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Material Production for an EST Course: Coursebook Design for the English Training Programme for Architects and Civil Engineers

Abstract

This paper presents the material production of an EST (English for Science and Technology) course in an English training programme for architects and civil engineers. The programme was specially designed for the construction professionals whose needs were investigated and analysed by the trainers, ESP (English for Specific Purposes) specialists from the British Council and Chinese counterparts. The article firstly focuses on the theories of needs analysis which support the investigation and analysis of the programme. After that, the needs of this programme (for both organization and participants) are recognized and organized with illustration of programme framework and a particular course (EST) syllabus. Then the literature of material design is reviewed and the rationale for the material writing is discussed with the presentation of a sample unit.

Key Words: needs analysis, material production, programme framework, rationale, task, EST, ESP.

1. Introduction

With the fast development of economy and technology in China, the demand for English application has been growing in all the professional areas. Many professionals need to read, write and speak English at their jobs to communicate with their work partners or to obtain information in English. As a result, various English training programmes have been developed to meet these needs in organizational settings, at tertiary level education or in language training classes/schools. As a part of Technical Cooperation Programme, the British Council and the Foreign Language School of Chongqing University co-operated to initiate a project, an English training programme for architects and engineers. The aim of this project was to offer specific English training to post-experienced architects and engineers to enable them to communicate in English in their profession. This paper is firstly going to discuss theories and research findings by reviewing some literature on ESP needs analysis. With the study, there will be the presentation of the designed practical needs in this project which were investigated and analyzed through interviews, pre-course tests and questionnaires. Then the programme framework and a detailed course syllabus will be schemed out. Afterwards, the study will focus on the theories of material production, on the basis of which the rationale of material design for this project will come up. Some segments of a sample unit will be presented to illustrate the material design.

2. Needs Analysis

In this section, literature on needs analysis will be reviewed first. Based on the study, the needs of target audience group will be investigated and identified as their business processes and communication needs in English.

2.1. Literature Research

As ESP is an approach to language teaching in which all decisions as to content and method are based on the learner's reason for learning (Hutchinson and Waters, 1987:19), ESP programme designers should put a great weight on learners' needs even though these needs are perceived by course designers as in EAP (English for Academic Purposes) at tertiary level education or surveyed and analysed as in EOP (English for Occupational Purposes) in any professional application. Mackay and Mountford (1978:21) also stated that "in order to design and teach effective courses, the teacher and planner must investigate the uses to which the language will be put". After adequate investigation into learners' needs, "the teacher is one step nearer being able to translate these needs into linguistic and pedagogic terms in order to produce and teach an effective course" (Mackay and Mountford, 1978:21). Therefore, it can be conceived that the needs analysis is an initial and allimportant step to ESP programme. Holliday (1995) presented the scope and approach of an ESP course as needs analysis, curriculum design and implementation design, where needs analysis came first.

It is known that ESP is distinguished from General English not in the existence of needs as such but in the awareness of the needs (Hutchinson & Waters, 1987: 53). So it is vital for programme developers to find learners' needs and analyse them in the view of not only teachers, but also course designers. According to Hutchinson & Waters (1987: 55-63), learners' needs could be categorized as target needs and learning needs. These needs could be further identified as objective needs and subjective needs (Chen, 2006) which include necessities (organizational and personal target requirements), wants (learners' personal perceived needs) and lacks identified from present situation analysis (Hutchinson & Waters, 1987; Shaaban, 2005). For

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many ESP practitioners, needs ascertainment of target situation and present situation is much easier than those related to learners' personal needs and wants because individuals have different needs which could cover a wide range from personally recognized job needs or promotion needs to affection or emotional requirements (Chen, 2006). Robinson (1991: 7) describes these as "what the students themselves would like to gain from the language course. This view of needs implies that students may have personal aims in addition to the requirements of their studies or jobs." Experience has taught us that a student is well motivated towards a particular course or activity if he finds it satisfies his needs relevant to him.

2.2. The Target Audience Group and Their Needs

The main participants of the course were post-experienced architects and engineers from different designing institutes and construction companies. They were all undergraduates and postgraduates who had a command of general English at intermediate level. All of the course learners were sponsored by their organization to take the programme full time for 3 to 4 months. The needs were identified by interviews with potential learners and sponsors, questionnaires distributed to some organizations and some pre-course tests which were taken by the learners to find their basic linguistic elements or lacks. Following the statement of Mackay (1978:21) "if a questionnaire is to be used, the teacher must determine what kind of information about what he requires and design questions to elicit this information", the checklist of *a target situation analysis framework* (Hutchinson and Waters, 1987:59-60) was employed. But the most applied instrument was interview. Since the paper focuses on material production of ESP, the processing details of needs analysis will not be discussed here. The following are the identified needs.

2.2.1. Why is English needed for the Learners' Profession?

Since China became committed to reformation and opening up, the building and construction sector has been facing up to fresh challenges. One of the solutions to meet the challenge is to provide courses to enable architects to get National and International Accreditation, which requires their English language competence. The other is to consider setting up agencies abroad and sending architects abroad for training, construction projects or international conferences or other forms of exchanges/communication. In fact, some of the design institutes and construction companies have begun to tender internationally for projects. Therefore, English, as a lingua franca, is needed when they are entering the world market.

2.2.2. The Architects and Their Business Process

There are different kinds of architects and engineers working on the design of certain projects. These include architects, structural engineers, service engineers (water, gas, electricity supply, heating, ventilation and air-conditioning), cost analysts, city planners, landscape architects and interior designers.

Their design or work processes mainly involve the following stages:

- site analysis and planning
- cost analysis, design and construction planning
- design procedures
- structural engineering
- environmental control and services
- construction and material cost
- project management

2.2.3. The Basic Communicative Needs:

From the above described work processes, three broad communicative areas were ascertained that require coverage in the provision of any technical language training in construction field:

- Design/Technical

 i.e. working drawings and related design literature e.g. case studies, codes, specifications and regulations
- Contractual/Business

 Contractual/Business
 i.e. the contract administration literature and the language of meetings, negotiations, etc.
- Product/Commercial & Technical i.e. product information, e.g. product descriptions for CAD software, HVAC units, lift/elevator technology, etc.

These in turn require the architects and engineers to be able to:

- describe site plans, sketches, outline proposals and working drawings (plans, elevations, axonometrics, isometric detailing, etc.
- answer and ask questions related to all the above
- discuss design concepts and matters of architectural style
- present design work and understand the intention of other specialists' critical comments and react appropriately
- understand authentic articles and texts related to codes, modern trends, techniques, standards and performance specifications
- understand materials related to bids, tenders, contracts and project management practices
- take an effective part in technical/business type meetings and negotiations, etc.

These learners' communicative needs will then be integrated into the following curriculum design and syllabus writing.

3. Course Outline

Based on the above needs analysis, the course designer identified the global aims of this course as: to enhance the participants' listening, speaking, reading and writing skills in general English; to bridge the gap between general English and common core technical English; to introduce linguistic element input along with specialist subject input and to activate learners' interests, awareness, confidence, autonomy and exploitability in learning by employing communicative classroom activities (Chen, 2005). Thereby, the programme framework was developed and EST course syllabus was devised.

3.1. The Programme Framework

The programme framework was devised with three stages --- preparatory courses, core courses and project courses (See Appendix 1). This division aimed to prepare the learners with adequate linguistic competence by gradual training inputs.

In the framework, EST was one of the project courses at the third stage. According to the communicative needs of the target group, the destination goal for the learners was to apply language skills in the job communication. Thus, the ESP programme was designed to develop the participants' integrated skills, involving speaking, listening, technical reading, EST, commercial English and practical writing in three stages: preparatory, core course/intermediate and project course/upper intermediate.

3.2. EST Course

EST course focuses on practical projects, authentic material packages from case studies and working details. *Text 2* in *Unit One* is presented as a sample text to demonstrate the material writing principles (See Appendix 2).

The rationale and theoretical basis of ESP material production will be studied in the following section with discussion on a sample text and the activities or tasks.

4. Rationale for the Material Production

There are three possible ways of material application: existing materials, materials writing and materials adaptation (Hutchinson and Waters, 1987: 96). At the second stage, *Core Course* stage, a general technical textbook was selected form existing

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materials to bridge the gap between general English to specific technical English. This targeted at offering the learners enough linguistic elements not too difficult in both language and contents. But at the third stage, *Project Course* stage, a more subject-specific textbook was designed to train the learners' language competence to achieve their goal of communication at jobs. There are several reasons for the material writing as Hutchinson and Waters (1987: 106) listed: 1). it was not available commercially because such a textbook was very specific in a particular area; 2). existing materials couldn't satisfy the learners' special needs, nor could they offer either language or content in depth. Based on the rationales, an existing textbook was selected only at the second stage.

4.1. Framework of the Coursebook

The coursebook includes six units covering twelve texts using the subject matter of students' specialty (Williams, 1980). It provides a clear and coherent unit structure and embodies a view of the nature of language and learning (Hutchinson and Waters, 1987: 107). Each unit presents a certain topic, e.g. Unit One focuses on construction materials and their applications in cladding. Two texts in each unit are organized to present the unit topic with case studies and some practical working details. All the six topics are related to the common issues of architecture and up-to-date techniques. This organizing structure supplies enough chunk of linguistic input in a familiar content of students (Williams, 1981) because these topics are chosen from the needs analysis based on the interviews and questionnaires. The needs survey revealed that architects and engineers need information on modern design techniques concerning the topics of cladding (materials, processes and techniques), external walls (style and structure), working details (techniques and products), fire codes and regulations, lighting (up-to-date systems) and HVAC (heating, ventilation and air-conditioning). Therefore, twelve texts are selected on these topics related to the learners' areas of interest. According to Williams (1986), in the absence of interesting texts, very little is possible. Besides, two texts under one topic illustrate the topic more explicitly. They offer course participants more information from different case studies.

4.2. Organizing Principle

Johns and Davies (1983) refer to text as linguistic object and text as vehicle for information. As a linguistic object, a text should show the syntactic structures being taught at that point in the course and contain a certain proportion of new vocabulary to be learned (ibid). Accordingly, all the texts are designed with activities of language input, such as vocabulary learning and syntactic learning in language awareness tasks. As a vehicle for information, text writing should depend on learners' purposes and needs of their specialisation and concentrate on content of the text and process by which that content is acquired (ibid). Since the coursebook is written for postexperienced architects and engineers at the upper intermediate level, it organizes all

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the architecture related content through which linguistic elements are acquired as well as content. Generally, the organizing principle is the topic and task based on an analytic syllabus (Wilkins, 1976). According to Wilkins, analytic syllabuses "are organized in terms of the purposes for which people are learning language and the kinds of language performance that are necessary to meet those purposes" (ibid: 13). The post-experienced learners already have an intermediate command of general and sub-technical English. Their purpose in learning EST was to communicate in their construction profession. Therefore, the coursebook of the topic-based syllabus is designed to meet this purpose. Furthermore, Nunan (1988:28) says that "learners are presented with chunks of language which may include structures of varying degrees of difficulty". Since there are no existing specific textbook for this EST course, authentic materials are selected and organized into a coursebook. But, as Moordin and Samad (2005) point it out that ambiguity is unavoidable concerning the way the language content is presented. It is true of the language presentation in the coursebook because it could not be adapted in terms of linguistic complexity with authentic materials. The textbook writers are required to extract patterns and regularities from those items to smooth the learning. In addition, the language presentation of varying degrees of difficulty supplies participants with opportunities to review the learned vocabulary used in a subject specific context, to learn new lexis on the target topics, to review grammatical structures and thus to obtain language By studying topic-based and task-based texts, the participants' awareness. communicative needs are satisfied through an increased command of the language in their own profession.

4.3. Selection of Input Texts

Consideration of EST text selection includes authenticity, content and language input.

4.3.1. Authenticity

According to Robinson (1991:56-58), in-house produced materials are more specific for unique learning situation, "have greater face validity in terms of the language dealt with and the contexts it is presented in". Authentic materials differ form teacher-written textbooks in organization of vocabulary choices and grammatical structures. They appear to have no difficulty sequence, but they are used in the way of real profession situation. They are superior in relevance to learners' lives and jobs as well as in display of easy but realistic, ready-to-use language (Hwang, 2005). Therefore, all the texts are selected from authentic materials, such as journals, newspapers, research articles, reports, newsletters and subject content books. They are neither simplified nor revised because the original texts supply participants with authentic language interaction. The sample text, for example, is chosen from the Architecture journal. The reading text Glass under Tension (Appendix 3) and the text for information transfer Commonwealth Edison Transmission/Distribution Center (it is a drawing copied from a journal.) are all original articles. The listening tapescript is also written from an original article Medical Center Library Vanderbilt University. They offer a real situation of language use in the architectural field so that course participants can learn practical and useful language skills and items to apply in their profession.

4.3.2. Content

A material design model as described by Hutchinson and Waters (1987:108-109) consists of four elements: input, content focus, language focus, tasks. "Language is not an end in itself, but a means of conveying information and feelings about something. Non-linguistic content should be exploited to generate meaningful communication in the classroom." (ibid: 109) The ultimate aim for the learners is to be able to communicate orally or in written form in genuine work settings. Thus, the contents of all the texts are relevant to the participants' professional needs and personal interests as mentioned in 4.1 and 4.2. The sample text *Glass under* Tension introduces the application of glass to create curtain walls and why tensile structure systems are used in glass-clad buildings. It covers not only its application in history but also the recent development of manufacturing techniques and new projects. Two articles of practical project case studies are demonstrated to illustrate the topic of tensile systems used in glass-clad buildings. All the three articles are presented with photos and drawings because in technical reading, visual data greatly assist students' comprehension (Williams, 1982). The selection of the content aims at exploiting the architects' knowledge of the topic to depict the kind of linguistic and communicative characteristics of the topic (Mackay and Mountford, 1978:138). Since these at-work course participants are already familiar with the subject, they do not worry about understanding the content, but rather the unfamiliar linguistic fractions. However, with the visual aid of pictures and drawings in the materials, they can understand language items through information transfer (Nuttall, 1982). As for language teachers who will teach the course, this presents a challenge to them because they have to be expected to learn some subject knowledge through the teaching process. Otherwise, it is hard for purely linguistic teachers to handle the language class involving in specific subject content. This is another topic of teacher training and qualification of ESP practitioners, which is beyond the discussion scope of this article. However, teachers could learn some content knowledge while learners are expected to learn both skills and language. Therefore, teachers and learners could help each other and learn from each other through the implementation of the coursebook.

4.3.3. Language

Language is the other focus in a coursebook, in which learners have the chance to take the language to pieces, study how it works and practise putting it back together (Hutchinson and Waters, 1987:109). The sample text (Appendix 3) highlights the lexis, structures and discourse. Firstly, it presents many significant vocabulary items: subject-specific words of the topic, sub-technical words in scientific English and many common core words as well. Lexis is important to express functions (Swan, 1990) and the lexical input enables participants to learn and master these expressions to communicate on their subject. The text also focuses on a variety of structural items, such as word formation, use of V-ed and V-ing words. The input of these items offers the participants an opportunity to generate language awareness (Wright and Bolitho,

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1993) as well as to refresh the learned grammatical structures. Finally, the discourse of the text shows significance with clear sub-titles, paragraph and sentence coherence, cohesion of lexical collocation, anaphoric references and substitution (Williams, 1983). These inputs can enable the participants to improve their reading comprehension and, in turn, to develop their information transfer ability.

4.4. Organization and Sequence of Tasks/Activities

The concept of 'task' has become an important element in syllabus design, classroom teaching and learner assessment (Nunan, 2006). Nunan (ibid) defines a task as a piece of classroom work that involves learners in comprehending, manipulating, producing or interacting in the target language while their attention is focused on mobilizing their grammatical knowledge in order to express meaning, and in which the intention is to convey meaning rather than to manipulate form. He (ibid) also emphasizes that the task-based language teaching has strengthened the introduction of authentic texts into the learning situation. Ellis (2006) designs the task-based lesson into three phases: pre-task, during-task and post-task. Based on task-based methodology, the tasks or activities of the sample text are designed as pre-tasks: Pre-reading Tasks; during-tasks: Reading and Understanding, Learning Vocabulary, Language Awareness; and post-tasks: Listening and Information Transfer. The organization of these activities is based on the participants' background knowledge of both subject and language professional needs and communication requirements. The sequence of the activities can not be based on the degree of linguistic complexity because chunks of language items appear on the basis of topics in the authentic materials. Therefore, the analytical approaches described by Wilkins (1976) dominate the task design. The task designers are required to analyze those holistic 'chunks' of language and break them down into their constituent parts so that they could make meaningful language learning activities. All the pedagogical tasks do not aim only to enhance learners' linguistic competence, but to offer a simulated communicative application. The task completion involves more than one single skill like a traditional activity, but integrated skills around one main skill. For example, in the Reading and Understanding section, the main skill is reading, but speaking and writing skills are also involved because the learners are required to discuss with their partners and answer questions. Besides, filling answers in tables and giving comments require writing skill. The communicative target-based tasks provide the participants with an opportunity to see how real communication happens and an opportunity to practise integrated skills.

4.4.1. Pre-task Design

The purpose of the pre-task phase is to prepare students to perform the tasks in ways that will promote acquisition (Ellis, 2006). This acquisition includes both language and content learning. So taking advantages of learners' previous linguistic and subject's knowledge is the basic consideration in the pre-task design. The aim of *Pre-reading Tasks* is to make the participants think about the topic in terms of content and language by referring to their professional experiences and linguistic

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knowledge. *Pre-reading Tasks* and the teacher's notes are presented in Appendix 4. They are based on the literature and textbooks of Johns and Davis (1983), Grellet (1981) and Carrell and Eisterhold (1988).

4.4.2 During-task Design

During-tasks (Appendix 5) cover Reading and Understanding, Learning Vocabulary and Language Awareness. Reading and Understanding aims at improving reading skills, such as predicting, skimming, and scanning; developing comprehension by identifying, inferring; and recognizing cohesion. The purpose of *Learning Vocabulary* activities focuses on vocabulary-attack skills through identifying word chains that have topic relations and generating rules of word formation, while the Language Awareness tasks intend to arouse the participants' awareness of learned structural items used in their subject specialisation. Williams (1986) in his 'Top Ten' Principles for Teaching Reading emphasizes that the primary activity of a reading lesson should be text reading, which is a central activity. Based on this, three times ??? of reading tasks are designed: scanning the first paragraph and the first sentence of each paragraph to obtain the main idea of the text; detailed reading for full comprehension and skimming parts of the text to understand cohesion from noun and pronoun references. In the light of Williams' principles, the best skills and strategies for learners are to expand their 'sight' vocabulary, their recognition knowledge of commonly occurring sentence patterns and rhetorical patterning in a text. He (ibid) also stresses a reader's contribution of meaning (experiences of prior knowledge of language and subjects) to a text. Furthermore, he claims that classroom procedure should reflect the purposeful, task-based, interactive nature of real reading with required inter-learner discussion of the text and associated tasks. With this understanding, the tasks of comprehension check, cohesion, word formation/families, language awareness of use of V-ed and V-ing are designed to enhance the learners' linguistic competence by raising language awareness and assisting them in bringing their prior language and content experiences to learning processes in a communicative classroom. The task design models refer to the literature and coursebooks of Williams (1980, 1981, 1982, 1983), Glendinning (1973), Ellis (1984), Chaplen (1981), Johns and Davies (1983) and Cumming (1985) of both textbook and teacher's notes.

4.4.3. Post-task Design

Johns and Davies (1983) regard post-task as follow-up activity to the reading of a text. The group post-tasks into four types: 1) transfer of information in a text to other forms, e.g. diagramming, framework, gapped summary; 2) application or explanation of information, using what is learned from a text to carry out tasks analysing data, interpreting situation, solving problems; 3) extension of information; 4) application of techniques. Williams (1986) thinks that using a text does not necessarily equal to teaching reading. He (ibid) points out that teachers should use texts to develop appropriate cognitive strategies which lead learners to reconstruct the author's original message, develop generalizable, transferable strategies of meaning-reconstruction, which the learners can employ outside the reading lesson. Following these principles, *Listening* and *Information Transfer* tasks (Appendix 6) are

created as post-tasks of the EST course. *Listening* activities mainly concentrate on improving listening skills in subject content with visual aid and interpretation of given exercises, while *Information Transfer* enables participants to encode a reading text into a drawing form, which is an essential skill for participants as post-experience architects. The design of the tasks is much influenced by Glendinning (1973), Ellis (1984), Williams (1980, 1982, 1986) and Johns and Davis (1983).

4.5. Design of Tapescript and Teacher's Notes

In order to expand the learners' knowledge in the subject area and language skills, another authentic journal article *Medical Center Library Vanderbilt University* is used as listening material. The textbook of Waterhouse (1981), *English for the Construction Industry*, offers many ideas for writing a tapescript from an authentic material into a conversational tapescript in the specialist field of construction. The following is a part of it which shows the translated conversational style:

Davis: Er ... you see ... we use a hybrid tension and compression system ... because ... it can support the glass ... or deliver lightness and transparency economically. And also ...

Davis: It can ...

Tom:] Sorry, why do you say 'economically'?

'*Top Ten' principles for teaching reading* by Williams (1986) and the article of Johns and Davis (1983), *Text as a vehicle for information: the classroom use of written texts in teaching reading in a foreign language* offer much conception for writing Teacher's Notes. Appendix 7 shows parts of the notes with omission of Teaching Methods, Procedures and Suggested Answers.

5. Conclusion

ESP material writing like any EFL material writing involves inputs of content, languages and tasks designing as described by Hutchinson and Waters (1987). Since the EST coursebook is specially designed for a specific group of learners, an analysis of needs was conducted to ascertain the learners' requirement on which the material had to be selected and tasks be planned. This paper discussed the needs analysis based on a theoretical review and demonstrated the communicative needs for the course participants. Then the course outline was devised including a programme framework and an EST course syllabus. When these tasks of ESP were completed, the material production was presented with discussion of the coursebook framework and organizing principles. With a sample unit, the rationale for the selection of EST course material and task design were thoroughly explained drawing on the theories and research of ESP syllabus design, material selection and writing, content

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and language consideration as well as task planning. The presented designing procedure tried to depict the possibilities to improve the learners' enabling skills and to arouse their language awareness. In addition, it tried to exhibit how to bring the learners' background linguistic knowledge and professional experiences to EST course study and to expand the knowledge in a genuine situation application, which is the aim of any ESP courses. In this ESP project, this sample material writing and its designing principles have offered some ideas and modules to my colleagues to complete coursebook writing for the programme.

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Appendix 1. Programme Framework

Stages Tasks	Preparatory	Core Course	Project Course
Speaking	general topics of conversation, greeting, informal discussion practice, etc.	effective communication (meetings, negotiations and presentations)	talking about Architecture/buildings (activities specifically designed for architects and designers)
Listening	focus on general topics to enable the participants to understand aural variations	practical and conversational listening (top-down skills)	authentic and on-site conversation, aural variations
Reading	general English review	technical description and reading	
EST		general EST (Nucleus: Architecture and Building Construction)	EST (authentic material package about case studies, working details and codes)
Writing	review on general topics	focus on commercial and business writing	,
Business English		social programme	commercial English

Appendix 2. EST Course Syllabus

Unit		Activities	Reading and	Learning	Language	Listening	Informatio
	Topics		Understanding	Vocabulary	Awareness		n Transfer
Unit	Cladding						
One	focus on mater	ials and their					
	applications						
	Text 1	Concrete into					
		stone					
	Text 2	Glass under	prediction	word family	V-ed as	looking/	reading &
		tension	identifying gist	word	modifiers	reading &	drawing
			comprenension	formation	V-Ing's	listening	
			cohosion		Tunctions		
Unit	External Walls		conesion				
Two	focus on basic o	oncents of					
	external walls						
	Text 3	External wall					
		-offices (1)					
	Text 4	External wall					
		-offices (2)					
Unit	Working Details	6					
Three	focus on techni	ques and cost					
	analysis						
	Text 5	Mind over					
		machine					
	Text 6	Technical &					
		Practice					
Unit	Fire Codes and	Regulations					
Four	focus on fire co	des and their					
	applications						
	Text 7	Fire					
	-	protection					
	Text 8	Fire Alarm &					
		Vontilation					
Unit	Lighting	ventilation					
Five	focus on variou	s liabtina					
	systems	Singhting					
	Text 9	Architect-					
		designed					
		lighting					
	Text 10	Lighting the					
		workplace					
Unit	HVAC						
Six	Six focus on heating,						
	ventilation, air-	conditioning					
	and their codes	1					
	Text 11	Cool storage					
	Text 12	Indoor					
		ecology					

Appendix 3. Text: Glass under Tension

Glass under Tension

Hardware traditionally machined for racing yachts is now being architecturally applied to create curtain walls that are more transparent than conventional cladding. American architects are beginning to take advantage of slim, stainless steel rods and fittings to create tensile wall systems that can support more with less.

Such technology was first considered by Buckminster Fuller in the late 1940s and has been applied to many structures in Europe, especially in Britain and in France, over the past decade. One of the most significant glass-clad tension-supported buildings is the 1985 Museum of Science and Technology at La Villette in Paris, designed by Rice Francis Richie. Others known for their tension-supported glass-clad structures include Nicholas Grimshaw and Norman Foster.

Reducing structure

Tensile systems reduce the size of structural members by replacing the lateral load-resisting structure of a curtain wall with an intricate network of rods that measure as little as ¼ inch in diameter. Conventional curtain walls usually consist of aluminum mullions up to 18 inches deep and backer steel trusses comprised of bulky tubes and angles.

While both tension and compressive forces are resisted by a single member in conventional structures, tension members are designed only to resist tensile loading from a specific direction and are useless if thrown into compression. Wind forces on an exterior glazed wall, usually compensated for by a structural member located perpendicular to the wall, can be withstood by a pair of tension rods separated by compressive struts, one resisting inward forces and the other resisting outward forces. Tensile structures are usually built from rods, rather than cables, because rods are stronger and smaller in diameter. These rods consist of steel with a breaking strength of 200,000 pounds per square inch, about four times the strength of ordinary steel.

Advances in manufacturing

Tensile technology has also been advanced by the development of the computer tools needed to calculate the dynamic behavior of tensile structures, enabling engineers to correctly size the members. Nonlinear systems are especially challenging to design, because the tension elements are left slack and are tensioned only as needed to resist building movement. Tensile structural systems have also grown more sophisticated with the advent of computerized numerical-controlled manufacturing, which facilitates the production of a range of fittings with slight but essential variations, such as those required to create curved, glass-clad walls.

To achieve near total transparency, glass can be attached to the tensile system without mullions. In other applications, the glass is held in standard mullions or narrow channels that are fastened to structural members. Alternately, the glazing can be adhered to the tensile rods with structural silicone.

Tensile cladding systems have been slow to catch on in the U.S. until now because American architects have not been well acquainted with the technology. In addition, the high degree of customization required of many glazed tension structures has meant a high price. But projects such as the Medical Center Library at Vanderbilt University, with its hybrid tensile system, and Pilkington and Tripyramid's standardized systems promise to break down cost barriers. Such developments will enable more architects to experiment with the lightness, delicacy, and transparency inherent in tensile cladding systems.

Virginia Kent Dorris From Architecture Journal

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Appendix 4. Pre-Tasks

Pre-reading Tasks

1. Some Things to Think About

Working with Glass: How often have you worked with glass as a cladding material? Be ready to share your experiences with the rest of the group. Think about some of the joys and also difficulties of working with glass in this way. Was its use successful or not? If you have not worked with glass, think about why not.

2. Pre-reading Discussion

You are going to read a passage called 'Glass under Tension'. Work with a partner to answer the following:

1). List some of the words (e.g. materials, properties, etc.) that you expect to find in the passage?

2). From your own work experiences and knowledge, which advantages of tensile structure are likely to be mentioned?

Teacher's Notes

1. Students are required to do individual work, but they can discuss with partners. The previous work experiences are main resources of this task.

2. Students go on with discussion on Task 1, but should concentrate on vocabulary and advantages concerned with tensile structure systems.

Appendix 5. During-Tasks

5. Comprehension Check

Now read the text carefully. Try to get as many facts and details as possible.

1). What types of attachment used in a building are mentioned in the text?

2). How have computers helped engineers and architects in their design of tensile structures?

3). What two broad categories of tensile system are mentioned in the text?

4). What is the main advantage (as mentioned in the first paragraph) of tensile wall systems?

5). What specific properties or qualities are mentioned in the final paragraph?

6). Why are tensile structures usually built from rods and not cables?

7). List the buildings and architects mentioned in the text?

Architect	Building

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8). List some **specific differences** between conventional curtain wall systems and tensile systems by completing the table below:

Conventional Curtain Wall Systems	Tensile Curtain Wall Systems
lateral load resisting structure	intricate network of rods
bulky tubes and angles	
usually have mullions	

9). What is the **main difference** between conventional and tensile curtain wall systems?

10). **An example** is given in the text of how particular forces can be compensated for in the design of buildings. Fill in the table below with the necessary information from the text:

Force	Conventional Specification	Alternative Specification	
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6. Cohesion

Skim the paragraphs from the text again. Decide what the circled words refer to and write down your answers:

- 1). More what? Less what?____
- 2). What technology does this refer to?_____
- 3). Other what? ____
- 4). What can be withstood?
- 5). The other what?_
- 6). What enables engineers to correctly size the embers?_____
- 7). What technology? _
- 8). Which developments?

Now compare and discuss your answers with a partner.

Learning Vocabulary

When reading the text, you have met some unfamiliar words. Do not look up all of them from dictionaries. It will interrupt your comprehension. Try to identify and analyse them from their formation, classification or context clues.

7. Word Formation

Identify and understand the meaning of the 12 words listed below from their word formation. Classify them from their formation and put them under the proper

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headings. Work with a partner to discuss and explain the meaning or use of the words.

e.g. add \rightarrow addition 'addition' is the noun form of 'add' because suffix '-tion' gives the noun form.

whiteboard \rightarrow white + board 'whiteboard' is a compound noun consisting of an adjective, 'white' and a noun, 'board', meaning a white board.

oil (n.) \rightarrow oil (v.) 'oil' used as a verb is converted from the noun form of 'oil', meaning 'put oil on or into'.

Affixation ビン	Compounding	Conversion
Prefixation Suffixation		
1). hardware (line 1)		
2). stainless (line 6)		
3). backer (line 29)		
4). size (line 52)		
5). nonlinear (line 52)		
6). numerical (line 58)		
7). facilitates (line 59)		
8). customization (line 74)		
9). compressive (line 32)		
10). compression (line 37)		
11). tension (line 32)		
12). tensile (line 35)		

8. Word Families

Work with a partner. Scan the text again and write down all the words connected with...

forces/loads	components/parts	<u>glass</u>
tension/tensile	rod	glaze
		delicacy
vertical		
	cable	

Language Awareness

9. Use of V-ed

1). Look at V-ed words from the text in the following table. Identify their positions as modifiers from the context and check the table.

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V-ed word	Pre-position	Post-position
e.g. machined (line 1)		\checkmark
a). glass-clad (line 14)		
b). tension-supported (line 14)		
c). designed (line 17)		
d). known (line 18)		
e). comprised (line 30)		
f). compensated (line 38)		
g). located (line 39)		
h). separated (line 41)		
i). needed (line 54)		
j). computerized (line 62)		
k). numerical-controlled (line 62-63)		
I). required (line 66)		
m). standardized (line 84)		

2). Can you, in each case, write a longer phrase or sentence which captures the meanings.

e.g. glass-clad: clad with glass

a). tension-supportedline14)
b). designed (line 17)
c). known (line 18)
d). comprised (line 30)
e). compensated (line 38)
f). located (line 39)
g). separated (line 41)
h). needed (line 54)
i). computerized (line 62)
j). numerical-controlled (line 62-63)
k). required (line 66)
I). standardized (line 84)

10. Use of V-ing

From the text, you may find many V-ing words (gerunds or present participles). But they have different grammatical functions in the sentences. Look at the following V-ing words in the text and analyse their functions. Check the table and compare your analysis with a partner. Then give your explanations.

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V-ing Forms	Noun	Action	Modifier	Links	Explanation
eg. cladding (line5)					something used to clad exterior building. Here it is a curtain wall.
fittings (line 7)					
replacing (line 24)					
load-resisting (line 24- 25)					
resisting (line 42)					
breaking (line 47)					
enabling (line 55)					
building (line 60)					
manufacturing (line 63)					
glazing (line 72)					
cladding (line 75)					

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Appendix 6. Post-Tasks

Listening

11. Browsing and Listening

1). Look at the following photos and drawings of Vanderbilt University Medical Center Library. Identify and discuss what they show.

2). You are going to listen to a conversation between an architect and a journalist talking about using a tensile structural system in the curtain wall construction. Read the **elements chosen** in the table before listening. Then complete the table with information from the conversation.

VANDERBILT UNIVERSITY MEDICAL CENTER LIBRARY

Elements Chosen	Reasons for Choice/Purpose of Elements
a). hybrid tension and compression system	
b). the use of as many standard components	
as possible	
c). steel tension structure	
d). X-bracing vs single diagonal steel members	
e). stainless steel tension rods to be	
prestressed and adjusted	

3). Now listen again and complete the sentences:

- A). The area of the library is _____.
 - a). 18,600-square-foot
 - b). 86,000-square-foot
 - c). 80,600-square-foot
- B). The ______ wall of transparent glass is insulated.

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C). The curtain wall glass is _____ inch thick.

- a). 1
- b). 3/8
- c). 49
- D). The vertical trusses are spaced ______ feet apart.
 - a). 49
 - b). 40
 - c). 14

E). The curtain wall will be completed ______.

Information Transfer

12. Reading and Drawing

1). Reading:

The following text is about the Commonwealth Edison Transmission/Distribution Center. Read the text carefully and underline the words which give information about the building's facade.

2). Drawing:

The text provides a description of the west elevation of the building. Try and draw this elevation of the Commonwealth Edison building by using the information in the text. You may have to draw the elevation in stages: the window wall first, then the bays, columns and finally the truss network. Draw as much detailed as possible. Compare your drawing with that of others, and make any changes you feel are necessary.

3). Describing:

In a small group, describe your drawing in your own words.

Appendix 7. Teachers' Notes

<u>Aims</u>:

These in turn require the architects and engineers to be able to:

- To present and practise expressions describing a tensile structural system and its application in specific buildings.
- To practise reading skills.
- To develop awareness of functions of grammatical items and lexis.
- To practise listening skills with literal and visual aids.
- To practise information transfer with reading comprehension.
- The text presents content, language and visual input. Tasks include skills and functions.

<u>Input:</u>

Content

• an authentic article from an Architecture journal talking about the new technique of a tensile structure system and glass used as curtain wall material.

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- a specific application of the techniques to Vanderbilt University Medical Center Library.
- another application to the Commonwealth Edison Transmission/Distribution Center.

Language

- lexis: subject-specific words, sub-technical words, common core words
- word formation: affixes and compound words
- word family: words of material, forces and loads, glass, components and parts
- V-ed & V-ing words: V-ed words as modifiers of both pre-position and postposition; V-ing words used as modifiers, nouns, action behaviours and links
- spoken forms: conversational features of colloquial, hesitation, rephrasing, self-correction and noise fillers

Pictures

- photos of North Wall of Vanderbilt University Medical Center Library
- photos of design details
- photos of vertical truss
- axonometric drawing

<u>Tasks:</u>

Skills

- reading: skimming for gist, scanning for specific details and information, intensive reading for full comprehension, reading rubrics
- speaking: discussing, answering questions, giving comments, presenting, explaining,
- describing
- listening: a tape-recorded conversation, others' speaking, teacher's lecture
- writing: writing down answers, filling tables and blanks, writing comments

Functions

- identifying
- listing
- hypothesizing/predicting
- visualizing
- understanding

Teaching Methods, Procedures and Suggested Answers:

This text is suggested to be implemented for 4 hours: 1st hour: Task 1-5 2nd hour: Task 6-9 3rd hour: Task 10-11

4th hour: Task 12