The terminology work of IFIP and ICC

By I. H. Gould* and G. C. Tootill**

This paper describes some of the difficulties encountered in the preparation of a multilingual vocabulary of Automatic Data Processing. The methods of the International Federation for Information Processing and the International Computation Centre separate and clarify these difficulties and constitute an advance in the technique of vocabulary preparation.

1. Introduction

The men who write an ordinary English dictionary are experts on language—on philosophy, etymology and literature. They concentrate their attention on words, and observe what each one seems to mean to talkers and writers. The dictionary is their summary report on their observations, and it reflects the average of other people's opinions on the meanings of words.† This statement is true in general of all dictionaries of ordinary language, whether they are monolingual or bilingual.

The objective of dictionary makers is to record established usage of words as faithfully and as accurately as possible, without trying to instruct people that they ought to change their habits of usage. We will call this method of determining the meaning of a word the OBSERVATIONAL method.

In specialist fields, especially scientific and technical, a different method is common: the specialist instructs his audience, of listeners or readers, that a particular word has a meaning that he himself has devised. As an example, notice that we did this in the last paragraph, and we shall do so again several times. This method is very important and useful; consider, for example, how the words "energy," "force," and "power," which often have very similar meanings in ordinary language, acquired their precise, distinct, meaning in physics. We will call this method of determining the meaning of a word the DOGMATIC method.

Now the specialist starts with a definite idea—we will call it a CONCEPT—which he explains and defines, and which he wishes thereafter to refer to quite often. Then he selects a word or words to represent his *concept* in a *dogmatic* manner—we will call the word or words a TERM. This is similar to a basic technique in mathematics, exemplified by the instruction: let x be the height of the tower. Here x is the *term*, and the words "the height of the tower" constitute the definition of the *concept* (a very simple one in this example).

2. Monolingual specialist glossaries

How should the compilers of a specialist glossary proceed? In general, they should use an observational approach, but not always. As the scope of a glossary widens, for example from punched-card equipment to Automatic Data Processing equipment (which includes electronic computers as well), or from British English to British and American English combined, many difficulties and unsatisfactory features of usage become apparent. The observational method would tend to produce an erudite work, replete with qualifications and exceptions. It would be too bulky for practical use. To give the best possible service to users of the glossary, it is necessary to resolve difficulties dogmatically. Let us elaborate this point, since it is a fruitful source of misunderstanding and thence of irritation.

A monolingual glossary has two main objectives:

(1) explanation—to explain to novices the meaning of specialist terms, and

(2) standardization—to guide experts in the choice of the correct term to express their meaning (particularly important for teachers and authors).

For explanation, the observational glossary is satisfactory, but for standardization a dogmatic glossary is required to correct imprecise or unhelpful usage. Of course, the expert teacher or author, while welcoming the advice of many specialists (for example, his doctor), often rejects the advice of the terminology specialist. This is a pity, because he thereby loses the benefit of careful and extensive studies of terminology; he makes his own utterances less understandable to others.

Terms in common use can be incorrect or misleading in their apparent literal meaning. For example, to enhance precision in a computer, two words can be used instead of one to represent a number. This is often called "double-precision working," whereas in fact, of course, if a word consists of say 20 bits, the precision is not doubled, but multiplied by more than a million. One could, of course, manufacture a logarithmic definition of precision, as an alternative to the usual one, in order to justify the term "double precision," but it seems better in this case to talk about "double-length working," for which the authority of usage also exists. Again, any procedure for locating the maximum of a linear function of variables, which are subject to linear constraints and inequalities, is usually called "linear programming." Since it is often, but not necessarily, done by programming a computer it is better called "linear optimization." The novice finds this less confusing.

* *Elliott Brothers (London) Ltd., Borehamwood, Herts.*
** *European Space Technology Centre, Delft, Netherlands.*

† There are a few exceptions, of course, like Dr. Johnson's reputed definition of "Lexicographer" as "a harmless drudge."

Sometimes the correct term for a concept depends on the circumstances. For example, there is a component of some A.D.P. equipment that is similar in principle to a manual telephone-switchboard. If it is part of a punched-card machine, it is sometimes called a "plugboard," whereas if it is part of an analog computer, it is usually called a "patchboard." It would be possible to define two different concepts to correspond, but this would be to perpetuate an unproductive distinction in terminology. It is better to lay down that both terms denote exactly the same concept, i.e. that they are SYNONYMS, thus giving permission for either to be used in connection with both punched-card machines and analog computers.

Sometimes this meaning of a term is completely changed by a change in its context. A term that has this property denotes two (or more) different concepts: it is called HOMONYM. For example, to "pack" is to compress data for storage (as when a string of zeros is replaced by an indication of the number of zeros in the string), but in British usage the same word is the usual one for a set of punched cards. In general, it is better to deal with homonyms by selecting a different, non-homonymic, term for each concept represented by the homonym. In this instance, the concepts are so different that there is not much danger of confusion, but even so it would be well to say always a "deck" of cards.

These, then, are three simple examples of the need for the dogmatic method: wrong terms, near synonyms, and homonyms. The reader must not think that this is unprofitable pedanticism. Examples quoted here have to be simple, or this paper would become too long. In practice, glossary compilers meet much more elaborate difficulties in trying to apply the observational method, and often find that extreme concern with details is very helpful.

3. Multilingual specialist terminology

Terminology work often has a third objective to combine with two mentioned in the last Section. It is:

(3) How should a multilingual dictionary of a specialized subject be prepared?

The method proposed by J. E. Holmstrom (a professional linguist) is as follows. Definitions of concepts are selected from existing specialized glossaries (or written expressly for the purpose) by experts in the subject. The definitions are translated into another language, and submitted to native users of that language who are also experts in the subject. These latter experts nominate the term that they use for each concept, and thus provide a translation, into the second language, of the terms in the original language that corresponds to the selected concepts.

This as formulated is an observational method, and is a noteworthy advance on the more common observational method in which linguists sift the specialist literature in several languages for explanations of the meaning of terms. By matching what they understand to be the meanings, they obtain translations of terms. However, a linguist may well achieve very poor results by this method, since he is usually, at best, a novice in the specialist subject, and since the explanations of the meanings of terms that he encounters in the literature are often very bad, and if not bad, applicable only in a particular paper of restricted scope. The Holmstrom method brings to bear expert knowledge of the subject, as well as lifelong knowledge of the relevant language, and is obviously an improvement.

It does not, however, solve the problem of near translations—words in different languages whose meanings overlap considerably, but are not completely the same, like "breakfast" and "petit déjeuner." Fortunately, in scientific and technical subjects, and especially in A.D.P., near translations do not arise as this example does—reasonably and inevitably from differences in national habits; they are, on the contrary, usually fortuitious and not worth retaining. This is because the technical facts are the same, no matter in what language one discusses them.

When a speciality is well established, and sufficient time has passed without major new developments, we could expect good monolingual glossaries to exist, and in this case the Holmstrom method would probably be satisfactory.

4. The IFIP–ICC method

An attempt made by ICC in 1958 to use the Holmstrom method in A.D.P. gave rather unsatisfactory results. When the work was terminated by an externally imposed deadline, definitions of closely similar concepts were competing as alternatives for acceptance. The difficulties arose from the fact that the subject was too new for usage to have crystallized, and also, then as now, was developing too rapidly. Consequently, each proposal was met by counterproposals, and divergent views resulted. It became clear that international discussions between A.D.P. experts were needed to agree which concepts needed a term in each language, and how each such concept should be defined.

As a result, the IFIP Terminology Committee (later the Joint IFIP–ICC Terminology Committee) was formed towards the end of 1961. It consists of representatives from national terminology committees in the Federal German Republic, France, Italy, the Netherlands, the United Kingdom, and the United States of America, and it has also received contributions to its work from Australia, Canada, Czechoslovakia, Japan, Poland and Sweden.

This Committee has concentrated on concepts, and has refused, for the most part, to concern itself with terms. By this means it has largely avoided the difficulties, such as those already mentioned, which exist in starting from terms. Even with concepts only, it has been necessary to use dogmatic methods to remove useless variants, and to allow the concepts to relate to each other satisfactorily.

The Committee members have been fortunate in being able to use one working language only—English. This has accelerated the work considerably, but even so they have spent almost three years in preparing material for their "first edition," comprising definitions of about 1,400 concepts. Now that these are available, the work on terms can start; the various national committees will assign terms in their own language to the concepts, by the observational method if possible, but failing that, by the dogmatic method. The latter may well be essential, because the national committee must not change the definitions in the slightest degree. The committee will work either directly from the definitions in English, or from translated versions of the definitions.

The definitions make extensive reference to related concepts defined elsewhere, by using the terms that here have been assigned to these concepts,* so as to ensure that the set of concepts forms a coherent whole. The International Committee has therefore been forced, on occasion, to generate terms in English, but since the terms have only been a working tool to aid in the preparation of definitions they have not caused much discussion. It is fortunate that experts in A.D.P. are usually able to read English, since the use of specialist terms within the definitions makes it impossible to finish translating the definitions until a set of translated terms is available. Thus each national committee will need to assign terms in its own language to the concepts defined in English before translating the definitions.

Provisional terms in English have already been replaced by definitive terms, by the Sub-Committee for English, doing the job of the national committee mentioned above. The Sub-Committee for English is, in fact, also an international committee, comprising (in principle) representatives of Australia, Canada, the United Kingdom and the United States of America. Several languages will need to be dealt with internationally—for example, Spanish, and strictly, even French and German.

When terms have been assigned in more than one language, a bi- or multilingual dictionary can be put together, exactly as in the Holmstrom method. It is important to notice that if national committees change the definition of a concept when they allocate a term to it, they will destroy the exact equivalence with corresponding terms in other languages, and revert to the near translations which are so common in ordinary language. This would be particularly unfortunate in A.D.P. the speciality in which mechanical translation has its origin. A.D.P. experts must surely set a good example to experts in other subjects, in facilitating mechanical translation. They must provide translations of their own jargon which are independent of context, and with goodwill and a certain amount of compromise this should be perfectly possible.

* This feature of the work has made it possible to search for circularity in definitions by using a computer; the method is formally the same as part of a PERT program.

5. Format of multilingual dictionaries

How should the results of this multilingual terminology work be presented to the user? The man who is reading, or translating, a specialist paper in a foreign language would obviously like a simple dictionary of terms, arranged alphabetically in the foreign language, giving equivalent terms in his own language. However, if we are concerned with N different languages, this would imply $N(N-1)$ different dictionaries, each one being, in general, in relatively small demand, and therefore expensive. It is essential to produce an inexpensive dictionary even if this means that it is slightly less convenient to use. In fact, in the proposed scheme it will be necessary to search in two ordered lists, in two separate volumes, to obtain a translation between two nominated languages.

We should notice that the translation objective of terminology work depends on the other two objectives, explanation and standardization. For the translations of terms, laboriously arrived at, to be valid, the definitions of concepts must be widely disseminated. Further, the reader of a foreign paper who does not understand a specialist term in the foreign language may not on occasion understand the specialist meaning of the corresponding term in his own language. Translators also need definitions to deal with homonyms; we must admit that unfortunately not all authors will immediately make the effort to use preferred terms, and homonyms will still occur.

The IFIP–ICC Vocabulary will therefore contain both terms and definitions. The word "definition" here has its usual meaning in the context of terminology—an explanation and description of the objects and ideas that form the concept. This description is, as far as possible, precise enough to warrant the name definition. There will be a number (only N, instead of $N(N-1)$) of monolingual volumes, each of which will be in two parts. The first part will contain definitions, the entries being arranged so that objects and ideas that are related in essence are found close together and can therefore readily be compared. The entries will be the internationally agreed definitions translated into the language of the volume, and the title of each entry will be the term in that language for which the description is a definition. The arrangement of the entries will be the same in all monolingual volumes and each entry will have a unique serial number. The second part of the monolingual volume will consist of an alphabetical list of terms in the language of the volume, each term associated with the serial number of the corresponding entry in the first part, so that the entry corresponding to a given term can be located. Each monolingual volume will therefore serve as a glossary of A.D.P. in its language, for explanation and standardization.

Two different monolingual volumes, however, will constitute a bilingual dictionary. To find the translation of a term, one will locate the term in the second part of the volume for the original language, and obtain the serial number of the concept. Against this serial number, in the first part of the volume for the target language one will then find the translation of the term and the definition of the concept.

There are several advantages of the above format. A national organization will produce a volume in its own language only, thus avoiding difficulties with typesetting and proof-correction in foreign languages, and possibly of course even in different alphabets. No volume need be delayed because work in another language is not finished. Each monolingual volume will be in demand for explanation and standardization in its own right, and the price should then be the lowest possible. Two different monolingual volumes should cost less, in fact, than a bilingual dictionary based on the same material, but obviously selling in much smaller numbers. These points are the justification for the format which has been adopted.

6. The scope and structure of the vocabulary

What should be the scope of a vocabulary of A.D.P.? It is clear from what has been said that the wide scope of the IFIP–ICC terminology work is the source of much of the difficulty of the work. It is equally, however, an essential feature of a vocabulary which is to be authoritative and serviceable. Many concepts arise in slightly different forms in different specialities within A.D.P., and it helps the specialist if he can align his terminology with that of others, and of course it helps the novice if he can learn ideas that are of reasonably general application. For example, many concepts are common to analog and digital computing, or can be made so with slight generalization. This has been done as much as possible since the gap between analog and digital technologies has by now been bridged.

On the other hand, the vocabulary must not become too bulky, and it must not overlap unduly into fields other than A.D.P. These excesses can occur readily, because the technology of A.D.P. derives from general electronic and light mechanical technology, and the methods and procedures derive from those of mathematics, accounting and so on. There are inevitably some borrowed concepts included in the IFIP–ICC vocabulary, but only those which undergo narrowing, i.e. specialization for A.D.P., or those which are so important for the understanding of other concepts that they cannot be omitted, in case the reader happens to be unfamiliar with the subject to which they properly belong. The size of 1,400 concepts is about the maximum which it is practicable to have, and even so there are some areas where only the principal ideas have been defined. Table 1 gives an indication of the scope of the vocabulary.

Within each of the twenty sections listed in Table 1, concepts are classified systematically, and there is a list of terms at the start of each section which illustrates the interrelationships between concepts. A simplified example of such a list is given in Table 2, which represents the structure shown in Fig. 1. The reader can see

Table 1

Arrangement of main sections

GENERAL CONCEPTS PECULIAR TO DATA PROCESSING OR ADOPTED FROM ASSOCIATED DISCIPLINES

- A Data processing systems and techniques
- B Mathematics and logic
- C Engineering technology

DATA DESCRIPTION AND REPRESENTATION

- D Organization of data
- E Representation of data

TECHNIQUES IN HANDLING AND PROCESSING DATA

- F Preparation and selection of digital data
- G Arithmetical and logic operations
- H Checking

DIGITAL COMPUTER PROGRAMMING

- J Formalization and preparation of programs
- K Programming techniques
- L Instructions

SYSTEM OPERATION AND PERFORMANCE

- M Operating techniques and facilities
- N Reliability and maintenance

EQUIPMENT TECHNIQUES

- P Component units of control, input and output equipment
- Q Component units of arithmetical equipment
- R Storage techniques
- S Stores using moving magnetic media
- T Stores using stationary magnetic media
- U Properties and uses of data carriers
- V Data carrier equipment

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that the structure of this section is only partly hierarchical; some of the entries are simply listed, with no particular importance attaching to the order. This situation occurs in all sections: in some the tree structure is hardly apparent at all; in others there are several trees present, associated with each other on the same level. In the lists, a horizontal rule is used to indicate a change of theme between two entries having the same rank.

7. Examples of definitions

Finally, we give some examples of the way in which the Committee has defined concepts. It is well known that it is the most common or fundamental things that cause difficulty in explanation, and long discussions on

Terminology

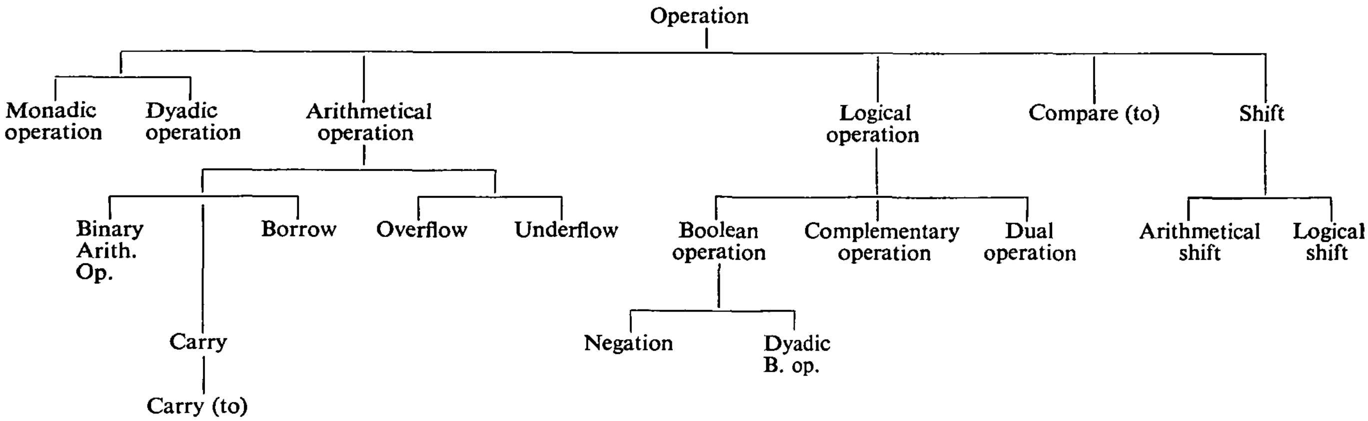

Fig. 1.—Tree structure corresponding to Table 2

Table 2

Layout of Section G (simplified)

G. Arithmetical and logic operations

Operation
    Monadic operation
    Dyadic operation

    Arithmetical operation
        Binary arithmetical operation
        Carry
            Carry (to)
        Borrow

        Overflow
        Underflow
    Logic operation
        Boolean operation
            Negation
            Dyadic Boolean operation
        Complementary operation
        Dual operation
    Compare (to)
    Shift
        Arithmetical shift
        Logical shift

some basic ideas gave rise to the following two concepts.*

DATA

A representation of facts or ideas in a formalized manner, capable of being communicated or manipulated in some process.

INFORMATION

In *automatic data processing* the meaning that a human assigns to *data* by means of the known conventions used in its representation.

* Terms printed in italics in the definitions are those allocated to concepts defined elsewhere in the vocabulary.

Strings of characters, electrical signals, holes in paper tape are thus examples of *data*, whereas the concept of *information* is similar to the normal meaning of the word, and rather different from its meaning in Information Theory, where a physical quantity is defined objectively. The characters on this page are data, and they may well convey different information to people of different backgrounds.

Three dependent concepts follow naturally from these two basic ones:

DATA PROCESSING

The execution of a systematic sequence of operations performed upon *data*, e.g. handling, *merging*, sorting, computing.

Note: Where data processing is performed in order to increase the value or significance (from a certain point of view) of the information conveyed by the data, it may be called INFORMATION PROCESSING.

AUTOMATIC DATA PROCESSING
A.D.P.

Data processing largely performed by automatic means; by extension, also the discipline which deals with methods, techniques, etc., related to such data processing.

Defining information permits tackling an important set of fundamental linked concepts:

CHARACTER

A member of a set of agreed elements, intended for use in conveying information either when arranged together in an agreed fashion (in general sequentially) or when isolated. Each member has one or more conventional representations on paper and in equipment, e.g. a letter of the ordinary alphabet or other ideograph.

Note: The representation of a character is usually the smallest element capable of being processed separately, e.g. one *column* of a *punched card*, one *row* on a *punched tape*, or, in some cases, a group of *bits*. The term "character" is not normally used for one bit where this is processed as the unit.

DIGIT
NUMERIC CHARACTER

A single *character* that represents an integer. That is, in decimal notation, one of the characters 0 to 9 (the DECIMAL DIGITS).

SYMBOL

One or more *characters* used to represent an entity.

Thus, as is brought out in Notes not reproduced here, a character is at a higher level of abstraction than any of the several ways of representing it. "Seven," "VII," and "7" are *symbols*, but only "7" is also a *digit*, because the other two examples contain more than one character. Arising from these definitions comes a useful distinction between the mathematical concept of a number, and the quite different concept of a NUMERAL, which is a group of digits, used to represent a number.

An example of a less fundamental set of linked concepts, of great practical usefulness, is the following:

FILE

A collection of *data*, complete, in some sense, for the purpose of a particular job. For example, in stock control a file could consist of the complete set of invoices for a given period.

A file may be considered, where convenient, as composed of a number of RECORDS, each record containing the data relating to one particular part of a job. In the stock control example, each invoice could constitute one record.

A record may be further sub-divided into FIELDS, each field being the smallest quantity of data considered as an entity for the purpose of the job. In the stock control example, each line on an invoice could constitute a field.

Note: 1. These terms are imprecise since the amount of data and its convenient sub-division will vary according to the nature of the job; further sub-divisions may be introduced at each level.

Note: 2. A file which is used as a main source of reference is frequently termed a MASTER FILE.

Note: 3. It is sometimes possible to relate the hierarchy

Field $\leqslant$ Record $\leqslant$ File

which is based on the information content, with the hierarchy

Machine Word $\leqslant$ *Block* $\leqslant$ Reel of tape

which is based on the method of operation of the particular equipment (where $\leqslant$ means" is included in"), but the relationship cannot be precisely defined except with reference to a particular job.

We come eventually to the topic of programming, which is made to depend on the following basic concept:

INSTRUCTION
ORDER (deprecated)
COMMAND (deprecated)

A general term for a *string* that specifies partially, or completely, an *operation* or a unit portion of a process. This specification is capable of being used, possibly in conjunction with other *data*, to cause that operation to take place.

Since the instruction does not necessarily, in itself, specify the operation completely, it is legitimate to apply the word to an element of, say, a FORTRAN program. Next comes:

COMPUTER INSTRUCTION
MACHINE INSTRUCTION

An *instruction* that specifies a *computer operation.*

Note: What is specified by the computer instruction and the way in which it is executed are not under control of the *programmer*, since such instructions are inherent in the structure of the *computer.*

COMPLETE INSTRUCTION
ABSOLUTE INSTRUCTION

A *computer instruction* that specifies completely a *computer operation* and which is capable of causing the execution of that *operation.*

For example, an *instruction* written by a programmer may be converted to a *computer instruction* by conversion of its various parts in accordance with rules that are applicable at the time of conversion. The computer instruction in turn may become a *complete instruction* by the action of the value of a modifier, current on one of the occasions when the computer instruction is obeyed.

The definition of a *program* depends on the definition of *instruction*, and thence:

LANGUAGE

A general term for a defined set of *symbols* and rules or conventions governing the manner and sequence in which the symbols may be combined into a meaningful communication.

Note: An unambiguous language, intended for expressing *programs*, is called a PROGRAMMING LANGUAGE.

Thus, granted that the representation of a symbol may be graphic or as sound waves, the concept designated *language* is not really different from the usually understood meaning of the word. The concept designated *programming language* is the foundation for definitions of *instruction set*, *computer language* (or *machine language*), and various concepts in *automatic programming*, which we cannot pursue now.

8. Conclusion

We have seen what requirements the IFIP–ICC terminology project had to meet, why the dogmatic method had to be used, and what form the results will take. The committee members have done a great deal of work; they are, however, conscious of the need for still further improvement in the product, and constructive suggestions will be welcome; a note stating where they should be sent will appear in the published vocabulary.*

The committee's work is nevertheless only part of the whole. The project is a full-scale test of a novel method of improving the terminology of a specialist subject; A.D.P. is a good test subject, because there is no long-established jargon, and because the computer field is a rather cosmopolitan one. The success of the project requires the use of the vocabulary by those who teach, by the editors of journals, by the writers of textbooks, papers, manuals, and sales literature, and by the organisers of, and the participants in, congresses and symposia. This paper is particularly addressed to these people, whose co-operation and informed criticism are invited.

* Announcements of publication of the various versions of the Vocabulary will be made in this *Journal.*

Correspondence

To the Editor,
The Computer Journal,

Program development with FACT

Dear Sir,

With reference to the article "Experience of Program Development with FACT" (*The Computer Journal*, Vol. 7, No. 2, July 1964) which contains some comments and statistics available from experience in operation of a Honeywell 800 installation, it may be of interest to your readers if some comparable details were published of a similar installation using the same type of equipment and software.

In Canberra, Australia, the Australian Government has established the Defence E.D.P. Proving and Training Centre where two Honeywell 800 computers have been used since September 1962 to prepare, test and prove programs for basic systems for processing the routine data requirements of the Royal Australian Air Force. Programming commenced using the FACT compiler language early in 1962, and today approximately 150 people are engaged in developing the systems including about 60 programmers. The computers use punched paper tape as the main input/output media. During March 1964 approximately 780 FACT and ARGUS program run requests were submitted for processing, and the average time between receipts and return was 2·37 working days. The longest time taken to action a run request was 9 working days. At the end of March 1964, the number of active programs was 432 of which 193 were being processed through FACT Compilation and ARGUS Assembly, and 239 were at the "Program Test System" or Checkout Stage.

My experience has been that the most important points of contrast with the article are:

1. The FACT compiler is now working comparatively well though considerable trouble has been experienced with it since commencing to use it two years ago. Other software has functioned satisfactorily.
2. The FACT compiler tape in use in March '64 contained more than "five known bugs," the latest compiler tape available in October '64 still contains a number of known errors.
3. It takes an individual with reasonable programming aptitude at least six months to become proficient in the use of FACT coding techniques, but considerably longer to learn to write efficient FACT programs.
4. One FACT program being developed by three senior programmers had 120 accesses to the computer before it was abandoned as too big, it then had absorbed 1·5 man-years of high class analyst/programmer effort and contained 60,000 lines of generated coding. The program was re-written, to process the same data, taking approximately 20 man-weeks of experienced programmer effort, and with new facilities becoming available in the FACT compiler, now generates 35,000 lines.
5. The re-written program of 35,000 lines has not yet been successfully checked out after 50 accesses to the computer; it is anticipated another 50 run requests will be required before it is proven as acceptable.
6. Of the bugs recognized, major errors have been in logic, coding misconceptions and violating compiler restrictions, transcription punching from coding sheets to paper tape, and a significant proportion of miscompilations and assemblies due to unknown errors in the compiler.
7. Due to the size of the project compared to the available equipment, it is not economically possible or practical to split FACT programs simply because they generate a significant number of lines of coding; many factors including possible processing times and estimated costs of reprogramming are taken into account before such a decision is taken. There are a number of programs being developed, which will become production programs, which are generating well over 20,000 lines of coding and will update and process data on multireel (up to 10 reels) files.

When programming commenced in early 1962 using FACT, the compiler was at a very early phase of development and was incompatible in many respects with the paper tape input/output media. Since that time much developmental work in improving the compiler has been undertaken by both Honeywell and the Defence P & T Centre staff. Though there have been serious problems with the FACT compiler in the past, its present state is significantly more efficient and complete than it was when programming commenced, and it is believed to be sufficient to allow the presently planned systems to be programmed and proven.

The most significant problems at the Defence P & T Centre are that the size of the present task, during the development and proving stage, in its requirements for machine time and use of software, is close to the maximum limits of both. It is hoped that when some of the systems have been proven and introduced as routine production processes, the computer load will be reduced. It is anticipated the first production Sub-System of the currently planned Air Force System will be operating by the beginning of 1965.

Yours sincerely,

ROBERT HURT.

Defence P & T Centre,
EDP Building,
Russell Hill,
CANBERRA, Australia.

26 October 1964.