How Engineers Write: An Empirical Study of Engineering Report Writing

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This study trials an analysis of engineering reports using a modified version of Gosden's (1993) analysis of the science research article Using Hallidayan sociolinguistic concepts the analysis primarily shows how engineering writers linguistically convert real-world entities and processes into non-real-world concepts and also tracks authorial presence in the article Concentrating primarily on the Mode aspect of Register, or how reality is constructed, the research looks at the system of organizing theme and information More particularly, it classifies the Subject in unmarked theme sentences to reveal strategic manipulation of thematic choices between real-world and non-real-world It is argued that the linguistic reconstrual into scientific concepts and data and then reconversion into real-world phenomena is the essence of the engineering report

A number of methodological and substantive findings are provided The modified version of Gosden's method of identifying (Un)marked Themes can be applied to engineering report analysis It is suggested that a new category, Analytical Concepts of Real-World Entities, Events, and Processes, *provides valuable information about the extent and position of the engineers' conversion of real-world entities, events, and processes into scientific concepts as it is the second most common thematic categorization It is claimed also that the small proportion of unmarked subject-themes in the Participant Domain of engineering reports suggests that the interactive metafunction is less important than in research articles because engineers do not need to position themselves within a discourse community*

These findings underline suggestions for improving engineering report writing in particular, better thematic organization, avoiding inappropriate narrative, greater use of adjuncts in marked theme sentences, and manipulation of theme subjects to enhance textual coherence

1 CONTEXT

This paper provides a limited description of the discourse used by engineers in what is arguably their major generic form, the analytical report The analysis employs the method that Gosden (1993) used in his analysis of the science research article and applies Hallidayan sociolinguistic concepts (Halliday 1978, 1994, Halliday and Martin 1993, Eggins 1994)

Gosden's research, which contributes to an already significant body of research into science research articles (Latour 1980, Bazerman 1983, 1984,

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1988, Myers 1989, 1992, Swales 1990), provides useful information about the nature of the genre and locates that generic form within a theory of discourse More particularly, Gosden shows how science writers linguistically convert real-world entities and processes into non-real-world concepts and also tracks authorial presence in the article Gosden uses two forms of linguistic analysis which I have replicated in a modified form Firstly, by considering the Subject in the unmarked theme sentences of Research Articles (RAs) he tracks the strategic manipulation of thematic choices between real-world and non real-world Secondly, by tracking the interactional themes revealing highest authorial visibility in the Introduction and the concluding Discussion of the Articles, Gosden claims 'greater insight into how discourse communities form themselves and carry out their work through texts' (Gosden 1993 72) These recurrent generic patterns, Gosden claims, can be applied most usefully in NNS (Non Native Speaking) and EAP (English for Academic Purposes) teaching with the added benefit of improving textual cohesion and coherence Furthermore the analysis helps to draw useful distinctions between the professions

My analysis gathers sociolinguistic data about the writing of engineering professionals in the same way that Gosden gathered information about scientists' writing It is not a comparative study, although some data is compared with that of Gosden Underlying both Gosden's and my research are theories about language, discourse, and genre which are briefly outlined below

2 LANGUAGE THEORY

Consistent with Halliday's (1978) sociolinguistic model (reaffirmed by Martin 1993), Gosden (1993 56) claims that writing is 'socially embedded' and 'socially constructive' That is, language realizes the social context, being 'structured to make three kinds of meaning simultaneously' (Eggins 1994 3) the interpersonal, the textual, and the ideational (Halliday 1978) Thus there is a mutually predictive relationship between text and context

3 DISCOURSE THEORY

Sociolinguist and New Rhetoric theorists substantially concur about the nature of a discourse community Halliday (1978), as a sociolinguist, understands the grammar of text as the realization of discourse 'a text is the product of its environment' (1978 136) Although Halliday refers to a 'paradigmatic environment' (ibid 137) rather than discourse, clearly the concept is quite similar to that used by Swales and, to a lesser extent, new rhetoric theorists such as Bartholomae, Bizzell, Bruffee, and Harris (Killingsworth and Gilbertson 1992 ch 8) The concurrence of ideas about discourse is evident in the theoretical comparison in Table 1 of Swales (1990 24–7), a sociolinguist, and rhetoric theorists Killingsworth and Gilbertson (1992) From this table, we can deduce that both theoretical paradigms recognize discursive communities, discursive boundaries, discursive devices, and generic forms

Table 1 Sociolinguistic and rhetorical theory comparison on discourse and genre theory

Sociolinguistic (Swales 1990)	Rhetoric (Killingsworth and Gilbertson 1992)
Writer as Member of Discourse Community	
has a broadly agreed set of common public goals (24)	Theorists such as Bartholomae, Bizzell, and Bruffee reject the notion of the private, individual writer and instead understand the writer as a participant in an ongoing discourse (163–164)
Discursive Boundaries	
has a threshold level of members with a suitable degree of relevant content and discoursal expertise (27)	The projects and agendas of the community determine what writers can and will do (165)
Discursive Devices	
has mechanisms of intercommunication between its members (25)	They have characteristic ways of communicating (170)
Generic Forms	
utilizes and hence possesses one or more genres in the communicative furtherance of its aims (26)	The discourse community consciously or unconsciously have developed conventional styles and text designs that might be characterized as genres, modes, or styles of the community's writing
Specific Lexis	
In addition to owning genres a discourse community has acquired some specific lexis (26)	

In summary, then, both sociolinguistic and rhetoric theorists could agree that discourse 'is the means by which communities develop and advance their agendas of action, build solidarity, patrol and extend their boundaries, and perpetuate themselves in the life of a general culture' (Killingsworth and Gilbertson 1992 162) However, the sociolinguistic notion of a specific lexis, not used in rhetoric theory, highlights one strength that this form of discourse analysis may have over rhetorical theory

4 NOTION OF GENRE

Within the sociolinguistic text-in-context model provided by Halliday (1978, 1994) and Martin (1992), genre can be understood as a method 'to describe how people use language to achieve culturally appropriate goals' (Eggins 1994 25) This is realized in language through schematic structure (how the beginning, middle, and end of text are organized) and its lexico-grammatical structure The lexico-grammar, far from being infinitely variable, realizes and redounds

with the contextual variables as it configures meaning in text (Martin 1992 494) A description of the genre can be predicted from the explication of the lexico-grammatical realization of register variables and the schematic structure [1]

Thus, genres are the products of social agents who use the language devices available to them within a specific socio-cultural context at a particular place and time Genre describes how text is structured within those constraints to construe meaning for various audiences and particular purposes

5 THE REPORT GENRE IN ENGINEERING DISCOURSE

Engineering writing is an instrumentalist discourse that is epistemologically constructed by the scientific concepts that provide its intellectual foundation (its social construction of reality) and is socially embedded in the relations and shared understandings that exist between engineer and client The engineering report appears to be the dominant textual form that engineers use to construct a particular social reality and, simultaneously, communicate a particular social relationship Engineers' reports might be classified broadly as either analytical or progress reports Progress reports are not considered in this study In analytical reports, engineers generally record their design of a construction or process, or their analysis of an existing construction or process, or present an opinion about a construction, process, or event that may be used in legal and quasi-legal situations (e g insurance claims)

6 RESEARCH FOCUS

The research is concerned centrally with the Mode aspect of Register that deals with how textual meaning is realized (Eggins 1994 78) This focus will yield information about how engineers organize natural phenomena into a paradigm of understanding Mode, says Martin (1992 509) is 'concerned with symbolic reality—with texture' or 'constructing social reality' At the level of Clause, mode is characterized by the system of organizing theme and information (Martin 1992 508, Eggins 1994 271) Theme, according to Halliday (1994 37), is 'the element which serves as the point of departure of the message, it is that with which the clause is concerned' By considering only unmarked themes in this analysis, all conjunctive and most (if not all) attitudinal themes are excluded from the analysis

7 RESEARCH METHOD

The research method replicates, with some modifications, that used by Gosden (1993) By looking at the relationship between the Grammatical Subject position and the Theme of the sentence in science research articles (RAs), Gosden was able to make some very useful conclusions about the nature of science discourse in general and the RA genre in particular (see 1 'Context' above) My interest is the efficacy of tracking Real-World and Non-Real-World (Participant, Discourse, Hypothetical-Objective) themes to see how real-world phenomena are linguistically reconstrued into scientific concepts and

data and then reconverted into real-world phenomena Another interest is to better understand the role of the engineer as discourse participant by analysing the degree of dialogic-participant discourse in the writer-reader relationship Relevant to both of these interests is the understanding that the engineering report, unlike the science RA, crosses a discourse boundary to (presumably) non-engineering clients (such as construction and fabrication managers and government authorities)

Gosden's (1993) Method

Gosden examines the themes of main clauses used in 36 RAs that appeared in a number of disciplinary, international journals Unmarked themes, that is themes that are coincident with the grammatical subject (GS), are then allocated by a dual classification, Writer Visibility and Writer-Community Orientation Writer visibility in the Four Domains (Participant, Discourse, Hypothesized and Objectivized, and Real World) are represented on a horizontal continuum from [Greatest Writer Visibility and More Interactional Themes] to [Least Writer Visibility and More Topic-based Themes] Within each Domain, subjects are allocated on a vertical continuum measuring Writer-Community orientation from [More External, Community-oriented Themes] to [More Internal, Writer-oriented Themes] (Gosden 1993 63) Marked themes (Adjunct + GS) and other sentence forms (such as imperatives) are not analysed in Gosden's research

Modified method

Three engineering reports were selected from two separate engineering firms for whom I have provided consultancy services Although a relatively small database compared to Gosden's research, this is sufficient to provide preliminary substantive and methodological information I acknowledge that the relatively small corpus of writing could lead to idiosyncratic results However, this preliminary research provides tentative conclusions that could be tested as working hypotheses in further research Each report represents a separate realm of engineering structural (identified as CC in this paper), environmental (MM), and communications (TM) These reports provide 655 sentences for analysis CC (235 sentences), MM (304), and TM (116) Sentences from the *Summary* were omitted from the analysis because, while the Summary is an important (and probably the most read) component of the report, it is prefatory in nature and, consequently, not part of the textual evolution of the report

Each sentence was allocated by the researcher to one of four report sections, *Introduction, Method, Analysis and Findings, Conclusions and Recommendations*, irrespective of the engineer-writer's classification These sections are similar to Gosden's segmentation of the RA into *Introduction, Experimental, Results*, and *Discussion* Although many other sectional divisions are possible, pre-analysis trials confirmed that every sentence could sensibly be categorized

into one of these sections Sentences were allocated to sections according to the following guide-lines

Introduction sentences which provide information about the circumstances of the report's commissioning, the client, the context, and scope of the study

Method sentences which explain the analytical method and computational devices

Analysis and findings sentences which provide objectivized empirical statements based on the engineer's data collection and applied inquiry These statements usually reconstrue everyday phenomena into pre-existing scientific categories and taxonomies to allow analysis to take place

Conclusions and recommendations Conclusions are those sentences which present the implications and inferences drawn by engineers applying their professional applied-scientific judgement to the objectivized empirical statements Recommendations are those sentences which deliver professional advice directing the clients' course of action

My sectional classification rarely coincided with the sections created by the engineers. In one report (CC), for example, the *Summary* was presented in Section 2 One explanation for this mismatch may be that engineers do not organize ideas very well into thematic categories This hypothesis is supported by Barabas's (1990 261–3) finding that a great area of 'disagreement and confusion' for engineer writers is properly locating report sections, especially in discriminating between data and results, and between results and conclusions

Each sentence of each report was then classified as one of the following

Unmarked Themes	Grammatical Subject (GS) and Theme (T) are conflated
Marked Themes	An adjunct precedes the GS
Other	Another form is used e g imperatives and demonstratives

Grammatical Subject is defined by Halliday (1994 31) as 'that of which something is predicated' and Theme is 'that which is the concern of the message'

The allocation of Grammatical Subjects in unmarked theme sentences to one of four Domains—Participant, Discourse, Hypothesized and Objectivized, and Real-World—replicates Gosden's method These Domains represent a horizontal continuum from where the writer is most visible and discourse interactional, the Participant Domain, to where the writer is least visible and topic-based themes supplant interactional themes, the Real-World Domain Between these two extremes are the Discourse Domain and the Hypothesized and Objectivized Domain In the Discourse Domain, references are made to 'internal discourse properties' such as the *paper, figure, previous studies* Whereas Gosden views the Hypothesized and Objectivized Domain rhetorically as the section where 'a wealth of subtle means' are used to comment on hypotheses and viewpoints it appears in engineering reports to be the practical and vital engine room where the real work of the report is done It is here that

the engineer converts real world experience into the hypothetical and objective[2] domain of a relevant scientific paradigm in order to organize the experience into categories and taxonomies with their relevant relationships

Criteria for Domain-themes

Within each Domain, the GS is allocated to a Domain theme, vertically arranged from more internal writer-oriented themes to more external, community-oriented themes The Domain themes of this report replicate those devised by Gosden, although I have added three extra Domain-themes (see discussion following the explanation of Domain-themes) based on trial testing Apart from the three extra Domain-themes which I created, the

Table 2 Distribution of Unmarked Theme Subjects in Domains

	PARTICIPANT DOMAIN	DISCOURSE DOMAIN	HYPOTH & OBJECT DOMAIN	REAL-WORLD DOMAIN	
More external community-oriented theme	Interactive Participant				
		Interactive Discourse Entity	Hypothesized Entity		
		Empty Discourse Theme	Empty H&O Theme		Real-world Entity
			Objectivized Intellectual Corpus	Empty Real-World Theme	Real-world Event or Process
		Micro Discourse Entity	Objectivized Viewpoint		Non-mental Engineering Analytical Tool
	Participant Viewpoint	Macro Discourse Entity	Hypothesized Viewpoint		Mental Process
			Analytical Concepts of Real-world Entities, Processes & Events		
		Discourse Event or Process			
More internal Writer-oriented theme	Discourse Participant				
	More interactional theme Greatest Writer Visibility				More Topic-based Theme Least Writer Visibility

explanations provided are largely those by Gosden (1993 65–7) Table 2 visually represents this organization The method of allocating the domain-theme according to the subject is described (from Internal to External orientation, or, from bottom to top) in the following section

A Participant Domain

1 *Discourse Participant* Use of *I* or *We* as report writer

2 *Participant Viewpoint* Use of *our* as possessive case referring to report outcomes such as *Our conclusion* A weakness in Gosden's classification system is to use the possessive pronoun rather than the subject itself as the basis of classification He had included *our data* as a typical subject for this classification I have created the special category *Objectivized Intellectual Corpus* within the *Hypothesized and Objectivized Domain* to place the word *data* (see C4 below) Otherwise, any other participant viewpoint subject using the possessive *our* is classified in this section

3 *Interactive Participant* Direct reference to the person or corporate entity that initiated the report The implied participant in Engineering Reports is different from the implied participant in Scientific Research Articles (RA) In RAs the writer participates with other scientists where 'scientific discourse consists of interactions among scientists in which the maintenance of face is crucial' (Myers in Gosden 1993 65) However, the interactive participant in Engineering Reports, a preliminary analysis revealed, is the client Scientific research references are rare in engineering reports This is an important difference from the RA classification which identifies reference to other researchers in the field. Other research was not evident in the reports I viewed

B Discourse Domain

1 *Discourse Event/Process* Reference to the discourse acts and processes of the actual investigative events This includes such nominalized items as *interpretation*, *conclusion*, *argument*, *explanation*, *observation*, and *description*

2 *Macro Discourse Entity* Reference to integral units of the discourse such as *paper*, *report*, *communication*, and *thesis* It may be used such as in the following construction *This report analyses the [X] and recommends [Y]*

3 *Micro Discourse Entity* Refers to discourse-internal entities such as *figure*, *chart*, *diagram*, and *plan*

4 *Empty Discourse Theme* Empty themes which occur in this and the subsequent two Domains are those that are introduced by *It* and *There*[3] In the Discourse Domain, they thematize other related entities and ideas within the discourse community For example *It can be argued* or *There have been reports*

5 *Interactive Discourse Entity* Refers to previous community-validated macro discourse entities such as *previous studies*, references to conceptual/knowledge absences within the community such as *Little is known* or to conceptual/knowledge accumulation within the community such as *There has been great interest*

C Hypothesized and Objectivized Domain

1 *Analytical concepts of Real-world Entities, Processes, and Events* My preliminary analysis indicated that the *Hypothesized and Objectivized Domain* probably required this Domain-theme which was not included in Gosden's method An important feature in the analysis of an engineering report (and, I suspect, the science research article) is the stage of making sense of the real world within a particular paradigm of scientific understanding In fact, this could be regarded, as stated earlier, as the intellectual engine-room of the report for it is the engineer's task to convert common-sense knowledge which 'can tolerate—indeed, depends on—compromises, contradictions and indeterminacies of all kinds' into scientific knowledge which is 'organized around systems of technical concepts arranged in strict hierarchies of kinds and parts' (Halliday and Martin 1993 6) Thus, the act of scientific naming is not just another name for scientific events, processes, and entities It is the discoursal semantic understanding, usually arranged in predetermined classes and taxonomies, which is implanted in the grammar and the lexis (see Halliday and Martin 1993 7–8 for more information on this) In other words, according to Halliday and Martin (ibid) the scientific theory underlying the lexico-grammar 'is a linguistic construal of experience' Sometimes the engineer makes this lexico-grammatical conversion relatively explicit For example, the terms *cleaners* and *solid wastes* are explicated in the following sentences (allowing the non-expert reader to understand the engineer's classification)

> Major cleaners include acids, alkalis, detergents and sanitisers [MM 88]
>
> Solid wastes consist of office paper, domestic waste, unusable milk crates, plastic sheeting, drums, chemical containers and raw material packaging [MM 98]

In each of these instances, the engineer has organized the real world entities of the area under analysis into sense-making categories which will allow him or her to apply their area of knowledge In some cases, however, the scientific lexico-grammar is not so transparent for the non-technical reader *wind-load* [CC 91] and *drag-coefficient* [CC 96] are scientific reconstruals necessary to make sense within the mechanical physics paradigm being applied but were not explained to the reader in this report An example of this reconstrual prior to technical-scientific analysis occurs in an environmental engineering report which classified one form of effluent as *high-volume, low BOD effluent* [MM 261] A by-product of this effluent, we are advised, is *biogas* [MM 264] This classification becomes important for the engineer to respond in different

technical ways to the components of the biogas which, we are told, are methane, carbon dioxide, and hydrogen sulphide Thus, it appears that the complex process of renaming and classifying (reconstruing) real world entities, processes, and events is vital to the engineer's task as an applied scientist However, their meanings are not always made clear to the reader

The efficacy of this sub-classification, *Analytical Concepts of Real-World Entities, Events, and Processes*, within the *Hypothesized and Objectivized Domain* is discussed in the Findings

2 *Hypothesized Viewpoint* This refers to comment and judgement on research matters in relatively modalized writing It occurs in such statements as *the possibility of , the most probable cause , the apparent contradiction*

3 *Objectivized Viewpoint* The theme may occur in comparative or superlative form such as *a significant difference*, *the most surprising feature* or with a strongly anaphoric reference such as *one of the factors*, *a further contribution* Compared with the *Hypothesized Viewpoint* the *Objectivized Viewpoint* lacks modal qualification Its evaluative modification of the headword suggests the status of the writer in making such a judgement

4 *Objectivized Intellectual Corpus* Gosden's model of the Hypothesized and Objectivized Domain, it appears, excludes a category for recording the term *data* While this domain provides categories for Hypothesized Entities such as 'models' and 'formulae' and for an Objectivized Viewpoint such as 'one factor' it does not provide a category to house the name of general relevant objectivized information For this reason I have created the category, *Objectivized Intellectual Corpus* At this state, the word *data* is the only word in this category, further research may identify more. Gosden's model does acknowledge the word 'data' in the phrase 'our data' However, it has been classified as *Participant Viewpoint* in the *Participant Domain* Gosden classifies the phrase in the participant domain largely because of the possessive pronoun, *our*, which focuses on the actor's research activities However, the word *data* is frequently used without the possessive pronoun as in *the data shows*

This use of the word *data* is integral to the recontextualization process where technologists convert real-world events, processes, and entities using particular scientific disciplines For example, when interpreting behaviour according to the science of psychology, information about real-world events is collected in categories for measurement and analysis For example, a blink might be recorded as an 'aversive response' In other words, the word *data* may be a lexical cue of this recontextualization A dictionary definition, 'the starting-point from which something is measured or calculated', acknowledges the denotation of 'data' as an act of creating uniformity of scale or categorization prior to a measuring or calculating activity Consequently tracking the use of the word, I contend, should help to identify this type of activity

5 *Empty Hypothesized and Objectivized (H and O) Theme* As for B 4 above, some sentences are introduced by expletive constructions (*There are, It is*) However, in this Domain the theme is often formulaic as it introduces evaluative information Typical constructions include *It is interesting to note that* and *There are two possible contributions*

6 *Hypothesized Entity* References to hypothesized and theorized modes of testing and research such as *models, approaches, formula*

D Real-world Domain

1 *Mental Process* This refers to intellectual processes and entities, often in nominalized form, which lead to hypothesized and objectivized viewpoints They include *calculation, comparison, analysis, extrapolation, evaluation, estimate, assumption, idea, insight* and *question*

2 *Non-mental Engineering Analytical Tool* Gosden's model has placed in the category *Real-World Entity* two sorts of entities those under investigation and those entities used in the investigative process For example, in an RA, the entity under investigation may be a blood sample and the entity used to investigate the blood sample is a microscope However, the conflation of these entities into one category loses potential theme information (especially in comparative studies) This model's extra category of *Non-mental Engineering Analytical Tool* includes such items as *photographic record* and *monitoring* The preliminary analysis also unearthed the theme, *a great deal of effort*, which for this study is included in this category

3 *Real-world Event or Process* My analysis allocates to this category events or processes under the engineer's consideration (equivalent to entities under consideration in D 4 below), whereas Gosden seems to allocate events or processes which I include in D 2 That is, Gosden's categorization either conflates experimental and real-world events and processes or omits the real world events and processes

4 *Real-world Entity* This refers to material entities and objects of the physical world Entities such as *beam, wastewater, switch,* and *tank* are some of the many possible real-world entities that could undergo analysis

5 *Empty Real-world Theme* As for B 4 and C 5 above, some themes are presented in an empty expletive construction In this instance, the deferred subject may be a real world or research entity event, or process, or it may refer to a mental process

It is not clear from Gosden's (1993) account of his research, how he accounts for the use of the words *this, these,* and *that* at the beginning of the sentence when used as a demonstrative A sentence beginning *This leads to buckling of the weaker members* would be classified as having a demonstrative head word (Halliday 1994 313) which anaphorically refers to something In such

cases, demonstratives are allocated to an *Other* category (along with *Imperatives*) which is neither Unmarked Theme nor Marked Theme (Adjunct Context Frame + GS) By contrast, when the writer uses *this*, *these*, and *that* as a deictic, I have taken the nominal that follows it as the subject. Thus, a sentence beginning with *These vibrations,* would be classified as having a (real world entity) subject, *vibrations*, as an unmarked theme Because it was not made explicit, this method has been inferred from Gosden's allocation of a deictic *This paper* to the Discourse Domain (Table 3) as *paper* is a discourse domain subject

Occasionally a subclausal structure was encountered that is, a sentence without a main clause and/or a finite verb Such sentences are allocated to the *Non-sentence* category

8 FINDINGS

Four methodological and four substantive findings were made in this analysis

Method

1 The Gosden method of identifying (Un)marked Themes is useful and may be used to provide inherent and comparative data Table 3 provides the results of the Engineering Report analysis and compares this with the Research Article results Results are broadly similar in that unmarked themes account for more than two thirds of the sentences in Engineering Reports (ER) and Research Articles (RA) and have few in the *Other* category This broad similarity supports the reliability of the research

Table 3 Marked and Unmarked Themes in sentences of engineering reports and comparison with research articles

Composition	Engineering Report		Research Article*
	n	%	%
Unmarked Theme [GS]	511	79 2	67 2
Marked Theme [CF + GS]	118	18 3	32 3
Other	16	2 5	0 5
Total	645	100 0	100 0

*Taken from Gosden, 1993 68

2 Use of the category *Analytical Concepts of Real-World Entities, Events and Processes* (C 1) is worthwhile as it provides useful information about the extent and position of the engineers' conversion of real world entities, events, and processes into scientific concepts Accounting for 18 4 per cent ($n=94$) of all unmarked themes, it is the second most common thematic categorization after real-world entities (Table 4) Although common in all sections of the report, it was most prominent in the Analysis and Findings

Table 4 Subject Allocation by Domain-Theme

Domain and Subject	*n*	%
A PARTICIPANT DOMAIN	**21**	**4 11**
Interactive Participant	14	2 73
Participant Viewpoint	2	0 39
Discourse Participant	14	2 73
B DISCOURSE DOMAIN	**30**	**5.87**
Interactive Discourse Entity	4	0 78
Empty Discourse Theme	5	0 98
Micro Discourse Entity	7	1 37
Macro Discourse Entity	7	1 37
Discourse Event/Process	7	1 37
C HYPOTHESIZED AND OBJECTIVIZED DOMAIN	**185**	**36 20**
Hypothesized Entity	24	4 70
Empty Hypothetical and Objective Theme	13	2 54
Objectivized Intellectual Corpus	7	1 37
Objectivized Viewpoint	25	4 89
Hypothesized Viewpoint	22	4 31
Analytical Concepts of Real-world entities, processes and events	94	18 39
D REAL-WORLD DOMAIN	**275**	**53 82**
Empty Real-World Theme	16	3 13
Real-World Entity	161	31 51
Real-World Event/Process	58	11 35
Non-mental Engineering Analysis	28	5 48
Mental Process	12	2 35

section accounting for 63 per cent ($n = 48$) of all unmarked themes of that section

This suggests that the recontextualization from common-sense events, processes, and entities is at the heart of the professional engineer at work Real world phenomena are taken into the discourse domain of the professional engineer to undergo analysis and development which is the intellectual task of the engineer For example, the apparently straightforward sentence *The alarm sensors operate on a thermal mapping principle* [TM 55] is largely impenetrable to most laypersons because of the lack of knowledge about the *thermal mapping principle* It is clearly different from a layperson's description which might say something like 'The alarm sensors go off if there's a fire' The difference between these two sentences is not just a change in verbal sophistication It reveals differences in meaning-making (applied scientific vs layperson common sense) Recontextualizing the real-world entity into a scientific principle allows the engineer to begin the task of determining how the device might have been triggered in the case of a fire In other words, the recontextualization is crucial to the engineer's task

The transformation from the real-world to hypothesized and objectivized scientific world is often seamless In the following sentence, the word *loads* straddles both technical and non technical worlds

> Loads on the structure from the conveyors were estimated by our mechanical engineer based on typical values of similar conveyors [CC 19]

References to *members* and *beams*, understood as real-world entities is converted in one report [CC] into the more conceptual *bracing system* about which the engineer must determine tolerable stress loads Similarly, in the following sequence of sentences, a real world entity (*whey*) is converted into a concept (*a food supplement at a local piggery*) thereby allowing analysis in an economic or marketing paradigm (*market*) rather than an engineering one

> Some of the whey is currently utilised as a food supplement at a local piggery This market is presently much smaller than is desirable [MM 230–231]

Although this area (converting real world into analytical concepts) apparently was not important in Gosden's analysis, this analysis suggests that the conversion is significant in engineering discourse analysis Nevertheless, it must be acknowledged that classification into the domains of *Real-world* and *Hypothesized and objectivized* is sometimes difficult Allocating nominal items to groups sometimes bordered on the intuitive that is, using the context of its usage to determine whether the nominal is a real-world entity or has been recontextualized into a professional nominal For example, the term *composting* [MM 226] is understood in a real-world sense by laypersons as a gardening term However, in this instance the notion of *composting* is used in a fuller sense being incorporated into a scientific and technical solution to a waste problem in a factory

> Composting may be an appropriate waste treatment technique for semi-solid portions of the wastewater that float or settle and can be easily collected [MM 226]

Similarly, the term *weight* is understood by the layperson in a way that corresponds with physicists' notion of mass. Thus, when the term *dead weight* [CC 82–83] is used, it is really an *Analytical Concept of a Real-World Physical Process, Event or Entity* In some instances, engineers are required to operationalize everyday concepts into scientifically measurable entities such as one report where a structural analysis of a building included an analysis of the *comfort limit* and *fatigue limit* [CC 109, 201] of workers in the plant

Given the intellectual dynamic of the report, it is no surprise that this category, *Analytical Concept of Real World Entities, Events and Processes*, is so strongly evident in unmarked thematic sentences, especially within the *Analysis and Findings* section, accounting for 48 out of the 76 sentences in this Report Section (Table 5) The implications of this for writing clarity should be further considered In particular, the writer needs to consider the impact on the lay reader of varying the discourse from real-world to the scientific world (Table 5)

Table 5 Subject Allocation by Domain-Theme

Domain and Subject	Report Section			
	Intro	Method	Analysis & Findings	Con & Rec
PARTICIPANT DOMAIN	**7 (12.5)**	**5 (6.9)**	**7 (3.0)**	**2 (1 3)**
Discourse Participant	2	3	0	0
Participant Viewpoint	0	0	1	1
Interactive Participant	*5*	*2*	*6*	*1*
DISCOURSE DOMAIN	**6 (10 7)**	**8 (11.1)**	**6 (2.6)**	**10 (6 7)**
Discourse Event/Process	1	1	3	2
Macro Discourse Entity	5	2	0	0
Micro Discourse Entity	0	2	3	2
Empty Discourse Theme	0	0	0	5
Interactive Discourse Entity	0	3	0	1
HYPOTHESIZED AND OBJECTIVIZED DOMAIN	**10 (17 9)**	**23 (31 9)**	**76 (32.5)**	**76 (51.0)**
Analytical Con of Physical Process	4	10	48	32
Hypothetical Viewpoint	2	0	8	12
Objective Viewpoint	0	1	11	13
Objective Intellectual Corpus	0	6	1	0
Empty Hyp and Obj Theme	0	0	5	8
Hypothetical Entity	4	6	3	11
REAL-WORLD DOMAIN	**33 (58 9)**	**36 (50 0)**	**145 (62.0)**	**61 (40 9)**
Non-mental Eng Analysis	1	18	4	5
Mental Process	0	6	3	3
Real-World Event/Process	7	2	25	24
Real-World Entity	24	10	107	20
Empty Real-World Theme	1	0	6	9

Note all numbers, except those bracketed, are raw data Bold numbers refer to that Domain Numbers in ( ) represent Domain as percentage of that report section

3 This lexico-grammatical analysis of the engineering report is quite robust in locating the text within a particular social context Of particular significance in this analysis is the register variable of Field, defined as 'the situational variable that has to do with the focus of the activity in which we are engaged' (Eggins 1994 67) This analysis has shown how Field can vary along a continuum from the 'technical, specialized' to the 'common-sense (everyday)' through to the heavily taxonomic organization of reality into established categories of scientific knowledge (Eggins 1994 71–4) [4] Table 6 shows that the proportion of *Hypothesized and Objectivized Domain* unmarked themes grows from 17 9 per cent in the Introduction to 51 0 per cent of the unmarked theme sentences in Conclusions and Recommendations The first large jump occurs in the Method section (up to 31 9 per cent) and, by the Conclusions and Recommendations stage, the engineer-writer

appears to predominantly use the discourse of the expert Engineers predominantly use *Analytical Concepts of Real World Entities, Processes, and Events* in these two sections 48 out of the 76 sentences in Analysis and Findings section and 32 out of 76 sentences in Conclusions and Recommendations (Table 5) Fundamental to these analytical concepts is the engineer's conversion of real-world phenomena into pre-existing scientific categories Within this preliminary research, I do not wish to develop this finding any further than noting the supportive implications for Halliday and Martin's (1993) use of Field in analysing science writing

4 This analysis also provides useful insights into the register variable of Mode, which accounts for 'the role language is playing in realising social action' (Martin 1992 508), the interpersonal metafunction, and in constructing social reality, the experiential distance metafunction These engineering reports could be classified as monologic and documentary texts (interpersonal metafunction) in which the moderate lexical density and synoptic structure (rhetorical staging and closed narrative) reveal the distance between engineering professional and the client Although the comparison in Table 7 is contaminated by varied methods of allocating subject, the small proportion of unmarked subject-themes in the Participant Domain of an engineering report indicates the relative unimportance of the interactive metafunction in Engineering Reports (4 1 per cent) compared with Research Articles (9 2 per cent) In most cases, the references in the participant domain are to the client, rather than other researchers in the discourse community

Table 6 Domains as a proportion of report sections

Section/Domain	Introduction	Method	Analysis and findings	Conclusions and recommendations
Participant	12 5	6 9	3 0	1 3
Discourse	10 7	11 2	2 6	6 8
Hypothesized and Objectivized	17 9	31 9	32 4	51 0
Real-world	58 9	50 0	62 0	40 9
	100 0	100 0	100 0	100 0

Table 7 Comparative distribution of subject roles by domain Engineering Reports and RAs

	Engineering Report %	Research Article* %
Participant Domain	4 1	9 2
Discourse Domain	5 9	6 0
H and O Domain	36 2	7 6
Real-world Domain	53 8	77 2

*Taken from Gosden (1993 68)

SUBSTANTIVE FINDINGS

1 *Poor organization*

Engineer-writers appear to have difficulty organizing sections thematically (see *Modified Method* in Section 7 above) This problem appears to be associated with engineers' use of narrative or recount genre This finding strongly supports Barabas's (1990) findings in her analysis of engineers' progress reports which found that 61 per cent of the reports' contents provide Type 1 (What I did) and Type 2 (How I did it) information She found that poor engineer-writers use an 'inductive, narrative approach' more than good writers do (Barabas 1990 237–41) Two of the reports in my analysis occasionally recount (in past tense) part of the method used and then follow this with an immediate analysis of the findings For example

> Non-linear structural analysis was used so that buckling members could be accounted for and the post buckling capacity of the structure assessed The automatic design checking facility of the software was used to determine whether members had adequate capacity Analysing the structure for various load combinations revealed that there are some problems with the existing structure These are [CC 21–23]

This segment of the report was contained in *Section 2 2 Structural Assessment* within Section 2, entitled (extraordinarily) *Summary* of a report [CC] written by two engineers writing separate sections Reports require effective organization and the limited evidence of this survey suggests that this is not done well This problem could be exacerbated in collaborative efforts which bolt together independently written sections thereby losing the necessary coherence Making this particular report [CC] even more difficult is the iterative procedure it uses The report provides a structural audit of a process plant using an iterative modelling procedure that varies factors such as bracing, vibration, and equipment and wind loads It would appear, then, that to communicate complex analyses, some writers use recount, arguably the simplest generic form, interspersing the findings along this narrative route

Using a narrative generic form appears to contribute to poor organization, however, where the iterative modelling is used [CC], the writer's difficulty in separating Method and Analysis and Findings arises largely because the method itself is contingent on a sequence of findings as varying data is entered into a changing model of the building structure Where such complex methods are used it may be better for the writer to provide a full and specific description of the site (part of the Introduction), followed by a general description of the iterative method, followed by the application of the method to actual and hypothetical data in the Analysis and Findings section Such an approach would help to eliminate narrative tendencies

Further evidence of organization problems is evident in some reports that cover three report sections in the space of a few sentences For example, the five sentences of the following extract could conceivably cover Introduction

[sentence 1], Analysis and Findings [2–4], and Conclusions and Recommendations [5]

> [1] A bulk storage tank for caustic will soon be installed [2] This will reduce the need for the many smaller containers shown in Photo 11 [3] The tank will also assist with the transition to computerised dosing for the CIP systems [4] Computerised dosing can result in conservation of chemicals and water, though this may not necessarily be the case [5] The level acid/alkali/water use should be compared with the level of cleaning required and then the balance between waste minimisation and hygiene can be optimised [MM 107–111, sentence numbering added]

Also, it appears that some writers inappropriately use the report to think through the problem rather than report on it The following passage could well have been written in this way

> [1] Consideration should be given to recycling the sulphuric acid used in casein production [2] Casein is precipitated at a pH of 4 7 (milk is about pH 6 6) [3] The precipitated casein is insoluble in water and is separated and dried [4] The acid slurry is currently a once-through system to help maintain a precise pH [5] With the use of instrumentation for feedback-feedforward monitoring and acid addition control, the solution could be recycled [MM 159–163, sentence numbering added]

Arguably, this group of five sentences moves from Conclusions and Recommendations [1] to Analysis and Findings [2–4] to Conclusions and Recommendations [5] While the sentences are not unrelated, they give the impression of thinking on paper This appearance of confused thinking is reinforced by the content of the theme positions in these sentences Sentence 1 hypothesizes a process to be implemented The 'new' information of sentence 1 [content of rheme position, *recycling*] is elaborated in Sentences 2 and 3 in the theme positions, *casein* and *precipitated casein*, giving the text the appearance of cohesion However, thematically, it is material that should be discussed elsewhere Sentence 4 takes the reader even further away from the recommendation by using a new content area, *The acid slurry*, in the theme position This semantic development is not only elliptical (what's the relationship between 'acid-slurry' and anything else that immediately precedes it?), but it is also generically more appropriate to Analysis and Discussion (like the preceding two sentences) The fifth sentence has to be 'unpacked' before being understood as a probable Recommendation This apparent Recommendation (*the solution could be recycled*) is hidden beneath a series of nominalizations (*use, instrumentation, monitoring, acid addition control*) with an agentless passive process

It would seem, then, that the tendency to narrate can cause confusion in engineering reports because it is an inappropriate generic form in certain sections If engineers more strictly regulate this tendency, schematic imprecision should be reduced For example, even in the following brief passage narrative intrudes unnecessarily

> An inspection was made of the controller dialler and the following aspects were noted [TM 32]

Presumably, the methods section should have established that an inspection of the controller dialler was conducted Thus, if the sentence were transformed to

> The inspection of the controller dialler showed

the reader more quickly engages the important feature of the Analysis and Findings section Similarly, in another section of the same report, the elimination of the narrative element (*was interviewed*) could streamline the sentence and enhance the thematic emphasis

> A representative of the installer of the equipment, [name], was interviewed, and he confirmed the directions in which the sensor units were installed

An alternative sentence structure that begins in the following way

> Confirmation that the sensor units were installed in [ ] direction

allows the rheme to develop the deferred theme in the embedded clause [*that*] without having to negotiate the superfluous narrative material

It appears that appropriately manipulating verbs could assist appropriate schematic structuring of the report That is, variations of verbal transitivity, modulation, and modality are appropriate in various sections of the report In the following passage, for example, the process type, modality, and modulation of the four verbs (or processes), *are associated*, *is*, *could be adjusted*, and *should be implemented*, of the three sentences are strongly related to the schematic placement I have provided

> [1] Dilute wastes are primarily associated with wash and rinse water [2] The existing wastewater system is satisfactory for the dilute waste, although it could be pH adjusted (raised) prior to spray irrigation [3] A routine soil testing program should be implemented to monitor the pasture condition [MM 218–220]

The first sentence which is presented as a statement of fact realized by the relational verb *are associated* represents an explanation within an Analysis and Finding The second sentence presents an authoritative conclusion (*is satisfactory*) which is modalized later by a subjunctive verb (*could be adjusted*) This latter modalization causes the sentence to straddle conclusion and recommendation (note there is no agent) The final sentence is clearly a recommendation (although again there is no agent) where action (realized in a material process, or verb, *implemented*) is presented as form of obligation (*should be*). Although this issue is not a concern of this paper, further analysis of the matching of process type, modality, and modulation with Report sections could prove useful

2 *'Objective' authoring*

Reference to other scientific or technical participants rarely occurs in engineering reports The participant recorded in engineering reports is the client (see Research Method, Section 7, above) Unmarked theme references to the client in the *Interactive Participant* category of the *Participant Domain* account for

only 2 7 per cent of all unmarked themes (Table 4) and occur mostly in the *Introduction* (usually to explain the circumstances leading to the report) and in the *Analysis and Findings* It would appear that the need to 'maintain face' with other engineers or scientists and to 'create a research space', so clearly evident in Scientific Research Articles (Swales 1990 140–2, Gosden 1993 69) is unnecessary in engineering reports Reasons for this are intuitively available but deserve closer analysis

The prime reason for this 'objective' distance and author invisibility (sustained largely through agentless passives, a cursory analysis suggests), I suspect, is that the engineer is commissioned to write a report The engineers' credentials are established by the client's act of commissioning a report By contrast, scientists seeking to have articles published in learned journals need to establish their credentials Engineers, like medical and dental specialists and lawyers, do not need to establish an authenticating posture Yet, unlike medical and legal professionals, engineers do provide very thorough (often narrative) accounts of their method Further research might explain why engineers are more likely than other professionals to record their activities in reports

3 *Low incidence of marked themes*

Marked themes occur in only 18 3 per cent (Table 3) of the sentences which appears to be significantly different from Gosden's finding that 32 per cent of science research articles begin in this way Marked themes occur when the theme 'conflates with any other constituent of the Mood system' than the subject (Eggins 1994 296), usually a circumstantial adjunct Adjuncts 'contribute some additional (but non-essential) information to the clause' (Eggins 1994 165) Sentences beginning with marked themes (through the use of adjuncts) often signpost that the sentence is doing something markedly different from preceding sentences (Eggins 1994 298) What these findings indicate about the two generic forms is not the concern of this paper However, if Eggins' claim that '[s]kilful writers choose marked themes to add coherence and emphasis to their texts' (ibid) is correct, then it may be that engineers are producing less coherent and less emphatic texts than might be possible within the generic constraints Engineers may find that greater use of adjuncts will improve the coherence of, and signal emphasis better in, reports

This analysis does not categorize the adjunct openings of marked theme sentences A vulgar classification of the 118 adjuncts, however, indicates that time adjuncts account for about 25 per cent ($n = 29$) and reason adjuncts account for 14 per cent ($n = 16$) The time adjuncts may be related to the narrative methods that engineers often employ However, further studies of adjunct use might more usefully employ the classification of adjuncts provided by Eggins (1994 165–71) That is, adjuncts can be classified according to whether they add experiential meaning (time, manner, location, etc), interpersonal meaning (mood, polarity, comment), or textual meaning (conjunctive, continuity)

4 *Textual cohesion*

Of the residual sentences, 10 of the 16 *Other* sentence openings begin with a demonstrative Many sentences beginning with demonstratives such as *this, these, that* do so to enhance textual cohesion by anaphorically referring to information in the previous sentence Using demonstratives in only 1 6 per cent (n = 10) of all sentence openings might suggest that engineers could more extensively use this device to maintain textual cohesion if used appropriately (Halliday 1994 ch 9)

9 IMPLICATIONS FOR ENGINEERING WRITING AND ENGINEERING WRITING RESEARCH

This research has provided valuable practical information about effective engineering report writing and valuable theoretical information about the role of language in technical analysis This research method is workable and provides valuable information about the engineer-writer's transformation of real-world events into scientific concepts and their restatement in real-world terms Future research using a larger sample from various engineering fields (e g civil, mechanical, electronic) may reveal differences among these fields

There are two valuable practical insights yielded by this research Firstly, greater awareness by engineer-writers of the concepts of marked and unmarked themes should enhance their writing ability That is, if engineer-writers consciously oriented the subject-themes of each sentence to the hyper-theme of the paragraph and to the macro-theme of the report, greater semantic coherence would be inevitable Secondly, greater strategic use of the adjunct in the marked theme construction seems possible Adjuncts as marked themes 'signpost' emphasis (especially mood, polarity, and comment) or establish semantic coherence (conjunctive, continuity) Strategic placement of these adjuncts would enhance cohesion

The research suggests that engineers do not position themselves within a discourse community, although a much larger study would be needed to corroborate this As well, it has been shown that theme-subjects do vary throughout the engineering report Manipulation of these should allow the writer greater control over textual coherence Finally, this study has shown that the process of renaming and classifying real-world entities, events, and processes which is revealed in the category, *Analytical Concepts of Real World Entities, Events and Processes* comprises a very large part of the report and is most evident in the *Analysis and Findings* section I claim in this paper that this process of conversion is the linguistic realization of the engineer's professional and intellectual task But the question may well be asked why is this record made? When one considers the tasks of other professionals such as medical and dental specialists, solicitors, and accountants, there seems to be less recording of the reasoning process leading to a professional opinion The reporting process of engineers and other professionals seems to differ in two important ways

One difference is that professional 'opinions' of medical and legal

professionals are usually for the writer's use or exchanged among the professionals rather than with the client For example, a medical specialist often communicates a prognosis and diagnosis in a relatively brief letter to another doctor Solicitors brief barristers rather than the client on points of law to the extent that the client may not even appear in court or be involved in a litigious exchange Another difference is that the conduct of the legal and medical analysis itself is often not reported on, certainly not in narrative form For example, a barrister (presumably) would not write 'After I analysed the Taxation Act for X, I then conducted a search of the *ALJ* for relevant High Court decisions on this matter' Nor would a medical specialist necessarily identify or justify the technology used such discourse is likely to mention incidentally the technology and method used such as 'The CAT-scan revealed no lesions in the frontal lobe'

What is usually requested of legal, medical, and technological specialists by clients is the appropriate solution to a real-world problem Although I have not conducted relevant research into other professions, it seems that engineers are more likely to provide a much fuller account of the processes leading to conclusions and recommendations If this is so, then the reasons for recording this should be considered One area that deserves consideration is the explicit or implied audience of the engineering report Is it the case that the report is primarily intended for the writer? Why does the report not simply make recommendations or conclusions (similar to the specialist reporting a prognosis to the GP) without providing the narrative of events and a justification of the method used? Does the genealogy of the engineering report's extensive narrative and justification begin in the scientific report and research article or has it evolved for other reasons?

(Revised version received August 1996)

NOTES

[1] Of course, such a model accepts that genres change over time (phylogenesis in Martin's model) Lemke has labelled this phenomenon 'metastability'

[2] The term 'objective' is used here to mean that the engineer invariably records information as 'fact' and 'uncritically' applies scientific formulae to formulate or justify a course of action

[3] Use of *there are* and *it is* These constructions introduce clauses or sentences that label something as unquestionably existent These existential statements have a subject which Gosden calls 'empty' According to Halliday (1994) the word *there* 'has no representational function' (ibid 142) Where an entity, process, or event follows the verb (often a verb to be There are) the author is claiming something to be 'existent', (ibid) This is recognized by Gosden as an *Empty Real-world Theme* However, Gosden has sensibly identified two other instances of this construction One of these is where the author hypothesizes (*It is unlikely*) or objectivizes (*It was evident*) This is labelled as an *Empty Hypothesized and Objectivized Theme* Finally, where the ensuing word refers to activities or events of the discursive process itself such as the conclusion, other reports (*There are reports*), and findings and recommendations (*It is recommended*) rather than

the real world or the process of hypothesizing and objectivizing, the subject is classified as *Empty Discourse Theme*

[4] Wignell, Martin, and Eggins (1993 137) define a *taxonomy* as 'an ordered, systematic classification of some phenomena based on the fundamental principles of superordination (where something is a type or kind of something else) or composition (where something is a part of something else)'

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