Chapter 12

Summary & Conclusions

1. Summary

This thesis has described a Systemic resource model, and its use in sentence processing. Three linguistic strata were described -- semantics, lexico-grammar and graphology. Two types of processing involving these resources were described: sentence analysis and sentence generation.

One of the main focuses of this thesis was on the integration of different aspects of the linguistic model (including both linguistic processes and resources). Integration across several dimensions was demonstrated:

- **Integration Across Strata**: the inter-stratal formalism introduced in chapter 6 provides a powerful means of relating the representations on two strata to each other.
- **Integration Within the Semantic Stratum**: usually in Systemic work, each of the semantic components - ideational, interactional and textual -- is considered in isolation. In this work I have shown how these semantic components are integrated together. This intra-stratal integration is facilitated by using the same formalism for each of the semantic layers, thus allowing an inter-weaving of ideational, interactional and textual structures. For instance, the ideational content of an utterance is related to the speech-act specification by placing the proposition as a role of the speech-act. Theme is also represented as a role of the speech-act. Textual spaces are represented as a covering over the ideational entities (following Halliday & Matthiessen (to appear)).
- **Integrating Resource & Process**: rather than just describing linguistic resources, or processes, I have provided an integrated description of both resources and processes, showing how the Systemic resources are utilised in processing.
- **Analysis & Generation**: I have attempted to present Systemic processing in a general way, abstracting out from specific processes, such as analysis and generation. To this end, I discussed natural language processing as a series of stages re-representations between strata. Various control strategies for performing the re-representation were introduced, and later exemplified in the context of the specific processes: generation and analysis. To facilitate the integration of these processes, three constraints are imposed on the resources:
  - <u>Bi-Directionality</u>: the resources are required to be bi-directional, providing sufficient information for <u>both</u> analysis and generation,
  - <u>Declarativisation</u>: the resources are required to be declaratively represented, which allows any process to access the resources, and re-represent the resources as appropriate to that process.
  - <u>Standardisation</u>: the resources are required to use the same formalism for representation on each linguistic strata. This allows a simplification of the

processing problem, since the same core processes can be re-used. To this end, the WAG system provides a Systemic knowledge representation system, which provides facilities for representation and processing of Systemic resources and structures.

2. Contributions

In attempting to describe a complete sentence processing system, this thesis has covered a large number of topics. The significant contributions of this thesis are scattered over these topics. A list of the more significant contributions follows:

2.1 Resource Model Contributions

- **Inter-Stratal Mapping**: I presented a formalism for representing the inter-stratal constraints on the features of a lower stratum, drawing upon Kasper's unpublished work, but extending upon it. The presently implemented formalism improves on existing implementations, such as Penman's Chooser-inquiry formalism.
- **Textual Spaces**: Sentence analysis and generation has been extended by the introduction of three textual spaces, relevance, recoverability and sharedness. Although the notion of textual spaces is not new (e.g., Grosz 1977/86; Halliday & Matthiessen (to appear)), it has not so far been implemented in a Systemic-based NLP system.
- **Interactional Representation**: A theoretically-based model of the speech-act has been described, extending the range of speech-act types. This representation improves on the Penman approach, by treating the ideational content as a role of the speech-act, rather than visa versa. The representation also introduces theoretically-based means to specify the required element -- the entity which the speaker is eliciting.

2.2 Process Model Contributions

- **Bi-Directionality**: With the exception of the experimental system of Bateman *et al.* (1992), this thesis reports on the first Systemic system which performs both analysis and generation in the same system. Earlier systems have performed either generation, or analysis, but not both. The system of Bateman *et al.* (1992) used only a small grammar fragment, and requires a HPSG parser to produce an initial analysis of a sentence.
- **Parsing**: The parser described in this thesis is at the forefront of technology in regards to Systemic parsing. It is the first to parse using the full Hallidayan formalism without needing to pre-parse with a non-Systemic cover grammar. The thesis includes discussion of the automatic re-compilation of the resources, re-indexing them into a form more suitable for bottom-up parsing.

- **Micro-Semantic Analysis**: With the exception of the experimental system of Bateman *et al.* (1992), this thesis reports on the first Systemic system which performs micro-semantic analysis[1]. Earlier Systemic analysers have produced only a lexico-grammatical analysis. The system of Bateman *et al.* (1992) involves only enough resources to analyse “Kim ate every cookie.”, and requires much of the initial lexico-grammatical structure to be provided either by hand, or by a HPSG parser. WAG’s micro-semantic analysis recovers ideational, interactional and textual information.
- **Sentence Generation**: I have extended the textual and interactional specification to allow more control over the sentence generation process. Numerous other improvements have also been made. See chapter 11 for details.
- **Systemic Feature Logic & Unification**: The WAG system includes the first Systemic-based KRS. While other researchers are turning to alternative formalisms to process systemic grammars (cf. Kasper 1986, 1990; Mellish 1988; Bateman *et al.* 1992), I have shown that a generalised Systemic KRS can be implemented, comparable to PATR, Loom, FUF, or TFS.
- **Documentation**: Documentation of Systemic sentence processing has been in relative short supply: some books and papers on generation have been published, and a handful of papers on parsing, but no work which covers both Systemic parsing and generation exists. This thesis has attempted to fill the shortfall, providing a global coverage of Systemic sentence processing.
- **A Linguist's Workbench**: one advantage that the WAG system has over the Penman system is the range of window-based tools to help the user browse the grammar (either through graphing or a hypertext interface), step through processes, acquire lexical-items, etc. (see chapter 1 for details). These tools facilitate the tasks of maintaining and extending large scale Systemic grammars.[2]

3. Conclusions

My work with the computational processing of Systemic resources over the last few years has led me to draw the following conclusions:

3.1 Systemic Parsing

At the present stage of hardware development, parsing with large-scale Systemic grammars is too inefficient to allow real application. By large-scale, I consider Nigel, with 1500 features, as the bottom-side of large: this grammar was developed for generation, where the grammar only needs to provide one means of expressing any meaning configuration. A parsing grammar needs to have a wider coverage, to handle the sentences which appear ‘on the page’. The grammar thus needs to be extended to parse a reasonable majority of the naturally occurring sentences of the English language.

The presently available Systemic parsers only handle grammars well below the size of the Nigel grammar, and are already facing problems of complexity. We can continue to

[1]While O’Donoghue (1991b) calls his system a semantic analyser, the analysis it produces is formally equivalent to the lexico-grammatical analysis of the Penman or WAG systems. O’Donoghue’s system is based on Fawcett’s formalism (Fawcett 1980), which calls the Systemic structure a grammatical analysis, and the features assigned to each unit is called the semantic analysis. Both these analyses together are formally equivalent to a Hallidayan Lexico-grammatical analysis.

[2]While Penman offers some tools -- a network grapher, and a generation debugging interface -- the WAG system offers a wider range of tools, and more user friendly interfaces on those which Penman offers.

improve their efficiency, but I believe that there is a limit to how far we can go in this direction.

Directions for the future are twofold:

1. Focusing on complexity issues, finding ways to reduce the complexity of disjunctive expansion (Kasper 1987a; O'Donnell 1993), and negation. We need also to explore other means to reduce complexity, for instance, finding new ways to pre-compile the resources, producing forms which facilitate more efficient processing.
2. I believe that deriving some sort of context-free backbone from the Systemic resources is a necessary step for Systemic analysis. While Kasper (1988a, 1988b) uses a context-free backbone, his approach is not ideal, since his context-free backbone is not automatically compiled from the Systemic grammar, but needs to be added by hand (it is also based on a non-Systemic formalism). A better solution involves the automatic extraction of a context-free backbone from the Systemic resources, or perhaps a grammar which is closer to context-free.

3.2 Integrated Processing Systems

One of the most important shifts in the last 15 years has been the move away from task-specific processing (e.g., parsing, generation), towards systems which provide a general information processor, e.g., a unifier (FUG, PATR, FUF, TFS, ALE), or classifier (Loom). This movement allows the researcher to dedicate more of their time to the development of their linguistic models, rather than on the details of the processing itself.

3.3 Integration of Analysis and Generation Technology

One of the important trends which is occurring in the NLP field is the integration of analysis and generation technology into a single application. This is necessary, for instance, in natural language interfaces (generating responses to analysed human utterances), machine translation systems (generating text in a target language based on the analysis of a source language), and text summarisation systems (generating a text summarising the content of an analysed text).

To support this integration, Systemic-Functional Linguistics would be well-placed, for several reasons, including the large amount of work on discourse, and the modular representation of the resources. Unfortunately, we are so far lacking in adequate analysis technology -- our parsers do not analyse sentences quick enough for real-time use, and our parsing grammars and lexicons need extensive development to handle previously unseen, naturally occurring, texts.

If we wish to avoid "missing the technology boat" in the next decade of natural language application, we need to focus our attention on improving our analysis technology, showing that Systemic grammar is as functional for computational analysis as it is for human analysis.