below is the code for the two listeners, the code is written in Java.

```
//listener that's fired everytime a element is started
public void startElement(String name, AttributeList attrs){
            //checks to see if this element if the product
            //element
      if (name.equals("product")){
            //if it is print out the name of the element
            System.out.print("product = ");
            found = true;
      }
}


//listener that's fired everytime the parser comes
//across character data
public void characters(char ch[], int start, int length){
      //Checks the flag to see if this is the data we are
      //interested in
  if(found == true){
    System.out.print(new String(ch, start, length));
    found = false;
  }
}
```

As the program parses the XML document the above code compares the start elements to "product". When a match is found the startElement method will print out '`product` = ' and set the value of found to true. At this stage the next event triggered by the parser is for the character data 'Elicon 250g' that is picked up by the characters method, because the flag found is true it will print out this data. The found flag is set back to false to prevent the program printing out the rest of the character data in the document.

Transforming the XML document.

XSLT (XSL (extensible stylesheet language transformation) which is an extension of the W3C standard for XSL, is a standard which covers how to convert an XML document into a range of other formats including a flat file or a word document. The standard is currently at recommendation stage, but will facilitate updating existing data sources from an XML document [8].

Displaying an XML document in a browser

XSLT can also be used to display an XML document in a browser. Using XSLT you can dictate the tags to include / omit, and how to display the information, for example in a table or frame, colours, font sizes, backgrounds etc. There is also limited processing logic for loops and conditional statements.

As the standard is yet to be finalised, browser do not yet support the standard, However at the time of writing three browsers support XML documents:

- Microsofts Internet Explorer
- Netscape Navigator
- Opera

Internet Explorer 5 uses a default style sheet for displaying XML documents. You can specify your own format using an implementation of a draft of the XSLT standard, or alternatively you can use a Cascading Style Sheet. Netscape does not yet support XSLT, but does support the use of a CSS to format the XML document. However the implementation of the CSS standard used by IE5 and Netscape are not the same. Opera also supports XML formatting using CSS's.

Benefits of Using XML

One of the primary advantages of XML is the low running and implementation costs of an XML solution.[9]. XML data is transmitted over the Internet. While there is an associated cost, it is considerably cheaper than using a VAN. Also as it is standard practice to encrypt sensitive data transmitted over the Internet, the security and integrity of the data during transmission is guaranteed.

Many implementations of XML related standards such as DOM and SAX's are available free, and the wide spread industry support for XML has resulted in a wealth of products coming to market which support XML.

A second significant advantage of XML is the flexibility of an XML document format. An XML document can be changed, without changing the software that sends, receives and processes the document. So the document content can be updated to meet the criteria of a new trading partner without impacting on existing trading partners solutions.

For example, using XML to describe medication on a prescription as shown in the following code:

```
<medication>
        <product> Elicon </ product >
        <quantity>  250g </quantity>
</medication>
```

an application can locate a particular tag and extract its value, regardless of the order of the tags within the document. Code to locate the product tag, as in examples 2 and 3 in section 2, would still work if , for example, a price tag was added to the document.

Finally there is a range of W3C standards and recommendations supporting XML. We have looked at some of these in section 2 above including DTDs, XML schemas, DOM, SAXs and XSLT. There are a

number of others including a query language of XML. This technology is in its infancy as yet, but the volume of support given to XML, and the rate at which standards are emerging and developing, will guarantee is widespread adoption in the industry.

Conclusion

XML is expected to revolutionise business to business trading, and become the standard for all e-commerce applications. As with EDI, XML can transmit message to a pre-determined format. It is however significantly cheaper to implement and is a more flexible solution than EDI. It is also supported by a powerful family of standards including standards to process, update, query and transform XML documents. There is a range of good quality software and tools that are available free and as open source code. Industry leaders have all adopted XML, so there is a vast array of XML compatible software on the market place. Therefore small and medium size enterprises, for whom the cost of an EDI solution proved prohibitive, can now benefit from the advantages of business to business electronic data exchange.

References

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Narratology

Fr. P. Boyle, Chaplain, ITB

Abstract

The following is a very brief summary of Narratology. Narratology is an evolving, multifaceted method of studying the various forms of narrative or storytelling from the earliest linguistic and literary forms to the many mediums and genres of the present day. While encompassing many and different methodologies the basic thrust of Narratology is to accept the 'text' as it is presented to the reader and to experience the differing realities in the text and through the medium of the text. Many of the ideas and concepts presented in this paper deserve a more robust treatment and a much closer examination than given here.[10]

Introduction

Narratology is the science of narrative. It is a multi-disciplinary field involved in the study of narrative, which negotiates and incorporates the insights of many other critical discourses that involve narrative forms of representation. Narrative may, in a rather broad sense be defined as 'a work with a plot.' Narratology, in this sense, concerns itself with the study of the narrative aspects of both literary and non-literary genres and representations which are not strictly narrative, such as, lyrical poems, film drama, even advertisements. A more narrow definition would relate to linguistic narrative which concerns itself with any work, which is mediated through the discursive activity of a narrator, e.g. novel, short story, even history. Spanning between these two definitions there are of course a wide range of linguistic and nonlinguistic discourses, presentations and strategies which could and do include some or all of the elements of 'narrative'.

For the purposes of this short study I will adopt the following definition of 'narrative': *'A narrative is the semiotic representation of a series of events meaningfully connected in a temporal and causal way.'*[11]

Each medium or genre, whether it is text, drama, or film allows for a particular presentation of the fabula, i.e. the events or happenings of the plot of the narrative. Each in its own and sometimes quite different way communicates the story. The depiction of various perspectives and different points of

[10] In *Narratology*, Eds Susana onega and Jose Angel Garcia Landa longman Group Ltd. 1996, one gets an idea of the scope of study involved in Narratology See table of Contents v & vi
[11] *Narratology*, op. cit. see p.3

view, the degree to which the narrator enunciates, informs, creates suspense, anticipation etc., these factors are at the discretion of the author and the skill with which he uses a particular medium or genre. In text, say a novel, the narrator is very often omnipresent, all-knowing and usually though not always anonymous. In classical Greek drama the chorus is the narrator, in film[12] it is the camera itself that unfolds the events of the story and can be termed the 'narrator', though some would argue that narration of its very nature must be enunciated in some fashion or other and that the visual unfolding or non-verbal revelation of the events of the story does not therefore qualify as narration in the strict sense.[13] Each medium or genre is specific in the way it can manipulate and handle time within its presentation. Each narrative medium, because of its limitations, its potential to be innovative and its possibility to expand the boundaries of technical parameters, must adopt a specific analytical approach to narrative structures and levels.

Narratives have, of course, been around from time immemorial. Interest has tended to concentrate on the genre or medium through which they have been communicated, from the Greek epics, the Passion plays of the middle ages, the classic novels of Dickens, James and Trollop to the Oxo cubes advertisements, even history,[14] can all come within the above definition of narrative.[15] In the past thirty or forty years the study of narrative and 'pure' narrative form has regained some prominence.

All narratives are forged by reality and imagination. The basic subject matter of the narrative, whatever it may be, is subject to the forces of the outside world. Though it must be said that certain types of narrative, the folktale, the epic, etc. and archetypal characters such as the hero, the heroine, the villain have remained virtually constant throughout the history of storytelling. With regard to what stories are told and the way in which they are told, opinions vary as to whether the individual and his/her worldview is more dominant and influential than the cultural and social circumstances from which they arise. It can also be argued that the various literary traditions peculiar to a society or indeed a to a language is a third element on a par with reality and imagination in the determination of the type and form of a narrative.

There has always been, up to the recent past at least,[16] a strong link between textual narrative and oral tradition. In the oral tradition of any culture one finds certain compositional elements, which remain

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[12] Cf. *Narrative Mortality*, Catherine Russell, concerning the place of narrative in cinematography.
[13] For Types of Narration see, *The Rhetoric of Fiction*, 2nd ed. Wayne C. Booth, The University of Chicago Press 1983, Ch 6, pp. 149-165
[14] Georg G. Iggers in his book *Historiography in the Twentieth Century* gives a good analysis of the developments and changes which have occurred in the science of history. See Ch 10, The "Linguistic Turn": The End Of History as Scholarly Discipline, pp. 118-133.
[15] Cf. Ch 2 of *Recent Theories of Narrative*, Wallace Martin,Cornell University Press, 1986, pp.31-54 for a detailed account of the various types of narrative.
[16] Newman, in A Grammar of Assent, articulates very well the impact of rapidly developing technologies and scientific discovery and the importance of nurturing perspective in a world that is changing so quickly. Cf. p. 191, *A Grammar of Assent*, John Henry Newman, University of Notre Dame Press, 1979 edition.

constant and easily recognizable, type-scenes, action motifs, characterization modes etc. These have been carried into the narrative text and are only subject to change and development very gradually. Often the study of literature has looked beyond the formal structures of the narrative to the subject matter and content to see how man and the world are mirrored in the literature. The text is regarded as a mirror through which the reader views the real world. The study of the text itself and the reality to be found there is often marginalized or disregarded. At the other end of the spectrum there is a school of thought which would content that the only reality is the text itself.

The use of literary devices, which, in a sense, distort or 'defamiliarize' reality and which are different from the normal ways of seeing and speaking, together with the presuppositions we bring to the text tend to shock us initially and perhaps urge us to revise our perception of our own reality.[17] The problem or perhaps the blessings of the study of narrative is that we need constantly to study, to analyze, to understand the literary devices or formulas through which the plot is communicated and to revisit again and again the history of narrative and that way it has used and manipulated the basic laws of literary structure.

This is not to say that Narratology is merely the study of the elements, which made up a narrative or of the literary devices one finds within them. If one were to confine oneself to the above it would be bring the study of narrative to the level of deconstruction. Deconstruction of the text may have merit in itself, but it is only one part of the exercise. So also are the delimitation of the various parts of the narrative, the exposition of the plot and subplots, the characterization of the personae, the revelation of the points of view,[18] focalization, keywords, wordplay, the ways the author or the narrator maintains the interest of the reader, his use of temporal, geographical or spatial indicators, the fate of the characters and the final resolution of the plot and its various complications.[19] All of these combine together to convey and communicate the reality of the narrative, whether that reality is factual or fiction. There are some who are of the opinion that the narrative defamiliarizes the world or the reality of the world from which it takes its starting point and those who contend that it defamiliarizes ways in which we speak about the world. What is sometimes forgotten is it there is a reality within the narrative itself, which is not just 'represented' by the subject, form and content of the narrative. In the eyes of the reader the words of the 'character' is the character and when the character speaks he/she speaks to someone or about something. 'Representation' comes at the level of interpretation, which in turn springs from the reality to be found within the narrative, as it is presented to us and in the form it is presented.

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[17] Cf. IV The Individual's Understanding of Himself, p.43ff. *The Undiscovered Self*, C.G. Jung Redwood Press Ltd. 1990 (first published in 1958)

[18] See Viewpoints and Interpetations pp.129ff. in *The Poetics of Biblical Narrative*, Meir Sternberg, Indiana University Press, Bloomington, 1987

[19] An extremely fine example of how all these elements are utilized to great effect can be found in Gore Vidal's *The Smithsonian Institution*, Random House, Inc., 1998.

The history of narrative can be traced through the history of various civilizations and in the history of languages.[20] Certain narratives, such as the epic, which refers to adventures and to a time far distant from the narrator and his audience, come to us in a unified language of an ordered hierarchical society. Interaction with different cultures and languages did not mean simply viewing the same 'reality' though different 'words' but it also mean experiencing different worldviews, different interests and attitudes to 'reality'. This in turn meant a development of narrative forms and methods of expressing the various strata of societies and languages communities.[21] One path of development was found in the contrast between the language and style of a literary work and the language of nonliterary styles and everyday modes of speech. The discourse of characters and even the dialogues between characters also began to reflect the difference in class, language community, culture, point of view and expectation. The level of activity to be perceived within the narrative is particularly significant when there are seeming differences of agenda and perception between the author and/or the narrator and the characters present in the narrative and the audience to which the narrative is addressed.[22]

The effort to perpetuate a unified style continued in certain forms of narrative right to the present day particularly in some forms of romantic literature, where unity of language, belief system and point of view are imposed by the author on narrator, characters and genre. Side by side with the above there developed a style in which the competing languages, belief systems, points of view were allowed to speak for themselves and given mutual recognition.[23] Most, if not all, narratives can be classified, basing classification on form and content, by time. The time in which a narrative came to literary form

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[20] In many respects the history of narrative is commensurate with the history of the visual arts. See *From Giotto to Cezanne*, A Concise History of Painting, Michael Levey, Thames and Hudson, 1962

[21] One can find a very good example of this on pp. 95-96 of *The Outsider*, Albert Camus, Penguin ed. of 1982.
'Even when you're in the dock, it's always interesting to hear people talking about you. I must say, during the presecutor's speech and my lawyer's speeches, a great deal was said about me, possibly even more about me than my crime. Was there so much difference, anyway, between the two speeches. The lawyer raised his arms and pleaded guilty, but with mitigation. The prosecutor held out his hands and proclaimed my guilt, but without mitigation. There was one thing though, that vaguely bothered me. In spite of all my worried, I'd occasionally feel tempted to intervene and my lawyer would always tell me 'Keep Quiet, it's better for you.' In a way, they seemed to be conducting the case independently of me. Things was happening without me even intervening. My fate was being decided without anyone asking my opinion….

[22] The Urge to be creative both within and outside traditions and conventions is part of the study of the history and development of narrative. Charles Handy sums this up very well when he says; '..research into creativity has suggested as part of the make-up of the creative personality – the urge to express oneself. Why else do artists paint or poets write their intimate thoughts? Why do writers write…?
P. 32 *The New Alchemists*, Charles Handy, Hutchinson, London, 1999.

[23] Benchmarks, indicating insights and new possibilities in the way in which man expresses himself in relation to his world can sometimes be easily identified, such as the writing of Giovanni Pico della Mirandola, regarded as one of the first of the Enlightenment thinkers, who in 1486 said the following:
We have made you neither of heaven nor of earth, neither mortal nor immortal, so that with freedom of choice and with honour, as though the maker and molder of yourself, you may fashion thyself in whatever shape thou shall prefer.
Cf. pp.39-40, *Consilience*, The Unity of Knowledge, Edward O. Wilson Little, Brown and Company, 1998

characterizes a certain projection of a world and an effort to discover a true concept of reality, which in turn lends itself to classification within a particular time span.[24]

While it is sometimes difficult to define exactly what narrative is, one can recognize certain characteristics which distinguish narrative from other forms of literature and other mediums of expression and communication. The history of narrative, of storytelling is rich in stages of development and diversification, some of which are easily recognizable and chronicled. The novel as a dominant literary form and its relationship to other forms of narrative has long been a matter of debate among literary critics. Some of the characteristics long thought to be peculiar to the novel and which differentiate it from other forms of narrative are no longer considered to be outside the domain of general theories of narrative, or have been adapted successfully by new emerging forms of narrative.

One can easily find examples of narratives to support particular theories. One of the challenges to Narratology is to formulate theories that speak to narrative in general. One way of doing this is to select a work that one is familiar with and then apply a theory to it to discover if the theory has any merit.

Narratives are formed within the confines of the conventions of particular ages, times, cultures societies and technologies. Certain circumstances of storytelling, of narratives differ from one time to another, scenes, events, careers, physical environment, social and political changes, all affect the ways stories are told and the forms and conventions which can be utilized in the shaping of a narrative.[25]

What remains constant is the effort to convey and experience reality, the reality of the reader, the reality of the text and the reality behind the text.[26]

[24] See Mikail Bakhtin's essay 'From the prehistory of novelistic discourse' pp. 104-136 *in Modern Criticism and Theory*, eds. David Lodge and Nigel Wood, Longman 2nd ed. 2000.
[25] One recent development of note is the presentation of scientific subject in narrative form, 'popular science'. Works such as 'A tour of the Calculus, by David Berlinski, Fermat's Last Theorem by Simon Singh, Richard Dawkins' The Blind Watchmaker, and The Lying Stones of Marrakech by Stephen Jay Gould, to mention but a few.
[26] See Pp. 63-70 of *Recent Theories of Narrative*, op. cit.

Book Reviews

The New Alchemists
by Charles Handy

Charles Handy is most importantly a philosopher. He is acknowledged as a highly successful writer, lecturer and broadcaster, a self-styled social philosopher and an author whose body of textbooks for business include *The Empty Raincoat* and *The Hungry Spirit.*

The New Alchemists seeks to tell the stories, in their own words, of twenty-nine individuals who each have created something significant out of nothing or turned the equivalent of base metal into a kind of gold. The range is interesting including business people, architects, designers, artists and administrators. The feature presented on each individual arises from detailed discussion and interview with the author and is supplemented by a detailed composite photograph as developed by Elizabeth Handy, his wife and a self-published portrait photographer. The preamble to the pieces on these new alchemists includes an assessment of the nature of alchemy, the seeds of alchemy and possible ways in which new alchemists can be developed, promoted or assisted.

The book is very well written. The style is light and easily accessible to anyone, whether as a student new to the area, an expert within the area or a casual reader. The photographs and features on these highly successful people are beautifully and simply presented. The range of people interviewed and portrayed as subjects, whether in interest, age or appeal, is so broad it is impossible not to identify with at least some of them. The new alchemists include Richard Branson (Virgin), Terence Conran (Design/Restaurants), Trevor Bayliss (Inventor) and Tim Waterstone (Waterstone's bookstores). The book has the capacity to entertain, educate and inspire the reader, the benefits being directly proportional to the amount of effort, study and commitment one applies to its pages and the ideas contained therein.

The author is quick to point out that the book is limited to a focus on London resident alchemists with few examples of entrepreneurs involved in manufacturing. Perhaps the simplicity of style and presentation belies the depth of research, knowledge, value and ideas that could be gained from reading this book, thinking about it's contents and most importantly applying some of the principles espoused between it's covers. Do somebody a favour and buy it for them as a present. Do yourself a greater favour and read it before you give it to them. Enjoy.

Tattler

This GREAT LITTLE NATION
By Gene Kerrigan and Pat Brennan
Gill & MacMillan 1999

If you ever heard the phrase "It would never happen in Ireland" here is a book to prove you're wrong. This book aims to cover as many as possible of the scandals and controversies that have shaped our image of Ireland since the Republic was form.

Our perspective on scandals can shift over time and as more information is brought to light. In some cases what was alleged to be a scandal turned out to be relatively innocent and in some cases a false allegation of scandal. Before you switch off, this book is not just about the Tribunals and although they are touched upon each entry is only about a page long and covers all the relevant points. The scandals are listed in alphabetical order, and at the end of some are suggested other related scandals, also covered in the book.

This is not a book you would read from cover, but would browse through picking out the topics. What happens is you get caught up in the book after reading one story, you may notice another one which catches you eye or suggested to see. Hence you move back an forth through the book. So of the topics, are funny, heartbreaking or will make you very cynical especially about the politics in Ireland. Also what hits you is that many of these scandals you remember hearing or reading about.

From the Great Tampon Scandal of 1944 to the Arms Crisis of 1970. From Taca to Tuffy to Traynor to "Thundering Disgrace" all are covered.

As the bank manger said to Charlies, "*it's a Great Little Nation*".

Sandra McCullagh

"As it is in Heaven" by Niall Williams

Two reviews from the ITB Bookclub.

This book tells the story of how one young man's dreary, monotonous life is utterly changed as a result of attending a concert, one winter's evening in county Clare. Stephen Griffin is so completely entranced by the beauty of the Italian music and the Italian violin player, that his life from then on is taken up with the pursuit of her. It is as if his life until then has been on "pause" and she has hit the "play" button. This development of character is not so much a transformation as a modification, not quite the chrysalis to butterfly, but rather to moth, and in many ways this change is more realistic than a dramatic Hollywood-style metamorphosis. Interwoven with this is the lonely life of Stephen's father, which also changes as a result of this event. Music is a central theme in this novel and is extremely evocative of baroque Venice. The story itself is rather fantastic and littered with coincidences, so that in truth, the reader does have to suspend his disbelief. Most of the characters are rather sad, pathetic people with unfulfilled lives and one gets the impression that Williams has somewhat over-simplified them. In fact one might wonder at the function and validity of some of the more peripheral characters, the two doctors, for example. The main character, Stephen, is also rather one-dimensional and insipid, indeed not the most likeable individual. However, one of the great strengths of the novel is the author's articulation of human feelings: grief, disappointment, acceptance, pain and joy and his ability to make these emotions very real to the reader. Add this to the wonderful descriptions of the Irish countryside, which come alive with the author's beautiful use of language. On the whole, this book is a compelling, uplifting read, ideal for the holidays.

Aidín O'Sullivan

As it is in Heaven

First the plot. ***As it is in heaven*** is fairly standard love story - man meets woman, seduces woman, then looses her, searches in vain for her and, without revealing the ending, is found in somewhat incredulous circumstances. The man in this case is Stephen, a teacher who lives near a cliff face in west Clare. Stephen is portrayed as a gaunt and hapless individual with a tragic past, which threatens to intrude on this loving odessy. The woman, by contrast, is as exotic as you are likely to meet in these parts. Gabriella is an Italian musician who lives in Kenmare because her Italian boyfriend dumped her there after an aborted circuit of the Ring of Kerry. She is a soft and vulnerable character who plays enchanting music on the violin enrapturing audiences reared on a diet of Miko Russell and the Corofin Ceili Band. The love affair is nurtured by Stephens's terminally ill father by various means, one of which is placing thousands of pound under bushes in Stephen's Green. There is the twist in the end, which unravels just as you are about to loose patience, but all in all you'd wonder what it was all about.

What makes the novel bearable is the quality of writing of Niall Williams. There is a beautiful sense of place for all of the story's locations particularly in the case of Kenmare's mountain terrain. The Gabreiella character is as sympathetic and endearing as any of Jane Austen's heroines. Despite the shortcomings of the plot it is a pleasant read. Definitely one to pack for the holidays. And finally you will never walk through the Green again without taking the occasional peek - under the bushes that is.

Tom Doyle