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The Personal Computer and the Personal Scientist

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There are a number of techniques used in psychiatric practice and management study which have been in the past dependent on their administration by experts, generally psychologists specializing in these techniques. Recently, the advent of low-cost personal computers with good user interfaces such as graphic displays has made it straightforward to take these techniques directly from the laboratory to the real world. In this paper we suggest that this is an example of the emancipatory use of the computer to aid people in dealing with a complex world. We illustrate our discussion with examples of a range of powerful clinical and management tools now transferred to the personal computer and originating from the work of George Kelly on Personal Construct Psychology. Kelly's techniques are widely applicable to all those interested in modelling their own approach to life, those of others, and the inter-relationships between them. We also argue that their are significant features of person-computer interaction that goes beyond those possible in person-person interaction. In conlusion we suggest that a key role for the personal computer may be seen as a symbiotic one with a person in emancipating his cognition by aiding the comprehension and control of an increasingly complex environment.

INTRODUCTION

There are a number of techniques used in psychiatric practice and management study which have been in the past dependent on their administration by **experts**, generally psychologists specializing in these techniques. Not only is the expert required to administer the material but also to analyse and interpret the results, and this has greatly limited the range of application of the techniques. In the last decade computer-based systems for the administration and analysis of these techniques have been developed and demonstrated to be effective in the laboratory and clinical trials (Elithorn & Telford 1969, Gedye & Miller 1969, Elwood 1972a,b,c, Klinge & Rodiewicz 1976). The use of interactive computer systems to undertake interviews previously performed by medical practitioners has proved very acceptable to patients (Card et al 1974, Lucas 1977) and it has even proved possible for the computer to act as an effective therapist in some situations (Stodolsky 1970).

Recently, the advent of low-cost **personal computers** with good user interfaces such as graphic displays has made it straightforward to take these techniques directly from the laboratory to the real world. The new personal computers are very well suited to this type of application since many have been designed as comfortable, homely workstations that are not technologically awesome to the user. The availability of rapid access to quite powerful computing facilities makes it possible to incorporate on-line analysis and to feed back to the user information that might be only intuitively available to a human administrator. The availability of low-cost graphic printing devices makes it possible to present the results of the analysis in a readily assimilable form. Thus, there is much in the new technology that enhances the techniques and goes beyond what is possible with human administration.

It is probably too early yet to discern the long-term impact of this **de-professionalization** of powerful techniques for analysing and modifying human behaviour. Perhaps there will be none -- we all too readily subscribe to the mystique with which the professions surround themselves and believe that their magic is more powerful than it actually turns out to be. However, we are now at a fascinating nexus where it is possible to encapsulate the **expert** within the computer and even outperform him in many respects, and there are no cost constraints to making the resultant systems widely available. In this paper we discuss these topics, analysing the advantages and disadvantages of the computer in this context compared with the human expert.

We illustrate our discussion with an example from a range of powerful clinical and management tools now transferred to the personal computer and originating from the work of George Kelly (1955) on **Personal Construct Psychology.** His techniques are widely applicable to all those interested in modelling their own approach to life, those of others, and the inter-relationships between them.

PERSONAL COMPUTERS AND THE COMPLEXITY OF LIFE

In examining the role of the computer as encapsulating an expert we see a far greater potential than the mere automation of established techniques. There is a more fundamental impact on society in aiding individuals to cope with the complexity of modern life, a role of greater significance for the computer than any so far played. Luhmann (1979) in his work on **Trust and Power** postulates **complexity-reduction** as the fundamental motivation for all our social institutions. He notes:

> "The world is overwhelmingly complex for every kind of real system... Its possibilities exceed those to which the system has the capacity to respond. A system locates itself in a selectively constituted 'environment' and will disintegrate in the case of disjunction between environment and 'world'. Human beings, however, and they alone, are conscious of the world's complexity and therefore of the possibility of selecting their enviroment -- something which poses fundamental questions of self-preservation. Man has the capacity to comprehend the world, can see alternatives, possibilities, can realize his own ignorance, and can perceive himself as one who must make decisions." (Luhmann 1979 p.6)

He goes on to note the added complexity of inter-personal relationships:

> "we invoke a whole new dimension of complexity: the subjective 'I-ness' of other human beings which we experience (perceive) and understand. Since other people have their own first-hand access to the world and can experience things differently they may consequently be a source of profound insecurity for me." (Luhmann 1979 p.6-7)

De Bono (1979) sees the computer as playing an important role in complexity reduction:

> "By great good fortune, and just in time, we have to hand a device that can rescue us from the mass of complexity. That device is the computer. The computer will be to the organisation revolution what steam power was to the industrial revolution. The computer can extend our organizing power in the same way as steam extended muscle power..... Of course we have to ensure that the result is more human rather than less human. Similarly we have to use the computer to reduce complexity rather than to increase complexity, by making it possible to cope with increased complexity." (De Bono 1979, pp.18-19)

The theme of Luhmann's and De Bono's remarks is not a new one. For example, Wiener (1950) emphasizes it in his **Human Use of Human Beings;** Licklider (1968) foresaw the development of a form of **man-computer symbiosis;** Gaines (1979) has compared the computer as an 'engine' for

moving around and conquering Popper's (1974) **world 3** of information and theory with the mechanical engines used to move around and conquer his **world 1** of the physical environment. More recently Toffler (1980) has seen information technology as supporting a **third wave** that takes us beyond agricultural and industrial societies to one of greater individual freedom and participation. It is only with the advent of the personal computer that the technology underlying these predictions has become manifest. The overall scenario predicted may be summarized as:

* 1 individuals are becoming dominated in their thoughts and actions by the organizational structures of an increasingly complex world;
* 2 individual decision-making is increasingly restricted because the basis for comprehending the ramifications and consequences of decisions is too complex for most people;
* 3 only a few are capable of being truly individualistic in moving within society's framework;
* 4 most give in and are driven by the organization rather than driving it;
* 5 some opt out destructively rebelling against the complete social order.

However there is also seen to be an alternative scenario in which 1 and 2 still hold but the numbers of people in category 3 is greatly increased at the expense of categories 4 and 5 because the personal computer is available to interface between the person and the complex society in which he is embedded.

This may seem to exagerate the possible importance of the computer. However, already many of the programs being made widely available at low cost to those who have computers in the home are ones which enable them to come directly to grips with a complex world without going through the experts normally required to mediate on their behalf. Some programs replace the professional adviser such as those which perform accounting functions, evaluate stock portfolios or allow elaborate business plans to be evaluated. These have obvious derivations from the mainframe computing services of yesterday but there is innovation in their availability on low-cost interactive systems in the home. Other programs allow the clerk who acts as gatekeeper to information to be by-passed such as those which give access to bank accounts and transport timetables. Some of the programs give access to expertize of a acientifically substantiated nature such as those on diet and nutrition whereas for others which cast horoscopes or deal tarot cards the basis of the expertise is less well-founded but nonetheless real to the users. Even 'adventure' games may be seen as providing personal access to a learning environment in a simulated fantasy world that has many of the aspects of real life.

Such applications also give a very different image of the use of the computer from the current stereotype in which it is usually seen as a **technical cognitive** tool (Habermas 1968) to exert authority over man.

We see the computer being used in what Habermas calls an **emancipatory cognitive** role to give greater freedom to the individual rather than further restrict it. In this respect, the emphasis on the truly personal computer is a significant one. It is not the 'computer utility' (Parkhill 1966), the global network, into which everyone connects -- that is too open to central control. It is rather the individual machine with its own capabilities for computation and storage that is part of a person rather than part of his environment. Thus **a key role for the personal computer may be seen as a symbiotic one with a person in emancipating his cognition by aiding the comprehension and control of an increasingly complex environment.**

There have been developed computer programs that play an **emancipatory** role in presenting to a person the structure underlying their thinking and interpersonal interactions. Mulhall's (1977) PRI essentially generates a state-transition diagram enabling someone to see the sequential nature of their social behaviour: that when they take one action it leads to someone else taking another, them taking a third, and so on, until they arrive at desirable or undesirable consequences. The PRI has been used successfully in a form of psychotherapy that emancipates the patient by presenting to him a comprehensible account of what is a complex, and emotionally loaded range of situations. In the context of management decision-making Boxer's NIPPER (1979) is an interactive program to make apparent the constructs underlying a preference relationship. In both clinical and management studies Slater's (1976) INGRID program has been used to give a map of personal semantic space which can be presented to a person to help him comprehend his own thought processes (Easterby-Smith 1981). Shaw (1980) presents a range of programs for eliciting and analysing both personal and group meaning: PEGASUS for interactively eliciting personal constructs; FOCUS for presenting the structure underlying the constructs; PEGASUS-BANK for allowing one person to interact with the constructs of another, e.g. an expert; CORE for deriving a relation between two grids; SOCIOGRIDS for deriving the shared constructs in a group of people; and ARGUS for eliciting a set of grids simultaneously from one person in several different roles.

All of these programs are emancipatory in that they feed back to a person information about his own behaviour, thought processes and relationships to others. They do not give rules, guidelines or other normative behavioural modifications, or any form of 'answer'. Their effects and impact come only from the greater understanding that the user may derive from them. Such an approach is suggested by Kelly's (1955) personal construct psychology and in the next section we discuss the theory, its role in computing and programs deriving from this.

THE PERSONAL SCIENTIST

George Kelly commenced his studies as an engineer but moved into clinical psychology and developed a radically different approach to the subject that emphasized the questing nature of the individual and the idiosyncratic content of our models of the world. Kelly put forward the idea of an individual as what Shaw (1980) terms a **personal scientist** using **personal constructs** as filters through which he perceives events:

> "Man looks at his world through transparent templets which he creates and then attempts to fit over the realities of which the world is composed." (Kelly 1955 pp.8-9)

He emphasizes the role of these constructs in our predicting and controlling the world and their status as personal conjectures rather than reality-derived absolutes:

> "Constructs are used for predictions of things to come, and the world keeps on rolling on and revealing these predictions to be either correct or misleading. This fact provides the basis for the revision of constructs and, eventually, of whole construct systems." (Kelly 1955 p.14)

Thus, making explicit the construct structures in use and identifying their strengths and weaknesses is a key process in aiding man's coping with a complex world. In psychiatry the assumption is that problems may often be related to the construct system through which the patient is viewing the world. In general we may expect many problems of knowledge, decision and action, both fundamental as in science and applied as in management, to be similarly related to the construct systems in use.

A variety of approaches has been taken to the elicitation of personal construct systems. As well as theoretical foundations, Kelly (1955) also proposed a methodology for the elicitation of personal constructs using a **repertory grid**. He assumed that constructs were bipolar and binary so that an element would be construed as being assigned to one or other of the poles of a construct. To elicit the constructs themselves Kelly used triads of elements and asked for some basis on which one element differed from the other pair in the triad, i.e. how could the elements in the triad be construed so that two were similar in some way and the other differed in that same way. The grid obtained of elements against constructs is essentially a binary matrix in which each element is assigned to one or the other of the poles of a construct. An extension generally adopted is to allow multi-point rating scales to be used bewtween the poles. Kelly notes that the repertory grid may be used and analysed in a number of ways, notably through some form of factoring that makes apparent relationships between constructs. Since its original description there have been many applications of the repertory grid and developments from it (Bannister & Fransella 1971, Slater 1976, Shaw 1980, Gaines & Shaw

1981).

Figure 1 shows a repertory grid elicited from a person contemplating a change of employment: the elements are different jobs and the constructs are significant distinctions between them. A '1' in the matrix indicates that the left-hand description on the row applies to the element on that column; a '5' that the right-hand description applies; and intermediate values that the element lies between the two descriptions. This grid was derived by the computer program PEGASUS (Program Elicits Grids And Sorts Using Similarities, Shaw 1980) which elicits a grid interactively from an individual, simultaneously acting as a psychological reflector for heightening his awareness and deepening his understanding of himself and his processes. This is done by continual commentary on related elements or constructs, together with the encouragement to differentiate between them.

```
                    * 1  2  3  4  5  6  7  8  9
                   ******************************
 know what it is 1 * 1  1  5  5  3  2  5  2  1 * 1 unknown
       exciting  2 * 5  1  2  5  1  1  2  1  3 * 2 doesn't excite me
  changes little 3 * 1  1  1  3  5  1  5  3  1 * 3 changes everything
     done before 4 * 1  4  5  5  4  2  4  4  2 * 4 totally new
can work at home 5 * 4  4  1  5  4  3  3  2  1 * 5 have to go out
  work with team 6 * 1  1  2  2  1  5  5  2  4 * 6 on my own
  more free time 7 * 3  3  3  5  1  1  1  1  1 * 7 not much free time
   probably dull 8 * 1  4  3  1  4  2  5  5  3 * 8 varied & interesting
                   *  *  *  *  *  *  *  *  unemployment
                   *  *  *  *  *  *  *  ideal job
                   *  *  *  *  *  *  consultancy US
                   *  *  *  *  *  consultancy UK
                   *  *  *  *  US teaching
                   *  *  *  government
                   *  *  company
                   *  another department
                   my job now
```

Figure 1 Grid Elicited by PEGASUS from Person Thinking of Changing Job

Before choosing his elements the user is asked to think about his purpose for eliciting the grid. Here it was stated to be "to decide whether to change my job". This is of great importance for the interaction which is to follow, since the elements are dependent on the purpose and the constructs are dependent on the elements. By using combinations of reviewing the purpose and adding and deleting constructs and elements, a depth of interaction can be achieved which could not at first be envisioned. The user is given the opportunity to reflect on his understanding of the topic and to examine and explore his thoughts and feelings in an atmosphere of heightened awareness of personal knowing. His perception may be changed in a way which by other means can take much time to accomplish.

The program is divided into six main sections and these are

illustrated here through the elicitation of the grid in Figure 1. The first section is the **Basic Grid** in which explanation of grids and the use of the terminal are given, and the first four constructs elicited. Before the user chooses his elements he is asked to think about his purpose which defines the universe of discourse and enables him to choose elements which are relevant and representative of the topic area since the choice of elements largely determines the depth of interaction which can be achieved. This is shown in the following dialogue with PEGASUS in which computer output is in upper case and the responses in lower case.

```
THIS IS A PROGRAM TO ELICIT A KELLY REPERTORY GRID.
PLEASE READ CAREFULLY EVERYTHING THAT IS PRINTED AND
MAKE SURE YOU UNDERSTAND WHAT YOU HAVE TO DO.
A REPERTORY GRID IS A TECHNIQUE DEVISED BY KELLY TO
HELP YOU EXPLORE THE DIMENSIONS OF YOUR THINKING.

YOU MUST DECIDE ON A PURPOSE FOR DOING THE GRID AND
KEEP THIS IN MIND WHEN YOU CHOOSE THE ELEMENTS--THE
THINGS YOU ARE GOING TO THINK ABOUT DURING THE PROGRAM.
THESE ELEMENTS WILL THEN BE USED TO ELICIT CONSTRUCTS.

THIS PROGRAM INCORPORATES FOUR VERSIONS OF PEGASUS.
 1. A PEGASUS GRID ELICITATION STARTING A NEW GRID;
 2. A STRAIGHT KELLY REPERTORY GRID ELICITATION
    WITHOUT COMMENTARY (MIN-PEG);
 3. A PEGASUS GRID ELICITATION USING A STORED BANK
    OF CONSTRUCTS (PEG-BANK);
 4. A PEGASUS GRID ELICITATION WITH PART ALREADY
    ELICITED BY YOU RECENTLY (PRE-PEG).
WHAT IS THE NUMBER OF THE VERSION YOU WISH TO USE ?1

TYPE IN ON ONE LINE YOUR PURPOSE FOR DOING THIS GRID

 ?to decide whether to change my job

NAME SIX ELEMENTS.
YOU MUST CHOOSE A SET OF SIX ELEMENTS KEEPING IN MIND
WHY YOU WANT TO DO THIS GRID. THEY COULD BE PEOPLE, EVENTS,
PIECES OF MUSIC, PICTURES, BOOKS, OR WHAT YOU WANT BUT
WHATEVER YOU CHOOSE THEY MUST BE OF THE SAME TYPE AND
EACH MUST BE WELL KNOWN TO YOU. TRY TO CHOOSE SPECIFIC
THINGS. NOW TYPE EACH ONE AFTER EACH QUESTION MARK.
DO NOT FORGET TO PRESS THE RETURN KEY AFTER EACH.

ELEMENT  1  ?my job now
ELEMENT  2  ?another department
ELEMENT  3  ?company
ELEMENT  4  ?government
ELEMENT  5  ?US teaching
ELEMENT  6  ?consultancy UK
```

The conventional method is then used to elicit the first few constructs, that is to present a triad of elements to be divided into a pair and a singleton indicating the poles of the construct. After the user has named the poles the computer assigns a 1 to the pair and a 5 to the singleton, and he has then to assign ratings from 1 to 5 to each of the other elements. These are then retyped in groups to highlight the relative position of each element with respect to the others, and an option to change the ratings is given. This is shown in the following dialogue with PEGASUS.

```
TRIAD FOR ELICITATION OF CONSTRUCT 1
 1 my job now
 2 another department
 3 company

NAME THE PAIR

CAN YOU CHOOSE TWO OF THIS TRIAD OF ELEMENTS WHICH ARE IN
SOME WAY ALIKE AND DIFFERENT FROM THE OTHER ONE.
TYPE IN THE NUMBERS OF THE PAIR ONE AFTER EACH QUESTION
MARK. DONT FORGET TO PRESS THE RETURN KEY AFTER EACH.

 ?1
 ?2

NAME THE POLES OF YOUR CONSTRUCT

NOW I WANT YOU TO THINK ABOUT WHAT YOU HAVE IN MIND WHEN YOU
SEPARATE THE PAIR FROM THE OTHER ONE.HOW CAN YOU DESCRIBE
THE TWO ENDS OR POLES OF THE SCALE WHICH DISCRIMINATE
my job now AND another department FROM company
JUST TYPE ONE OR TWO WORDS FOR EACH POLE TO REMIND YOU WHAT
YOU ARE THINKING OR FEELING WHEN YOU USE THIS CONSTRUCT.

LEFT POLE RATED 1 -- ?know what it is
RIGHT POLE RATED 5 -- ?unknown

TYPE IN THE RATINGS

NOW IF my job now AND another department ARE
ASSIGNED THE VALUE 1 AND company IS ASSIGNED THE VALUE  5
ACCORDING TO HOW YOU FEEL ABOUT THEM PLEASE ASSIGN TO EACH
OF THE OTHER ELEMENTS IN TURN A PROVISIONAL VALUE FROM 1 TO 5

 1 my job now           1
 2 another department   1
 3 company              5
 4 government           ?5
 5 US teaching          ?3
 6 consultancy UK       ?2
```

```
POLE 1 --know what it is

 1 my job now          1
 2 another department  1

 6 consultancy UK      2

 5 US teaching         3

 3 company             5
 4 government          5

POLE 5 --unknown

DO YOU WANT TO CHANGE ANY OF THESE VALUES ? no
DO YOU WANT TO CHANGE THE POLE NAMES ?no
```

The second section, **Construct Match**, provides feedback when two constructs are highly related. The user is first asked to add an element which is either at pole 1 on the first construct and pole 5 on the second or vice versa. If he can add a new element it must be rated on all the constructs so far elicited, but if he cannot split the two constructs this way he is asked if he would like to delete a construct, combine two constructs into one, or just carry on. Feedback from a construct match is shown in the following dialogu.

```
THE TWO CONSTRUCTS YOU CALLED
 1 know what it is--unknown
 4 done before--totally new
ARE MATCHED AT THE  66 PERCENT LEVEL.
THIS MEANS THAT MOST OF THE TIME YOU ARE SAYING
know what it is YOU ARE ALSO SAYING done before
AND MOST OF THE TIME YOU ARE SAYING
unknown YOU ARE ALSO SAYING totally new

THINK OF ANOTHER ELEMENT WHICH IS EITHER
know what it is AND totally new
OR done before AND unknown
IF YOU REALLY CANNOT DO THIS THEN JUST PRESS RETURN AFTER
THE FIRST QUESTION MARK BUT PLEASE TRY. THEN YOU MUST GIVE
THIS ELEMENT A RATING VALUE ON EACH CONSTRUCT IN TURN.
AFTER EACH QUESTION MARK TYPE A VALUE FROM 1 TO 5
WHAT IS YOUR ELEMENT ?consultancy US
RATINGS :

know what it is--unknown ?5
exciting--doesn't excite me ?2
doesn't affect other things--changes everything ?5
done before--totally new ?4

DO YOU WANT TO CHANGE ANY OF THESE VALUES ?no
```

It is interesting that the user here does not do as the computer asks in the ratings assigned but does add a new element. This illustrates the role of the feedback in stimulating the user's own thought processes rather than directing them in ways determined by the program.

When four constructs have been entered, the program moves into the third section, **Element Match**, and begins to calculate matching scores between elements. Each element is matched with every other on the basis of the ratings used, and a comment made on the highest match if it meets the set criterion. The first choice offered is to add a new construct on which the two elements are placed at opposite poles, and then all the elements must be rated in the usual way. Alternatively an element may be deleted, or no action may be taken. Feedback from a element match is shown in the following dialogue with PEGASUS.

```
THE TWO ELEMENTS  2 another department AND  6 consultancy UK
ARE MATCHED AT THE  80 PERCENT LEVEL.
THIS MEANS THAT SO FAR YOU HAVE NOT DISTINGUISHED
BETWEEN another department AND consultancy UK
DO YOU WANT TO SPLIT THESE ?yes
HELP ?yes
THINK OF A CONSTRUCT WHICH SEPARATES THESE
TWO ELEMENTS AND THEN KEEPING THIS IN MIND
ACCORDING TO HOW YOU FEEL ABOUT THEM PLEASE ASSIGN TO EACH
OF THE OTHER ELEMENTS IN TURN A PROVISIONAL VALUE FROM 1 TO 5
NAME THE POLES OF YOUR CONSTRUCT
LEFT POLE RATED 1 -- ?work with team
RIGHT POLE RATED 5 -- ?on my own
TYPE IN THE RATINGS

 2 another department   1
 6 consultancy UK       5
 1 my job now          ?1
 3 company             ?2
 4 government          ?2
 5 US teaching         ?1
 7 consultancy US      ?5

POLE 1 --work with team

 1 my job now          1
 2 another department  1
 5 US teaching         1

 3 company             2
 4 government          2

 6 consultancy UK      5
 7 consultancy US      5

POLE 5 --on my own
```

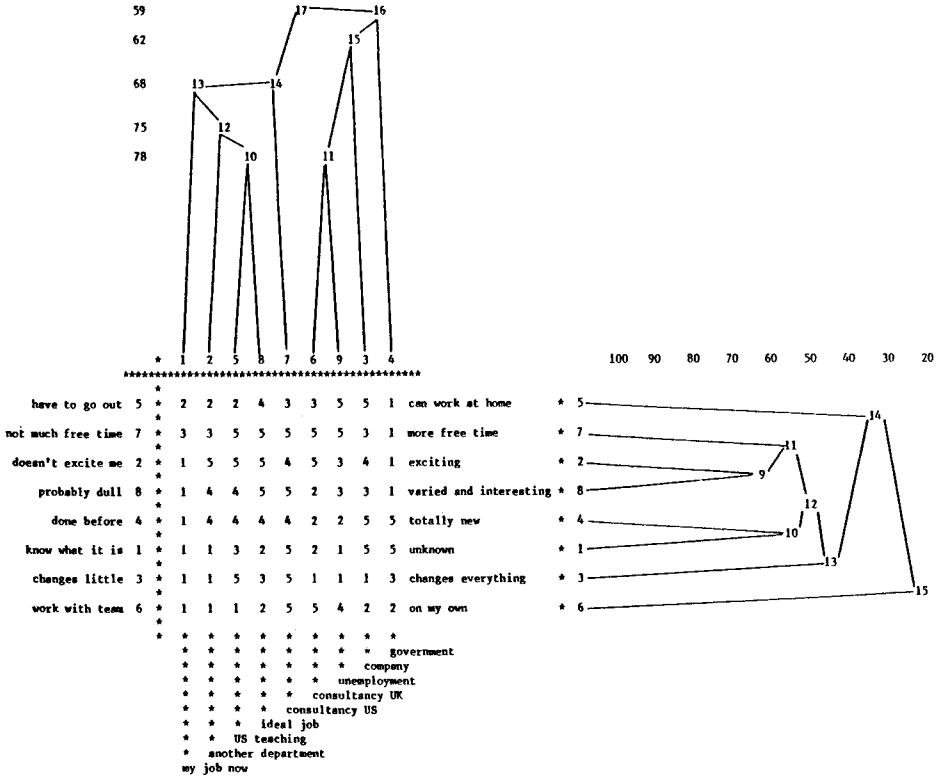

Figure 2 FOCUS Hierarchical Cluster Analysis of the Grid of Figure 1

Section four allows the user to **Finish** at this stage in the cycle. Section five, **Review**, gives the choice of adjusting or redefining the purpose, and altering the level of match on which feedback commentary is given. There is an opportunity to see a focused version of the grid to date, and to delete any element or construct which is felt to be unsatisfactory in any way. In the sixth section, **Alternative Elicitation**, the user is given the freedom to add an element or to add a construct without using a triad if he so wishes. For example in the elicitation shown the element 'ideal job' was added in this way.

When the grid reaches the maximum size allowed, or if the user chooses to finish before that, the results are analysed using the FOCUS procedure as shown in Figure 2. This is a two-way hierarchical cluster analytic technique which systematically reorders the rows of constructs and columns of elements to produce a focused grid which shows the least variation between adjacent constructs and adjacent elements. The printout shows the trees of the elements and constructs as well as the focused grid with the element and construct labels. It can be seen that the element 'ideal job' matches most closely to 'US teaching' and that 'unemployment' and 'consultancy UK' have similar characteristics. It can also be seen that constructs 7, 2, 8, 4 and 1 form a related cluster with 5, 3 and 6 only loosely linked in. Since the PEGASUS feedback encourages the separation of constructs very close matches are rare.

As a PEGASUS elicitation proceeds this FOCUS algorithm is used to offer to the user a possible explanation and interpretation of his meaning system in the terms of the similar patterns he uses in supposedly different circumstances. Cross-references are mapped across the grid and exhibited to the user in such a way as to offer him the facility to reconsider and change anything he feels to be inappropriate, which in turn enables him to be more aware of the links he is implicitly holding in his cognitive model. Here the conversation can be seen as a feedback loop with the computer acting as an emancipator by re-presenting the content of the conversation and the implicit links within it. In this way the participative analysis extracts and presents the essence of the personally meaningful relationships in the grid. It may well be impossible for a person to derive such relationships themselves without help -- for example, the studies of Michalski and Chilausky (1980) on expert systems show that inductive algorithms are better at extracting the rules for an expert's decision than the expert himself is at expressing them.

THE ROLE OF THE PERSONAL COMPUTER

It would be easy to assume that such interactive programs are merely more convenient ways of eliciting construct systems through extensions of the repertory grid and do not themselves add anything qualitatively new to the process. However, such an assumption would be missing certain crucial psychological factors in the person-computer situation

and its differences from the person-person situation. We have observed informally in making PEGASUS available to a wide range of people in a variety of situations that those coming to it for the first time often seem to find it a very dramatic experience. They react to it intensely and become gripped by the interactive process of construct elicitation. They also feel that they are learning something new from the process and are prepared to use this in determining their actions.

Probably such involvement is also significant in the elicitation of construct systems by people rather than computer interaction. However, we believe there are certain quite fundamental differences when the elicitation is done in such a way that interpersonal interaction is clearly absent. In particular, when a person is feeding back comments and guidance it is a natural and ready assumption that they are injecting the constructs rather than eliciting them. It is easy to believe that the elicited constructs do not come from oneself but that one is in a tutorial or debating situation with another person. One has to be persuaded that this is not so and the persuasion has to be stronger the more striking and significant the constructs elicited. However, when a computer is the tool by which one's construct structure is being reflected or laid bare then such an assumption of outside injection and interference is far less tenable.

When constructs are being elicited by a computer program then one is more likely to accept that it is precisely and only oneself that is being portrayed. We 'trust' a computer program to be doing just what it appears to be doing without deeper motivations and without attempting to persuade us to its point of view. No-one is telling you anything -- you are seeing, in interacting with PEGASUS, possibly for the first time the basis for your own thought processes. Very often extreme surprise is the first reaction -- the person had not thought that he was viewing the world in the way portrayed. If another person were eliciting the construct structure then the surprise would be taken by the subject as an indication that the elicitor was incorrect and followed by a process of ignoring him or arguing with him. With computer elicitation the reflected structures are accepted as being self-generated and the surprise leads to a motivation to know more.

That this knowledge can be totally private to oneself is another important feature of interaction with the computer. We do not like, as Kelly put it, to be "caught with our constructs down". When another person is involved we are more reluctant to expose and explore our constructs the more surprising they are -- perhaps because the surprise is often the result of a conflict between our ostensive value judgements and the basis of our behaviour. Or it may just be sloppy verbal behaviour -- that we are naming two distinct constructs with the same label -- a scientist found that he was using the word 'time' to label several different constructs and generating confusion in his arguments because of this.

Another reason that we are reluctant to explore construct structures freely in interacting with another person, particularly a professional

person, is that we are acutely aware of the possible 'waste' of their time. This phenomenon has been noted (Card et al 1974) as accounting for a major part of the preferences expressed by patients to be interviewed through an interactive computer program rather than their doctor. There are many pressures and artefacts of interpersonal relationships that can totally obscure and undermine such reflective processes as we require in the elicitation of personal constructs. Adams (1979) has put this argument in reverse in noting that children learn quickly to play games on a personal computer and conjecturing that this is because of the lack of interpersonal complications.

These are some of the key psychological factors in which the use of a personal computer for the elicitation of constructs is significantly different from previous manual techniques. They can be summed up by noting that one can see one's reflection most effectively in a stream if one is sure that no-one else's reflection is mixed up in it (and that no-one else is muddying the waters).

There are technical factors also, however, that add new dimensions to the computer elicitation of constructs. The most notable is that already demonstrated in PEGASUS -- that relationships between constructs may be inferred instantly and queried with the user. This immediate analysis and feedback is a key factor in most applications of interactive computers and can go way beyond what any manual analysis can accomplish. Instant feedback whilst one remembers one's line of reasoning is very different from delayed analyses that arrive at a later time when the entire context of the replies one has been giving may have been forgotten. Construct structures in particular have a high degree of context-dependence -- it is often precisely the relationship between the structures elicited and the role we are adopting in answering the questions that elicit them which is of prime interest to us. Using Wolff's (1976) vocabulary, we **surrender** ourselves to a particular role and become a 'physicist', a 'manager', a 'father', etc., and it is the analysis of our construal of the world in the specific role which we are attempting to **catch.**

In terms of this discussion it seems reasonable to suggest that one takes an existential view of the phenomenon of computer elicitation of personal constructs regardless of one's view of Kelly's theory and methodologies based on it. The computer interaction is in itself a meaningful and significant experience for many people and they gain from it. Perhaps it is only that introspection is not a skill developed by most current educational systems -- we promote the 'received view' of knowledge and act as teachers to bring the minds of students into conformity with our consensual models of reality. What you think does not matter in itself -- only that it does not deviate from what it is 'correct' to think. It is a novel experience for many people to realize that there are actually individualistic thought processes going on within them. It is even more novel for them to realize that these condition 'reality' and that different approaches to life and different reactions to the same circumstances may be ascribed to different construals of reality.

CONCLUSIONS

We have argued in this paper for a highly significant role for the **personal computer** in enabling an individual to operate effectively in his role as **personal scientist** in coming to interact with an increasingly complex world. We have illustrated the argument with examples of interaction with a computer program that **emancipates the cognition** of a person involved in a decision-making process. We have also argued that the role of the computer is an essential one which goes beyond that which another person might supply. In conclusion we can only note that it is early yet to determine whether the role we see for the computer is coming to pass. Current programs are primitive and restricted by technology, our knowledge of psychology and our creative imaginations. We hope that this paper will encourage the further exploration of the development and application of **man-computer symbiotic systems.**

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