TAKING NOTES IN ENGINEERING LECTURES

Suggestions for ESP materials development

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INTRODUCTION

For many students on Engineering courses the medium of instruction is a foreign language, and English is pre-eminently the foreign language used. Students requiring a knowledge of English in order to follow such a course are clear examples of specific purpose learners, with complex, interrelated needs just in terms of the linguistic and study skills they must master in order to perform adequately. A preliminary, linguistic analysis of the background to one skill such students require, taking notes at lectures, has been presented in "Engineering Lecture Discourse and Listening Comprehension"*; the present paper reports two aspects of an attempt to develop that work. The first concerns one way of incorporating visual information with audio recordings, and the second outlines some ideas on the use of native informants in preparing the material. Both represent an attempt to exploit information from the target performance non-native speakers should aim to achieve, arrived at from analysis of field data.

THE VISUAL ELEMENT OF ENGINEERING LECTURES

1. If you make an audio-recording of a lecture, and then transcribe what was said, it will be difficult at times to match parts of the transcript to a record of the notes and diagrams that the speaker put on the board while talking. The transcript will contain continual reference to something assumed by the speaker because it is in front of his audience :

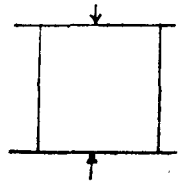
Acknowledgments : I would like to thank Charles Alderson, Michael Breen, Christopher Candlin, Professor Stephen Harris and Alan Waters for comments on an earlier draft. The remaining errors and lapses of style are all mine, of course.

* D.F. Murphy and C.N. Candlin, in *Practical Papers in English Language Education*, Vol. II, mimeo University of Lancaster, 1979.

if you put a load on a strut like that (9.5)[**]

where "that" refers to a diagram that he has just drawn, and where the relative proportions of the strut or column are important. In other words, although in the example just given we may easily understand that the referent of "that" is a strut, we also need to know that it is a strut like the one in Diagram 1a, a long, thin column, rather than a short, fat column such as 1b :

Diagram 1a



1b

Throughout the lecture cited here the text contains references to visuals that were before the audience, and where there was some risk of ambiguity, say in distinguishing between two similar diagrams, or for emphasis or clarification, the lecturer also used gesture to explicate a reference. The integration of the spoken word, visual display and gesture does not permit separation of the different elements, together they constitute a lecture, each conveying part of the total information. To subtract one is to subtract from the message. Consequently, in language training for foreign students, it seems important to provide as much comparable information, in as many channels, in order not to deprive them of potential avenues of interpretation that they can expect in the target situation they are preparing for. An audio-recording alone would make their task harder than the task of the student in the discipline.[***]

2. In preparing materials for use on a language course for students of Engineering it is possible to imagine a solution to the difficulty presented by the example above by supplying descriptions :

if you put a load on a long thin strut,

which goes some way to ensuring the point crucial to this example goes across. However, in my experience so far, engineers teaching their subject use illustrations as often as they can, so that even if this example was found in a lecture, I feel confident enough to assert that it would be accompanied by something like Diagram 1a. There are difficulties that this account has not hinted at : to do with how thin "thin" may mean, where an illustration saves many words,

[**] This number refers to the lecture transcript.

[***] This topic is given fuller treatment in Murphy and Candlin, op. cit., section 7.

or how to describe a graph. Use of visual information may simplify the verbal message: without it, the possible learning tasks related to materials cannot be authentic to the teaching objectives, insofar as they are determined by the nature of the text.

3. However, I am not considering the scripting or ghosting of an Engineering lecture for use on an ESP course, but the use of unscripted, unrehearsed native speech recorded in a lecture before a student audience. The use of such audio-recordings is becoming more widespread in general purpose courses (e.g. Moller and Bolliger, 1979) and in ESP courses (e.g. McDonough, 1978, where "slides and visual material" were "not reproduced"), and there is a little material available on film or video-tape (e.g. Candlin, Bruton, Leather and Woods, 1978). Using such authentic material in the classroom has distinct advantages at certain times: even ones as simple as that in the lectures I am considering here, the pace of delivery is that of an Engineering lecturer in front of an undergraduate audience, where I assume that their behaviour is to some extent controlling or modifying his pace. That would not be easy to reproduce in a recording made by a teacher.
4. Having decided that I would use such an audio-recording in preparing materials it became necessary to decide how to display the visual information, and what parts of it to select. The selection for the extracts here is based on the analysis made in Murphy and Candlin, 1979, and includes the diagrams and notes drawn by the lecturer, given stage by stage, and those gestures which link spoken word and a diagram, as well as certain gestures made while speaking but not pointing to, or outlining visuals on the board. These gestures I have called iconic: they reproduce and stand for their referent; the gesture of tilting the pursed hand by the mouth, as if holding a cup, to mean "drink", is an everyday example of an iconic gesture.*
5. The lecture had been recorded on audio and video-tape, but it would not be possible to use the video-recording in a note-taking exercise because the notes are not clear enough to copy from a TV screen at any distance. However, video equipment is not widespread and I wanted to try out a simpler cheaper medium, tape-slide. There is good support for the use of static rather than moving visuals for most educational purposes, and considerable success has been reported with the use of tape-slide presentations in disciplinary courses, both in terms of their popularity with students, and their effectiveness as a medium of instruction (e.g. Hills, 1976; Schramm, 1977). The reported uses are of purpose-made

* The lecture extract referred to here, and the lecturer's accompanying notes are given in an appendix.

tape-slide-programmes, whereas I have put slides with a lecture recorded before an audience, or rather with extracts from a lecture. The equipment necessary for making and presenting tape-slide sequences is simple and need not be expensive; technical details of making programmes are described in many books on audio-visual aids (e.g. Duncalf, 1978).

6. In preparing a scenario for the extract it was necessary, as I have said, to decide what visual information to select from the analysis of the video-recording. Obviously the diagrams and notes written up by the lecturer had to be included :

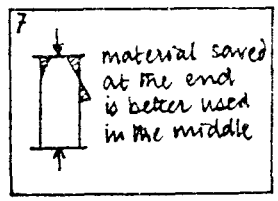
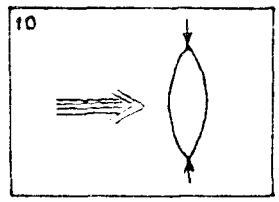


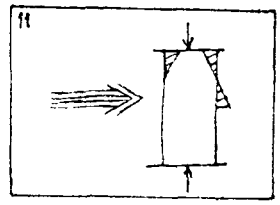
Diagram 2

Exophoric reference, where the lecturer's spoken text was linked, by gesture, to a diagram is included as the visual information may clarify the spoken text, and reduces the possibility of confusion :



- this is going to cost more to make than. *(9.5)*

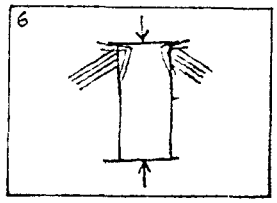
Diagram 3



- the straight one. *(9.5)*

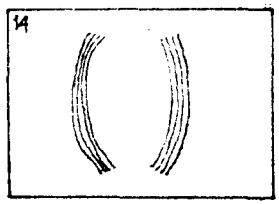
Diagram 4

The diagram, 4, shows an example of the lecturer's use of gesture to underpin or emphasise what he is saying, rather than gesture clarifying an otherwise obscure part of the text. Similar emphasis occurs with :



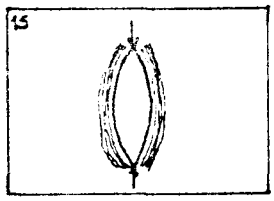
- so why not save some material at the ends. (9.5)
Diagram 5

where he touches the top end of the straight-sided column. The lecturer also uses gesture independently of any diagrams:



- you'd have to make a mould.
Diagram 6

This attempts to reproduce statically the iconic gesture made with both hands when the lecturer was facing the audience: it traces the movement he made with hands held a few inches apart, open flat, with palms facing, as if he was running them over an elliptical body. He reinforced the point of this by going on to outline the curved sides of the diagram he had drawn:



- (14. you'd have to make a mould) which was curved. (9.5)
Diagram 7

7. Twenty four slides were needed for this four and three-quarter minute extract; ten record the diagrams and notes, in different stages of development, seven show exophoric reference and six show reference which I loosely classify as emphatic or supportive; and two reproduce iconic gestures. There is research to suggest that students find colour more interesting than black and white visuals, and of course it permits some coding, for example, in slide 15 (shown above) the "gesture" was drawn in a different colour from the diagram (slight underexposure gave the whiteboard a greenish tint and ensured that the slides

did not dazzle when projected). This technique seems to add sufficient visual information to clarify the text and achieve something of the multi-channel presentation that students have to process in a lecture. Tape-slide as a medium is obviously different from a lecture in some respects; it is possible to focus more closely at times on parts of the visual information, returning to display previous information only as and when it is required. The lecturer can only achieve this by use of gaze-direction and an eraser! In preparation there did seem a danger that some slide-changes would be too fast, in particular that the requirement to change from a slide showing a diagram or notes to be copied might not leave time for students using the programme to complete this. In practice this has not happened, probably because the original pace of delivery had to allow for this too. I will return to the programme in use later.

USING INFORMANTS' NOTES

8. Making notes well is recognised as a necessary study skill, however it is not always clear what constitutes an adequate set of notes. In teaching people to take notes it seems important to take account of the expectations of those who teach and learn within a discipline. An ESP materials-writer/teacher will want materials-related tasks that direct students to acquiring the skills that the good average Engineering student uses or is considered to need by an Engineering lecturer. With this aim in view we collected sets of notes from British students at the original lecture. From these notes it is possible to see a little of the note-taking process as accomplished by native students: what they select for recording, and whether this comes from the visual or verbal information presented to them. It is not possible to compare their work with that of foreign students at the same lecture, but it can be used to evaluate that of foreign students using extracts from the lecture to practise note-taking. I suggest that this may indicate focuses for the tasks to accompany the use of such material, and that these are particularly appropriate for use in a self-access programme.

   Six sets of notes made by native speaker students were obtained after the lecture and examined with the lecturer. They were all considered to be adequate in his view, and two sets were singled out as being "very good". The notes for the extract being considered here were all passed without criticism". The students themselves were not interviewed. The sample is small and the evaluation rudimentary, however, they have provided information for a preliminary investigation that has seemed sufficiently worthwhile to suggest that more methodical follow-up will prove valuable.

9. In examining these sets of notes the record of what was put on the board was taken as the basis for comparison. I wanted to see how far the students straightforwardly recorded the lecturer's notes and diagrams, and how far they made modifications and selections in their record.

1. Omissions

All of them left out the sub-title for this section, "Real Struts.*** Five students omitted the last diagram (15 in appendix), a strut.

2. Extrapolation

Four of the students interpreted "So why not save some material at the ends" to mean both ends of the strut and drew the first diagram like this:

Diagram 9

This may not always be correct, it may only be possible to make savings at one end, depending on the loading of the column. The lecturer did not pick on this as an error, presumably because such calculations were

*– beyond the soope of this course (9.3)****

* Adverse comments were about such points as failure to copy the top of a graph curve adequately, e.g.

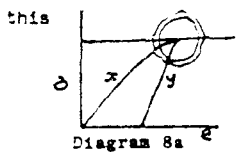
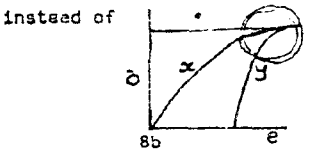


Diagram 8a



8b

This kind of point can obviously be incorporated in correction sheets when such material is used on a self-access basis.

** Of course the topic does appear to be *ideal struts:* further complicated by their frequently being called "columns" in Engineering textbooks (e.g. Haug and Arora. 1973; Palmer, 1976; Parker, 1972 but "struts" in Allen and Bulson, 1980). The terms are almost interchangeable for "compression member"; "column" may be more generally used for a compression member in a building, and "strut" for a compression member in a framework; designing compression members is a problem in both *civil* and *mechanical* engineering (Stephen Harris, personal communication).

*** Surveying the literature I found that the great majority of authors did not consider tapered columns at all, in one of two treatments of the subject they are just considered a "specific case" requiring a separate formula for calculating their load-bearing properties (Allen and Bulson, 1980). In the other (Haug and Arora, 1979), this optimal design is to achieve a "minimum weight column" and in fact, under the greatest load considered, the column is straight-sided!

3. Additional Notes

Two students recorded the final comment comparing the difficulties of securing ties and struts:

S2 : don't have same problems securing struts as ties :

S5 : struts need not have holes drilled (loading attends) ↓ ↑.

One student prefaced the note to diagram 2 with

S6 : more mixture required to prevent buckling in centre of strut so....

And the same student added to the notes with diagram 4

S6 : so not often used-cheaper to use more material and simpler shape.

There was a certain amount of rephrasing, and one student rephrased many of the notes, e.g. with diagram 2:

S4 : it is often practiced to take material from the ends and use it in the middle to reduce the tendency to buckle.

The only one to copy it noted that diagram 5 showed

S3 : (an) old-fashioned strut.

11. The tape-slide presentation has been used with nineteen foreign students on a course in technical English in which they had already worked on note-taking for some time. It is informative to compare their notes. They proved to be less selective: only five omitted the final diagram. Otherwise they could be inappropriately selective: two copied notes only and no diagrams; and seven of them did not develop the first diagram (12 in appendix) beyond its first stage:

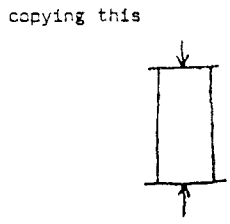
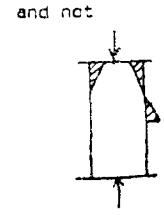


Diagram 10a



10b

Some managed extra notes; e.g. prefacing diagram 2 by

- we can prevent this strut from buckling by....

and - there is not such an effect on the end;

One noted that

- we don't have same problem than we have with ties.

Since the native students had, in the previous lecture, heard about ties they had reason to note this; the reference to ties needs glossing (this was done, see 14 below).

12. Extra notes reveal some important misunderstandings: one records a note on the need for a curved mould next to diagram 5 adding "steel rods in the middle". He confirmed that he had used his knowledge of reinforced concrete to interpret the lecture. Rather more serious is a note with diagram 4, the tapered strut,

    - the danger of the top is less than in the bottom.

    An odd mistake appeared where three students wrote "-sigarate shape" for "cigar shaped", and argued that they did not agree it was *cigar* shaped:

EXPLOITING THE INFORMATION AND THE PROGRAMME

13. In this section I am going to examine points I think the preceding section raises for consideration in preparing such a tape-slide programme for use in self-access; this medium is eminently suitable for use in this mode, as Hills reported. The whole area of self-access is receiving considerable attention at present and work on listening skills is probably the most advanced (cf. Vernede, 1979 and Windeatt this volume).

14. There are pointers to the need for careful presentation of the extract, particularly references to knowledge the lecturer assumes is common: his treatment of ties, and recall of the "phenomenon of buckling" (diagram 13 in appendix); students using the programme will need to know about these:

    - This is from a lecture on structures. The lecturer has talked about the use of ties and is now talking about struts or columns. He has mentioned the danger of buckling and has shown how to calculate loads on struts.

    I would not propose starting a course or part of a course with the programme under discussion, but rather using it in a series of extracts. In this way some assumed knowledge might be built up by students before they got to this paticular section. Making decisions about the relative importance of parts of a lecture is not easy when you only have a short extract (one eighth of the whole) and it would be easier if this extract was one in a series.

15. Students need to be clear what tasks they are being given and what is being assumed of them: for example, many of the group of foreign students who used the programme still had not learned that they did not need to record everything that was displayed to them. Given their previous educational background it may not be surprising that they felt all selection was a task for the teacher. There seems to be a tendency on the part of the language students to accord great weight to the visual point of the message, and they need to grasp, for this extract, that part of the message may be incomplete and party superfluous. More important, they need to follow and select information from the verbal message. To explicate the task they need to be told to

Take notes from what you see and hear during the leture extract. Try to select only those parts which are important to knowing how to design and make struts; everything you see and hear does not have the *same* importance or relevance.

What can you leave out in this extract?

Can you complete or add to one of the diagrams you see?

What important fact about using struts are you *told* and not shown? Note it down.

16. The basic criterion for selection has not been stated and it is evident that a fuller consultation of the informant(s) would be useful here. For the moment it is possible only to consider the purpose of the note-taking as a basis for definition. I have suggested elsewhere (Murphy and Candlin, 1979) that in teaching note-taking in a foreign language there is a danger that the skill will be seen as an end in itself and not an activity which is part of a series in a study-cycle. The Engineering student will use these notes in other parts of the course: seminars, problem-solving tasks, etc. In this lecture there is specific reference to "your project", which requires the use of struts, even if calculation of safe loading of struts is outside the scope of the course;

- *I'll just give the formula because you'll have to use it.*

This does suggest that the amount of information needed can be defined:

To decide what is important or relevant, note down things which you need to know in order to use struts yourself or solve problems including the use of struts.

Such a directive would relegate the historical note to a level of relative unimportance, and emphasise the importance of

- *you can just press on the end (9.5).*

The series of extracts in use might well conclude with a carry-over exercise, where the sum of notes were needed to work a number of problems.

17. Before carrying out some task dependent on the notes made from the lecture extracts, students need some way of evaluating their performance. First, a minimal set of notes might be offered; for this extract, diagrams 2 and 4 (3 is important but comes from an earlier part of the lecture), and a note that

Connection of struts is easier than ties; fewer holes; just press on the end.*

It should be understood that in some sense this record is "the least you would need to know". Attention may be drawn to the completed version of diagram 2 (see 15 above); and the reason for omitting diagram 5 given.

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* After all, this was announced as a topic at the start of the extract:
....real ties. on how you connect them, just spend a few minutes looking at real struts.

The extrapolation from the text, and from diagram 4 which suggests modifying diagram 2 to show material saved at the bottom end, as well as the top, may be pointed out. Doing this may make diagram 4 less essential for the record, but not the accompanying written notes.

18. The preceding suggestions would permit the language student to evaluate his/her ability to take notes but, as is evident I imagine, some might still be satisfied with simply copying what they see. Much, indeed most, of the selection is done by the lecturer through what he writes down or draws. However, informed selection by the student depends on interpreting and processing what the lecturer says, so some way of evaluating this understanding is needed. Take for example the omission of diagram 5.

    Did you understand that this is found in *older structures?*

    The lecturer says this before and after drawing the diagram. His example is from a station roof: most stations in Britain are old, often 19th century or early 20th.

A true false or multiple-choice test might be given to attempt first, with such explanations after; students might use their notes to complete this.

This would permit the student to check his comprehension and then look at those points which had not been properly understood. Again with diagram 5:

Question : The steel bars are inside a concrete strut YES/NO

Answer : NO: You are right the strut is made of steel bars.
YES: Are you thinking of reinforced concrete? The strut is made of steel bars; the struts in the station roof are made of *single bars of steel, bowed out into cigar-shape: other bits of steel ,hold them in position.*
Concrete struts shaped like this *you sometimes see* in *more architectural* buildings, such as *concert halls.*
Listen again, try to catch the phrases underlined here.

A similar treatment for diagram 2 might include questions about which part of the column-end, middle, top, bottom-was most vulnerable to the effect of buckling and whether an ideal column would be lighter or heavier, the first question to be discovered from the text but the second requiring inference. Grasping the first point would be more crucial and this could be indicated to the learner.

CONCLUSION

I have proposed the outline of a solution to the problem of incorporating visual information in ESP listening and note-taking material. The use of tape-slide seems a reasonably inexpensive way of acquiring the resources to present such material, particularly compared with the cost of video; it is aso technically easier to get good

audio-recordings and to add slides than to get good video-recordings. Tape-slide has been used in this way to students' and teachers' satisfaction in content-courses; its use has yet to be evaluated in the context where I am proposing it, though at this stage positive results seem likely. Considerable refinement may be possible in terms of modifying and improving programmes and material. Similarly the role informants might play in designing materials has been under-exploited here, and the considerable potential such co-operation offers might be put to use in many other ways.

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APPENDIX

From STRUCTURES, a lecture by A.N. Crossley, Department of Engineering, University of Lancaster

(Numbers in brackets refer to the diagrams given below)

(11) eh well I said quite a lot yesterday on eh real ties. on how you. connect them. just spend a few minutes looking at. real struts. (12) if you put a load on. a strut like that. the biggest danger is probably this. eh. phenomena. of buckling. (13) or bending sideways. I think it's fairly obvious that. the fatter this thing is in the middle. the more resistant it will be to being bent sideways. again I think you

can probably. eh. visualise. that there's not such a great effect. at the ends. eh. to bend sideways. and so why not save some material at the ends. and put it in the middle instead. so the material. there at the ends. is better. more efficiently used if it's put in the middle. and so an ideal strut. eh. an ideal thin-ended strut. isn't er a uniform thickness all the way down. it's probably more cigar-shaped. (14) something of that. sort. now it's the same old story. eh. this is going to cost more to make. than. the straight one. and so it's a question of balancing. savings in. materials. against saving in. manufacture. so this will certainly always be. more expensive. for example if you're making that out of concrete you'd have to make a mould. which was. curved. and that always. causes difficulties. whereas if you're making a straight one. you could just use. straight pieces of wood. and it might be cheaper to put in extra concrete at the ends there. than make a nice. shape like this. so the usual rule is unless you're going to make very significant savings. by making it cigar-shaped. then you don't bother. so you don't see a lot of. eh. structures like this. but there are a few around. especially the older ones. again. eh station roofs. the one in. Lime Street. you'll see. struts in the roof. (15) made like this. they're single. eh. bars of steel. and they're bowed out into cigar-shape. they've got. other bits of steel across. to hold them all in position. and that's a fairly. eh. common sort of strut in older. structures. you sometimes see this in. eh. concrete. buildings. but usually the sort of more architectural ones the concre. the concert halls that sort of thing rather than the. run of the mill. office building. now one advantage the strut has over. the tie. is that you don't have to start drilling holes in. or many holes in. to get the. to get the load in you can just press on the end. so you don't often have the (.) same difficulties with connections. and building struts. that you do with ties.

On the blackboard :

11. Real Strutts

12.

material saved at the end is better used in the middle

13.

long thin member fails by buckling

14. Ideal strut is cigar-shaped

more expensive because of shape

15.