# The Teaching of Ergonomics in Schools: What is Happening?

**Andree Woodcock[1] and Howard Denton[2]**

[1]*VIDe Research Centre, School of Art and Design, Coventry University, , Coventry, A.Woodcock@coventry.ac.uk*

[2]*Department of Design and Technology, Loughborough University, Loughborough, H.G.Denton@lboro.ac.uk*

The relationship between ergonomics and the disciplines it informs has always been tenuous. Woodcock and Galer Flyte (1997) hypothesized that teaching ergonomics in schools would lead to a greater acceptance and willingness to learn and use ergonomics techniques during tertiary education and once in professional practice. This paper discusses the relationship between ergonomics and design, and considers the teaching of ergonomics in both primary and secondary schools. Preliminary results of surveys conducted with first year undergraduates to investigate the teaching of ergonomics they received at both 'GCSE' and 'A' level are presented which indicate that most ergonomics education occurred, as expected, in design and technology courses, but was also present in other disciplines.

## Introduction

Gaining acceptance and use of ergonomics by designers and other professions has been difficult. This seems somewhat strange, firstly because humans have what appears to be an almost innate capacity for understanding and applying the principles of ergonomics. For example, Australopithicus Prometheus selected pebble tools and made scoops from antelope bones to make tasks easier to perform; in their use of computers for distance co-operation, designers will select those features which enable them to complete the task as effectively and efficiently as possible (Scrivener, Chen and Woodcock, 2000); additionally it is believed that children, even at pre-school level perform user centred design activities in their play and make activities (Woodcock and Galer Flyte, 1998). Secondly, ergonomics has proved to be beneficial when used to inform product and work place design. Thirdly, industry is looking for graduates who are able to design for niche markets.

There have been attempts to improve communications between ergonomics and the disciplines it seeks to inform. Woodcock and Galer Flyte (1998) reviewed these approaches which have included in-house training schemes (e.g. Shapiro, 1995), production of designer-friendly literature (e.g. Chapanis, 1990), development of techniques which could directly benefit many stages of the design process (e.g. Simpson and Mason, 1983) and the integration of ergonomics into other undergraduate courses (e.g. Woodcock and Galer Flyte, 1997). These are gradually changing the design and engineering climate. However, these approaches focus on practicing designers or students in tertiary education.

Informal observation has revealed some antagonism towards ergonomics amongst undergraduate engineering and design students. If unchallenged, this attitude might predetermine the use of ergonomics in later careers. For example, Meister (1982) showed that the attitude of senior managers affected the tone of the department, and that one of the ways this could be changed was through the greater integration of ergonomics and the continuing education of managers. If undergraduate engineers and designers are unappreciative of the benefits of ergonomics then we need to consider the reasons for this. This may include multidisciplinary course structure; assessments emphasising the mastery of skills and creativity at the expense of user evaluation. It is hypothesized that additionally, the failure to appreciate the value of ergonomics may be partly based on pre-university experiences of ergonomics.

Previous research suggests that pre-school children are cognisant of the need to consider others in their play and make activities, that this empathy with others continues in primary schools, but is downplayed in secondary school curricular, resulting in undergraduates who (for the most part) are antipathetic in their views towards the users It is argued that this is a lost opportunity and that the discipline of ergonomics has much to offer teachers, pupils and curriculum developers not only as a discipline in its own right, but also as a means of integrating diverse areas of the curriculum and enhancing learning experiences. The paper will now discuss preliminary investigations undertaken by the authors to assess the way in which ergonomics is taught in secondary schools. The paper closes by formulating a set of recommendations for a continuation of this work.

## Secondary Education

A computer based search of the national curriculum requirements for all subjects at Key Stages 3 (age 11-14) and 4 (age 14 –16) showed no specific mention of 'ergonomics', 'anthropometrics' or 'human factors' (8). Currently the Qualifications and Curriculum Authority (QCA) is conducting a major review of national curriculum requirements and qualifications such as ‘A’ level. Their guidelines for ‘A’ level subjects (http://www.qca.org.uk/) were searched for the terms 'ergonomics', 'human factors' and 'anthropometrics' in the subjects: design and technology, physics, maths, biology, physical education and art. The only hit scored was on 'ergonomics' in ‘A’ level design and technology guidelines. Here the requirement is for all new ‘A’ level Design and Technology syllabi to include a section on 'planning and evaluating' and within this is: section c. 'use ICT appropriately for planning and data handling, for example, the use of data base, drawing and publishing and design software. Interpret design data such as properties of materials, ergonomics and nutritional information.' (9). Within the grade descriptions offered for ‘A’ level design and technology is the statement (grade A) that: 'when developing and communicating ideas, take into account functionality, aesthetics, ergonomics, maintainability, quality and user preferences…..’

The overall position, however is clear: a student with ‘A’ levels in maths or a science may have looked at ergonomics, but it is more likely that they will not. A student with ‘A’ level ‘Design and Technology‘ should have learned something about ergonomics and should have applied this knowledge to project work.

To summarise, we would expect to find that students who had undertaken a Design technology course, either at GCSE or ‘A’ level would have received some tuition in ergonomics, and that this would probably be through project work. We expect to find some ergonomics taught in other disciplines, however, we were not sure which, the extent to which ergonomics would be taught, or the manner in which this may be conducted.

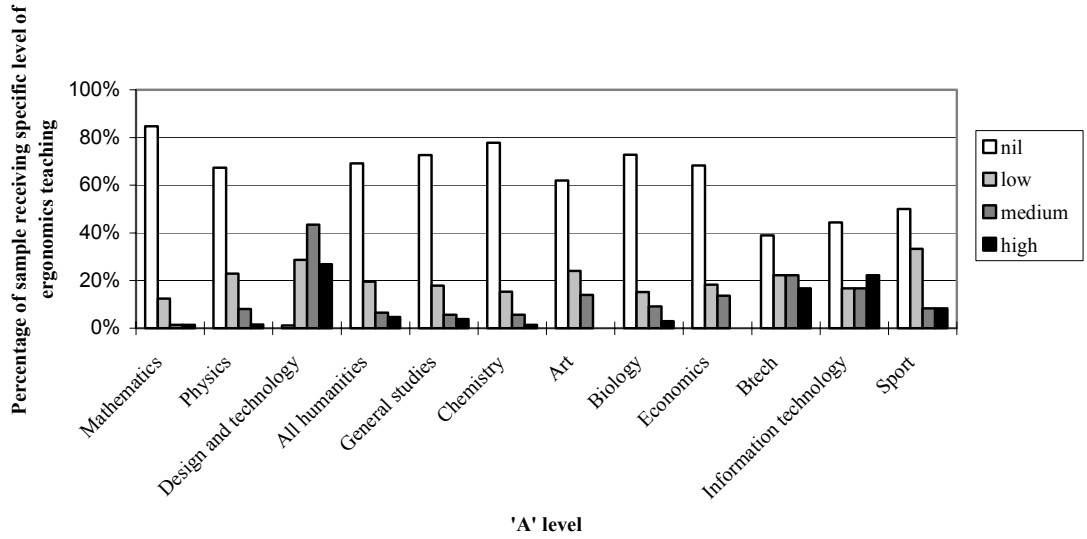
### *Investigation 1*

The aim of this study was to investigate further the current teaching of ergonomics in schools at GCSE and 'A' level to ascertain the subjects in which ergonomics is being taught, and the methods used to teach it. Such information is necessary for:

1. Curriculum developers who might wish to co-ordinate activity across subjects,
2. Educational product designers who might wish to develop teacher support material,
3. University staff who wish to better understand the prior learning of students.

In 1998 a survey of undergraduate students at Loughborough University was conducted to ascertain their experience of the teaching of ergonomics in primary and secondary education (Woodcock and Denton, 1999). The following results are based on over 350 responses.

At 'A' level it is only in design and technology that ergonomics is taught to any great extent, as is to be expected. However, it is interesting to note that ergonomics was being taught in other disciplines, most notably IT, sport and geography. Only in a few cases were single methods (eg lecture, handouts) used to teach ergonomics. It was shown, not surprisingly that students who had been exposed to a greater number of teaching methods had a higher level of understandng of ergonomics. These results would seem to indicate that multiple teaching methods appear to be more effective than the single use of any method including project work.




Other trends in our data were that younger respondents had slightly more knowledge of ergonomics than the older ones. However, the sample size for older participants was too small for this to achieve any levels of significance. With regard to the extent to which ergonomics was considered to be important in a later career, an encouraging 299 thought it was important and 32 that it was not. Of this latter group, 20 of were civil engineers and 9, mechanical engineers. The results also indicated a gender difference, with females having a higher regard of the value of ergonomics to their future careers (mean = 2.11), than male respondents (mean = 1.86).

We can see that only those students who have completed a full GCSE in design and technology (not all do) and particularly those who have taken an 'A' level in design and technology can be assumed to have studied ergonomics as part of their school work. Individually, students may have covered aspects of ergonomics in independent study or where a maths teacher uses ergonomic data as an illustration of data handling. Older teachers of design and technology will not have learned any ergonomics as part of their initial training. Students are dependent on these staff having read up on the subject when it entered these syllabi in the 1970's; not all can be relied upon to have done this.

. At GCSE level the trend there was some remembrance of ergonomics in technology, art, PE, dance and drama, and the humanities (most notably geography), as well as in the more design related courses. This trend is also continued at 'A' level, and may reflect the attempts by teachers to unify the curriculum

In relation to the teaching of ergonomics at GCSE level, less than half the respondents remembered any ergonomics being taught. Where it was it formed a very minor element unless it was developed by the teacher out of personal interest.

*Investigation 2*

This took place as a group questionairre with over 100 first year undergraduate design students in their opening lecture on ergonomics. The questionairre this time sought to confirm the principle subjects in which ergonomics was taught, the methods used ti impart this information, the methods most prefered by the students and the extent of their understanding of ergonomics before embarking upon the lecture course.

## Discussion

Education about ergonomics, is happening of its own accord at all levels of the educational system, without the structured input of ergonomists, as far as we are aware. A cross cultural, ergonomics and education task force is required to develop these emerging trends. As more schools have access to the InterNet we will see the twinning of schools and classes, and virtual pen pals. These activities should be fostered and integrated into the curriculum, and they should be designed, so they are not fortuitous, temporary occurrences. Teaching our children to celebrate and cherish cultural diversity should be one of the main goals for educationalists in the next century.

This raises issues of the importance of learning to work in groups and teams (Denton 1997, 1994). This is generally recognised as an educational objective from early years teaching (e.g. National Curriculum Key Stage 2, age 7-11, Design and Technology, p 4, section 2a. 'Work independently and in teams') to graduate programmes (The Engineering Council in *Standard Routes to Registration* stating that courses should develop in students '*the ability to work as a member of an engineering team'* p19, 3.3.4, iv.).

Bertodo (1994) emphasised the personal qualities working in such an environment would require - a breadth of knowledge and understanding, a team player, good communicator and problem solver. These abilities he felt, rank above the more traditional engineering competencies of inventiveness, creativity, rationality and thoroughness. However there are indications (Denton 1997) that not all university staff understand how to organise team-based learning and, particularly the ergonomics of team working, whether in one team base or remotely using computer equipment. Developing a team culture and having the ability to rapidly understand and adapt to other organisational structures must be a high priority in research and education, as it is creates barriers to effective international projects (e.g. Lee, Woodcock and Scrivener, 1999).

Developing a team culture and having the ability to rapidly understand and adapt to other organisational structures must be a high priority in research and education, as failure to do so creates barriers to effective international projects. Again, the ability to work and organise team activity is laid down in school, where children work with individuals and groups in their class, across classes for larger joint initiatives, and through the school, e.g. for school plays, and

mentoring initiatives, where older children help younger ones with reading. This approach needs to be maintained into tertiary education and through to the workplace.

## Conclusions

## Recommendations and future work

These results hopefully represent the start of a more detailed investigation into the teaching of ergonomics in schools. Group discussions with respondents will be used to show which methods of teaching ergonomics were perceived to be most enjoyable and instructive, and of the limited range of ergonomics material specifically tailored to the needs of school children, which were actually used. This will be followed up by a selection of interviews with teachers to investigate their approaches towards ergonomics.

Ergonomics can have an important part to play in the shaping of the national Curriculum. At the moment the importance of this does not seem to be recognised. Ergonomics is being taught in a rather piecemeal manner in a number of disciplines. However, in terms of project centred work ergonomics could form a central organisational role in bringing to gather different threads of the projects . For example in terms of looking at the relative importance of individual differences and similarities and with more emphasis on evaluation.

Also there are many attempts by schools to consider aspects of citizenship and challenging children with IT. The use of IT for the sharing of cross cultural activities would seem to hold great potential, and is an area which has been overlooked.

If young people are to be made more responsible for their actions, then they must understand the implications of these in terms of others. The transfer of thinking about others, from an approach to user centred design may help in this. For example in the re-education of children about driving behaviour, where the research results could be directly channeled into a course targeted at the pre-driving population. This would include the dynamics of cars, accident causation and what happens during accidents.

It would appear from our work that little attention has been given to the teaching of ergonomics to children, and that this area is ripe for the development of innovative, challenging and multidisciplinary teaching methods and resources.

The national curriculum is, nevertheless, flexible in terms of the precise nature of what is taught. Teachers could use ergonomics as a vehicle for learning in several subjects, for example, within maths, ergonomics could be a subject for statistical data management and interpretation; physical education and art might also raise the subject in various ways.

*References*


Chapanis, A. 1990, To communicate the human factors message you have to know what the message is and how to communicate it, *Communiqué, Human Factors Association of Canada,* 21/2, 1- 4

Denton, H.G. and Woodcock, A. 1999, Investigation of the teaching of ergonomics in secondary schools - preliminary results, In Juster N.P. (ed) *The Continuum of Design Education: Proceedings of the 21st SEED Annual Design Conference and 6th National Conference on Product Design Education,* (London: Professional Engineering Publishing), 129 - 138

Meister, D. 1982, Human factors problems and solutions, *Applied Ergonomics,* **13**, 3, 219-223.

Scrivener, S.A.R, Chen, C.D. and Woodcock, A. 2000, Using multimedia mechanism shifts to uncover design communication needs, in S.A.R. Scrivener, L. Ball and A. Woodcock (eds) *Collaborative Design, CoDesigning 2000,* September 13th-15th, Coventry, 349-359

Shapiro, R.G.1995, How can human factors education meet industry needs, *Ergonomics in Design*, 32.

Simpson, G. C. and Mason, S. 1983, Design aids for designers: An effective role for ergonomics, *Applied Ergonomics,* **14**, 3, 177-83.

Woodcock, A and Galer Flyte, M. 1997, Development of computer based tools to support the use of ergonomics in design education and practice. *Digital Creativity*, **8**, 3 and 4, 113-120

Woodcock A. and Galer Flyte, M. 1998, Ergonomics: it's never too soon to start, *Product Design Education Con*ference, University of Glamorgan, 6th-7th July.

Woodcock, A. and Galer Flyte, M. 1998, Supporting the integration of ergonomics in an engineering design environment, *Tools and Methods for Concurrent Engineering'98*, 21-23rd April, Manchester, England, 152-168