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Information Technology Research in the European Community

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Abstract

It has been said that one reason why the US and Japanese information technology industries are ahead of those in Europe is that, where these countries see opportunities, European industry and its customers see primarily risks. Recognising this as well as the strategic importance of information technology and integrated communications systems for the future economic development of Europe, the Community launched the first of several five year programmes in information technology and public communication systems in the mid-eighties. In this report we describe the main programme called ESPRIT, how it works and some of the results achieved to date.

Introduction

The European Community consists of 12 nations with a GNP of US$billion 4 862 (1988 figures). By the year 2000 the information technology and electronics sector of the European Community is likely to become the largest industry, representing some 300 billion ECUs (1 ECU = R3,82) or 6,7% of GDP. With the major impact these enabling technologies have on the competitiveness of the whole of a modern economy, Europe recognised very early that information technology is of crucial importance to the success of the planned, unified internal market and an essential factor in the Community's development strategy.

At the same time however, the positive balance of trade of the European Community in information technology amounting to some ECU 1,7 billion in 1975 was declining rapidly (it reached a deficit of almost ECU 22 billion at the end of 1988) and the Community decided something drastic had to be done. As a result it launched the First 5 year European Strategic Programme for Research and Development in Information Technology or ESPRIT I. It started on January 1st 1984 with a budget of 1,5 billion ECUs.

Table 1. The EC and its top 3 partners in numbers (1988)

	Population (millions)	GNP (US$ billion)	Per Capita GNP (US$)
West Germany	61,0	1 120,0	18 400
France	56,0	939,2	16 800
Italy	57,5	814,0	14 200
EC	**325,1**	**4 475,1**	**13 770**
USA	248,0	4 862,0	19 600

Source: US Department of State, Bureau of Public Affairs

The overall strategic goal of ESPRIT was to provide the European information technology industry with the technology base which it needs to become and stay competitive with the US and Japan in the 1990s. In addition to this primary objective, two secondary objectives were defined, namely:

- to promote cooperation in the information technology field between industries, universities and European research bodies on R&D projects up to pre-competitive level; i.e., prior to the development of commercial products, and
- to contribute to the development of international standards.

At about the same time the crucial importance of public digital telecommunications to the future social and economic infrastructure of Europe was recognised. Consequently a separate Research and Development programme in Advanced Communications Technologies in Europe (or RACE) was launched in 1985 with a budget of ECU 1,1 billion. The stated goal of this latter programme was

- to introduce Integrated Broadband Communication (IBC) into the European Community taking into account the evolving ISDN and national strategies while progressing towards Community-wide services by 1995.

Both these programmes have since progressed to second 5 year phases as, respectively, ESPRIT II with a budget of 3,2 billion ECUs, and RACE II with 1,039 billion ECU. In the meanwhile ESPRIT III is in its initial planning phases.

RACE is similar to ESPRIT in terms of its financing and organisation. Space does not allow us to detail all aspects of the programme in this report.

Strategic Themes

Although the ESPRIT programme broadly addresses the information technology and electronics industry, ESPRIT I had 5 major strategic themes.

1. *Microelectronics.* This field was perceived as the key strategic area for information technology R&D in the future.
2. *Software Technology.* The stated goal of this research area was to do what was necessary to put the software development process on a sound engineering footing. Sub-areas were defined to deal with formal methods, development tools, management aspects, quality measurement and the development environment.
3. *Advanced Information Processing.* This area covered knowledge-based systems, new computer architectures and speech- and image-processing.
4. *Office Systems.* When initially conceived in 1984, this application area was viewed as of strategic importance for the efficiency of business throughout the Community.
5. *Computer Integrated Manufacturing.* This area comprised the total range of computer integrated manufacturing activities, including: computer aided design (CAD), computer aided engineering (CAE), computer aided manufacturing (CAM), flexible machining and assembly systems, robotics, testing and quality control. The area was selected for its potential impact on the methods and economies of production, particularly in the information technology industries, and also for the manufacturing industry in general.

In addition, the Information Exchange System project was started with the twofold objective of

- providing communication services to ESPRIT participants, both industrial and academic; and
- encouraging the development and adoption of OSI standards.

It is indicative of the experience gained in ESPRIT I and technology developments since it was started, to note how the strategic fields chosen for ESPRIT II differ from those of ESPRIT I. R&D in ESPRIT II is carried out in the following four major areas:

1. *Microelectronics* was retained as the key strategic area for information technology R&D in the future.
2. *Information Processing Systems and Software.* The work in this field will provide the fundamental and generic technologies which will support the development of information technology products expected on the market in the next decade. Thereby ESPRIT II recognised that information and its efficient use is not only a means of administration and communication, but that it is part of an enterprise's competitive advantage.

   As an aside, it is interesting to note that, of the 30 billion ECU expenditure on software and services in 1989, about 50% was provided by the manufacturing, banking and other financial services. This is expected to remain true through to 1994, when the market is expected to be worth 70 billion ECU. About one third of this market comprises customer services, consultancy, training and services while packaged software represents about 40% of the market. The latter component is expected to increase to 50% of the market by 1994 with services and training remaining constant at 30%.
3. *Advanced Business and Home Systems and Peripherals.* It is clear that information technology in the business environment is moving to advanced integrated systems capable of serving all the functions of the enterprise in an integrated multimedia environment. The priorities for work in the Community documents reflect these salient points.
4. *Computer Integrated Manufacturing.* The emphasis in this strategic area has not changed significantly from ESPRIT I to II.

In addition to the above, the *Open Microprocessor systems Initiative (OMI)* was started in ESPRIT II. The major motivating factor for the Community was the 82% dependence on non-European sources for microcomponents, representing 7 billion ECU in 1989 and which is expected to rise to 16 billion ECU by 1994.

Funding

ESPRIT is an industrial programme and it was not started for, or by, academics. The main driving force behind the ESPRIT I programme was industry, who first defined the research areas and then the goals and workplans. Industry was represented by the largest 12 information technology companies (known collectively as "The Twelve") in Europe.

ESPRIT R&D projects are implemented by shared-cost research and technological development contracts, with the Community financial participation normally not exceeding 50%. Universities and other research centres participating in shared-cost projects have the option of requesting, for each project, either 50% funding of total expenditure or 100% funding of the additional marginal costs. ESPRIT projects have a maximum duration of 5 years but should normally be shorter.

In the case of ESPRIT I, the Twelve received 50% of the ESPRIT budget and were involved in 70% of all projects. Small- to medium-sized enterprises (SMEs) participated in 65% of the projects and received 14% of the funding. The funding allocation by sector participating in ESPRIT I is illustrated by the chart in Figure 1.

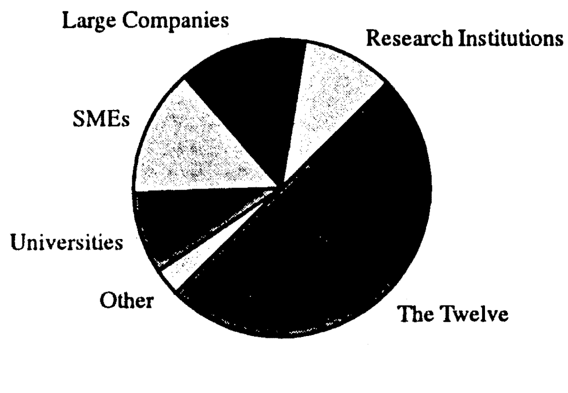

Figure 1. ESPRIT I funding allocation by participating sector

Basic Research

While ESPRIT I made no special provision for basic research, ESPRIT II includes a sub-programme, with a budget of 130 million ECU, aimed at developing new knowledge and expertise in the basic disciplines considered essential to secure the long-term future of information technology in European. Some 62 projects have been selected to carry out basic research in areas such as super-conductivity, optical and neural computers, speech and image processing and so on. In all, 211 university laboratories, 57 research bodies and 17 industrial companies are participating in these projects.

Apart from such projects, basic research activities also involve

- *Working Groups* which are concerted efforts to improve the systematic exchange of information and for which short scientific visits and workshop are funded, or
- *Networks of Excellence* which are composed of both academic and industrial teams geographically distributed throughout the Community. These are set up to provide a critical mass of complementary knowledge and expertise and to share limited and expensive resources. Funding for Networks of Excellence is restricted to the marginal costs of establishing the administrative and communications infrastructure necessary to carry out the coordination.

The evaluation criteria for basic research projects are less specific about the value for market exploitation of the expected results and more specific about conformity with the basic ESPRIT technical objectives, inter-disciplinary nature and scientific calibre of the partners.

Programme Management

Participation in the programme is solicited by a "call for proposals" made by a "consortium" comprising at least two participants or "partners" from different members within the Community [1] and usually no more than six – except for standards projects.

The proposals are then evaluated by external experts who take account of the following points in particular:

- The impact and potential for industrial exploitation of the expected results of the project.
- Eligibility of the partners.
- Technical merit of the proposal including a justification of the proposed theories and methods.
- Soundness of the proposal with regard to issues like the assessment of major technical risks and technological advances expected.
- All proposals are scrutinized for human and organisational factors to ensure that the results would be appropriate for the intended user base.
- Soundness of project plans with respect to the distribution of effort, clear and well defined roles for each partner, realistic timescales and the proposed management structure and methods of supervision.

Once a project has proceeded to contract signature[2] it is periodically subjected to four different audits until its completion:

- A *strategic audit* is carried out periodically to examine the evolution of the political, economic and social objectives in the light of world-wide strategic developments.
- An annual *technical audit* examines the progress of all projects which comprise the Programme. It is performed by a team of independent experts.
- A *programme management audit* evaluates overall management performance as well as individual project management and deliverables.
- The usual *financial audit* is done to ensure the correct use of public money.

Results

A total of 227 projects were implemented during ESPRIT I. They involved 536 participating entities and some 3 000 full-time researchers.

- Of the 327 participating industrial companies, almost 45% were firms employing fewer than 500 people and 40% of those employed fewer than 50. SMEs were extremely active, being involved in more than half the projects and being responsible for more than 25% of the research work in 60% of the cases.
- Nearly 200 universities and research institutes participated in approximately 70% of the projects. In more than half the cases, these scientific institutions were responsible for at least 25% of the work.

Towards the end of ESPRIT I, nearly 165 projects had delivered concrete results. Of those, 75 had already helped to put specific products and services onto the market, while for another 60 projects, the research worked had resulted in the transfer of technology for uses not directly linked to the project itself.

One detailed example is work in the Information Processing Systems and Software sub-field which let to the definition of a reference model for CASE (computer-aided software engineering) tools that has been adopted by the European Computer Manufacturing Association (ECMA). This has let to requests from the US National Institute of Standards and Technology to collaborate on the ECMA model as the basis for their own work on a reference model. Details about this and all other European Community research projects can be obtained from CORDIS mentioned below.

ESPRIT I participants who were questioned about their perceived successes of the programme considered increased knowledge as the most important benefit (69%), followed by a belief that research goals more ambitious than would otherwise have been set, had been reached.

[1] Partners in ESPRIT from outside the community are not eligible for financial support. A programme called EUREKA fosters extra-European research.
[2] Only 20% of all proposed projects in the case of ESPRIT I.

There have been direct benefits in being able to cover a wider range of research topics quicker by sharing results with the project partners.

A significant number of responses claimed a contribution either to existing products (35%) or new products (45%). It was felt, however, that there needs to be a greater degree of concerted action by project teams and a sharper strategic focus on market opportunities while, simultaneously, basic research must continue and even be increased.

15% saw no direct benefit.

Apart from technological reasons, ESPRIT and RACE were started, in the first instance, as Community programmes to promote cooperation in the information technology field between industries, universities and European research bodies on R&D projects. The extent to which this was achieved is thus an important criterion for measuring its technological successes. In this respect it is a general consensus that ESPRIT has indeed achieved a profound change in attitude in the Community. Cooperative, precompetitive research and development is now a formula which is working effectively.

Summary

It is apparent from the many ESPRIT reports that some participants in ESPRIT I, particular those from the Twelve, were originally rather sceptical about the likely successes of the programme. No small reason for this was that they had no accord on the product priorities for the industry as a whole.

Five years ago, the largest European companies viewed one another much more as competitors than collaborators. Five years later, however, apart from the major technological progress, a major, if not *the* major achievement is that there now exists a spirit of pre-competitive cooperation in the Community to the common advantage of all.

ESPRIT has become symbolic of the technological awakening of a European Community wishing to ensure its freedom to make the technological choices necessary for its own future prosperity.

Further Information

The European Community has set up an on-line information service to give quick and easy access to information on European Community research programmes. The Community Research and Development Information Service (CORDIS) is at present offered free of charge and comprises eight data-bases.

More information and CORDIS registration forms can be obtained from

ECHO Customer Service
CORDIS Operations
BP 2373
L-1023 Luxembourg
Tel.: (+352)34 98 11 Fax.: (+352) 34 98 12 34

Pieter Kritzinger is professor and currently head of the Computer Science Department at the University of Cape Town. During 1992 he was on research and study leave at the University of Dortmund in Germany and was thus able to observe programmes like ESPRIT and RACE at close hand.

Editor's Notes

A number of the articles in this issue of the South African Computer journal are in the field of Information Systems. Research in this area is beginning to blossom in the country. There are probably many more researchers in Information Systems than there are in Computer Science. It is hoped that not only academics, but also professional practitioners will submit articles.

Research in this area normally falls into three main categories. The first of these is pure research. This is a difficult area. Few researchers make a contribution here, mostly because the theory progresses slowly. However, these articles are to be encouraged. The second category of research is the collection of information from a variety of people in the field by means of questionnaire or interview and the use of this data to formulate policy and trends. An important aspect of this research is in order to corroborate theories or to identify areas where new theories are needed, or old theories amended. This has proved to be a very fruitful area of research and many beneficial results have accrued from it. The third category of research is performing careful analysis on a specific Case Study. In this area the case under study will need to display something which is innovative, either in the system itself, or in the way it was implemented. The case will need to prove something new and important or to break grounds into areas which have not formally been addressed.

All three types of work is worthy of publication if the results that they deliver are of benefit to the community which they serve. All three will be considered for publication by this Journal.

The journal divides into two sections. The primary section is involved with research while there also is a section on viewpoints and communications. Articles submitted for the latter are not refereed, but can be included after study by the editors. On some occasions articles submitted for the research section have been found appropriate for this section. This policy also applies to articles in the Information Systems field.

John Shochot
Subeditor: Information Systems

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An Enquiry Into Property-Goal Type Definitions Of The Term "Information System"

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Abstract

After reference to IS authors such as Lay [7] it becomes evident that there is as yet no unified definition of the term "information system." This research has attempted to extract, from the relevant literature, the supposed properties and expected goals of information systems that would enable the formation of such a definition. A questionnaire was designed to investigate support for the properties and goals suggested by the IS literature. Kendall association coefficients for the scores obtained were then determined to measure the levels of consensus among samples of 32 academics and 32 practitioners, both individually and as groups. The goals and properties of an information system were separately examined in order to approach an acceptable definition which Lay [7] claims is thus far lacking amongst academics and practitioners.

In the group of 32 academics, highly significant ($p << 5\%$) consensus was found between the IS properties identified in the literature and claimed by the respondents. The same was found for the group of 32 IS practitioners. Highly significant agreement between the groups of respondents was also found. In short, little doubt exists that these IS professionals have a very well developed idea of what an IS should exhibit in terms of properties and goals. However, very little ability on their part formally to define an information system was observed.

Keywords: *Information system definition, information system properties, information system goals.*
Computing Review Categories: *H.1.1*

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1 Introduction

In his article "Information systems research: A teleological approach?" [7], Lay questions whether the world of information systems (IS) is any closer to understanding the true nature of information systems after decades of research and practice. He also expresses concern as to the existence of a general unified theory of information systems. Emery [5] notes in confirmation that despite "huge investments" in information systems, little time or energy has been devoted to the underlying rationale from which the discipline of information systems is derived.

In response to these notions, the object of this research was to establish whether or not there is any consensus amongst IS researchers and practitioners regarding the meaning of the term *information system*. This term can be divided semantically into its two individual components, *information* and *system*. In this way a level of understanding of each concept may be obtained before attempting to find a meaning for the united concept, information system.

First, the evolution of the understanding and conceptualization of the terms *information* and *system* are presented. Information theory is introduced as a basis for the understanding and interpretation of the term information, after which various definitions of and approaches to the definition of the term are discussed. The notion of a *system* is then treated in a similar manner. General systems theory is introduced and explained in order to explore the existence of a universal concept on which any system definition may rely. numerous definitions are then examined in an attempt to resolve whether any general consensus exists as to the meaning of the term system. The defining of the information system concept is finally addressed and discussed in the light of the relevant literature.

Second, an empirical study was conducted whereby a telephonic questionnaire was utilized to measure the level of consensus amongst samples of IS academics and IS practitioners regarding the definition, properties and goals of information systems.

2 Literature Survey

Information

In their development of the Mathematical Theory of Communication, Shannon and Weaver [11] define information in terms of mathematical analysis. They are therefore concerned with the quantitative aspects of information rather than its meaning, value or effectiveness. They derived a mathematical formula ($\log_2 N$ where N is the number of possible outcomes of a symbolic event) to measure the amount of information in a given set of data. The amount of information is therefore measured by the number of binary digits, or *bits* required for the sender to communicate certain information to the receiver.

Mullany [9] describes the basic model of the communication system originally applied by Shannon. This consists of an information source, a sender or information encoder, a communications channel, a receiver or decoder, and a destination. Shannon defines information by relating it to the notion of uncertainty, which may be measured by the amount of variety or diversity in a message. Information is the uncertainty before a message is received less the uncertainty after that message is received.

In terms of information theory there is no apparent distinction between the terms *data* and *information*, which are represented in quantifiable terms only by *bits* or *binary digits*. Other authors, for example Davis [4], Galliers [6] and Schoderbek *et al* [10], have made a clear distinction between data and information. Schoderbek *et al* suggest that information should be defined as data which has form, structure, and/or organization. This distinction is re-iterated by Davis who uses the analogy of data as being raw material in unusable form while information is a finished product usable to some consumer.

In a discussion of information analysis, Galliers [6], defines information as a collection of data. These data are presented in a particular manner and at an appropriate time in order to improve the "knowledge" of the receiver (person, modem, etc). The receiver is then better able to undertake a particular activity or make a particular decision. He therefore sees information as being both contextual and enabling. Unlike Shannon's approach, information's value is related to context rather than to symbol quantity.

Schoderbek *et al* [10] clarifies Galliers' concept by defining information as inferentially intended and evaluated for a particular problem, at a specific time, for a specified individual, and for achieving a specific goal. Information therefore concerns structured data — that is, data selected and structured (in the opinion of the user) with respect to a problem, user needs, time and place.

Similarly, Davis [4] describes information as having value in a particular decision-making process. For the purposes of information systems, Davis claims that information is data which have been processed into a form that is meaningful and of value in current or prospective actions or decisions. Information may be meaningful to many individuals who may place different values upon its use. Nichols argues in [6] that in order to qualify as information, three attributes must be present: relevance, availability and timeliness. These give value to information being utilized for a specified task. He proposes two basic types of information which are required to represent an event; namely, quantitative and descriptive. Quantitative information specifies *how much* or *how many* whereas descriptive information serves to identify and qualify the quantified information.

The definitions presented by various information theorists have their basis in mathematics, which does not assist the layman in gaining clarity when dealing with the term information. Shannon attempted to break the definition of information down mathematically, but what is evident from the other authors discussed above is a need for a definition which is both qualitative, quantitative and remaining simple enough to enable it to be applied by the average systems developer. Ambiguity remains as to the precise meaning of the term information. However, Shannon's definition provides a legitimate way of defining information as the success of the digital computer verifies.

System

The notion of the general system originated with von Bertalanfy [10]. He suggested that there exist models, principles, and laws that apply to all systems or their components, irrespective of their particular discipline (physical or biological). The aim of General Systems Theory is therefore to derive certain principles which could apply to any system, thus introducing a system as having a philosophical nature rather than one which is entirely experiential.

Boulding postulates in Checkland [3] that a definition of system can be achieved by a compromise between specific meanings and general definitions. He acknowledges the need for an interdisciplinary theory or definition. Further he argues that if this could be achieved, a language would be made available to experts in different disciplines, allowing them to communicate similarities in the theoretical constructions of their disciplines.

Lilienfeld [8] rejects systems theory as a basis of understanding systems. He argues that while systems thinkers claim to have a universal field of study, they have only requisitioned those details which serve to illustrate their views, while disregarding others.

Schoderbek *et al* [10] discuss what they describe as the most fundamental distinction between types of systems, that of open and closed systems. They argue that this classification rests upon the availability of resources. These they define as all those things available to the system for performing its activities in order to achieve its goal. Where a system is closed, all the resources are retained within the system itself. In an open system resources are imported from the environment in which the system exists, transformed into output, and exported back into the environment.

Checkland [3] defines the concept of a system as embodying the idea of a set of elements connected together which form a whole, thus showing properties which are properties of the whole rather than properties of its component parts. He argues that an observer of a system will attempt to identify some entities which are coherent wholes, perceiving some principles of coherence in order to establish a boundary which will separate the entity from its environment. Each system is conceived to be part of an hierarchy of such entities involving interrelated subsystems.

Jordan proposes in Checkland [3] that the only things that need to be common to all systems are identifiable entities and identifiable connections between them. He also argues that there are three organizing principles which might distinguish a system. These principles are rate of change, purpose and connectivity. This approach is supported by Ackoff [1] who describes a system as a set of interrelated elements. He argues that a system is an entity made up of at least two elements and a relationship that exists between each of its elements and at least one other element in the set. In this way no subset of elements is unrelated to any other subset.

On the other hand, Emery [5] defines a system as not only an entity composed of related parts but also as being directed towards a purposeful activity or goal. He argues that all systems are made up of sub-systems in an hierarchical structure. Each sub-system is responsible for a portion of the system's activities, thus simplifying the design and management of the system as a whole. The subdivision will evidently continue until the task being performed is simple enough to manage without further division. A boundary exists to define the activities within the system considered to be integral parts of the system. Everything not included in the boundary is then referred to as the environment in which the system exists. This presupposes, of course, that system boundaries can be drawn easily; a proposition which one may question. In addition, the system has inputs, which are obtained from the environment, and outputs, which are provided to the environment. As the system is goal-oriented, the output would strive to constitute the purpose of the system.

The notion of goal-orientation is reiterated by Davis [4] who proposes that a system may be either abstract or physical. An abstract system he defines as an orderly arrangement of interdependent ideas or constructs whereas a physical system is a set of elements which operate together to accomplish an objective. He describes physical systems as consisting of elements which can be identified as belonging together in order to achieve a common purpose or goal. A general model of a system is posed by Davis [4] consisting of an input, process and output.

As can be seen from the above the importance of the system concept has received much emphasis, but a unified or integrated set of such concepts is still awaited. Different terms are utilised to denote the same thing and visa versa. Although researchers in a wide variety of disciplines, Ackoff [1] claims, are contributing to the conceptual development of systems thinking they evidently lack interaction and confirmation.

It is clear from the foregoing discussion that although numerous attempts have been made in obtaining a conceptually sound and comprehensive definition of system, the basic notions involved have remained fragmented. Where definitions have been provided that have been valid and comprehensive these have not allowed for the applicability to all situations and therefore could not be considered general. As a result, no universally accepted general definition of *system* has been achieved. If an information system is a special class of system therefore, no rigorous definition of *information system* can be expected either.

3 Information System

Despite the above assertion, authors as noted below have attempted definitions of the term information system; apparently to provide some framework and/or boundary for the discipline of IS. For example, Davis [4] initially provides a definition which would apply not only to machine-based, but also to manual information systems. He defines an information system as an entity which receives inputs of data and instructions, processes the data according to certain instructions, and produces the results. He qualifies this definition by restricting it to machine-based (computer-centred) information systems. For instance, he attributes to information systems the functional sub-systems of hardware, operating system and database system.

Ahituv and Neumann [2] describe an information system as providing information which is timely, is in the correct format required by the user, has the correct content necessitated by the user, and has a benefit to the user which outweighs the cost in attaining that information. They do not, however, intend these attributes to be imputed to a natural or biological information system.

Galliers' definition [6] suggests that the man-machine interface must be a necessary part of an information system. His definition does not take into account the natural or biological systems included in previous definitions either. In other words, the necessity of the man-machine interface excludes, a priori, the definition from application to social or biological systems; an oversight were one to consider an information system as a social system.

If these definitions are typical (and no others materially different were found in the literature) then one must agree with Lay [7] that information systems researchers have so far failed to conceptualize a rigorous definition of *information system*. As noted earlier, no rigorous definition should be possible since the concept of system itself escapes rigorous definition. However, no specific definitions which abandoned the system definition but defined the general subject area of IS could be found in the literature either. For example, in none of the literature studied was an IS defined as some mechanism (system definition aside) which handles information.

All the definitions discussed in this section really either ascribe properties to or describe goals of an information system under the guise of "defining" such a system. Such properties and goals may possibly be used to deduce a definition, but no significant effort could be found to do so. The next step in this study was thus to list properties and goals from available literature, and then to measure the agreement of samples of IS professionals with these. The properties and goals of information systems identified are presented in Tables 1 and 2.

4 Hypotheses

Since no specific definition of an IS was found in the literature, it was hypothesized that:

$H_{1(a)}$: *No well-formulated definition of an IS exists in the minds of most academics.*

Nothing in the literature studied suggested a differing perspective for IS practitioners, hence:

$H_{1(b)}$: *No well-formulated definition of an IS exists in the minds of most practitioners.*

The list of properties found in the literature (see Table 1) suggest the following:

$H_{2(a)}$: *There exists a general agreement amongst IS academics that each of the properties listed in Table 1 is a property of an IS.*

$H_{2(b)}$: *There exists a general agreement amongst IS practitioners that each of the properties listed in Table 1 is a property of an IS.*

Table 1. A summary of properties of information systems claimed in the surveyed literature

An Information System...	
1.	improves the user's ability to access information [2]
2.	must run on a computer [4]
3.	always involves the use of a database [4]
4.	processes either data or information or both [2]
5.	always involves computer networks [6]
6.	is always goal-oriented [5]
7.	is aided by an operating system [4]
8.	involves the interaction of people in an organization [2]
9.	involves a system of input-process-output via a set of predefined functions [4]
10.	is governed by rules and regulations [4]

Table 2. A summary of goals of information systems claimed in the surveyed literature

An Information System should...	
1.	improve accuracy of information thereby reducing human error [2]
2.	improve the ability of an organization to achieve competitive advantage [2]
3.	yield benefits which exceed the costs of its maintenance [2]
4.	improve the effectiveness of decision making [10]
5.	improve the presentation of output [2]
6.	improve the production of information on time [2]
7.	improve the reliability of information [10]
8.	improve the security of sensitive information [2]

$H_{2(c)}$: *There exists a general agreement amongst IS practitioners and IS academics that each of the properties listed in Table 1 is a property of an IS.*

The list of goals found in the literature (see Table 2) obviously suggests a parallel set of hypotheses: namely,

$H_{3(a)}$: *There exists a general agreement amongst IS academics that each of the goals listed in Table 2 is a goal of an IS.*

$H_{3(b)}$: *There exists a general agreement amongst IS practitioners that each of the goals listed in Table 2 is a goal of an IS.*

$H_{3(c)}$: *There exists a general agreement amongst IS practitioners and IS academics that each of the goals listed in Table 2 is a goal of an IS.*

5 Research Methodology

In order to establish whether any consensus exists as to the definition of an information system among IS practitioners and IS academics alike, a telephonic questionnaire was designed based on the above literature survey. The questionnaire involved voluntary as well as the prompted attributes presented in Table 1 and 2. The voluntary attributes were first requested to test for any thought as to the definition of an information system on the part of the respondent as specified by hypotheses 1(a) and 1(b). This was followed by 18 prompted attributes, selected to reflect the ten properties and eight goals of Tables 1 and 3 respectively, and to test the corresponding hypotheses 2(a) – 2(c) and 3(a) – 3(c).

A pilot study was performed on a class of second-year IS students at the University of Cape Town in order to refine the questionnaire. After this alterations were made in order to remove ambiguities and reflect a clear and concise research instrument.

A sample of 64 respondents was obtained of which 32 were IS academics and 32 were IS practitioners. The responses of each individual were then measured against the total for all individuals using Kendall's co-efficient of association. This was repeated for property items and goal items respectively and exclusively. The totals for academics and practitioners were compared against the grand total scores for both as well as for each other.

6 Results

58 out of 64 respondents declined to provide voluntary IS attributes. This means that at a significance level of 2%, 80% or more of the corresponding population would decline likewise. Dealing with Academics and practitioners separately, only 29 out of 32 in each case volunteered attributes. Converting once more to statistical terms, this implies that 75% or more of either group would decline to volunteer IS attributes at a significance level of 3%. This result supports the conjecture that the population of IS experts in general probably do not have well-formulated definitions for information systems. In other words, it confirms hypotheses 1(a) and 1(b).

The number of "Yes" and "No" responses for each item

Table 3. Number of responses, and significance levels, for each property

IS Property	Affirmative responses	Significance level
improves access to information	52	0,03
does not need to run on a computer	54	0,01
always involves a database	51	0,01
processes data/information	62	0,001
need not involve networks	61	0,001
must be goal-orientated	59	0,01
is not necessarily run by an OS	30	>0,2
involves person-to-person interaction	55	0,01
input-process-output, program	54	0,01
governed by rules and regulations	60	0,01

Table 4. Number of responses, and significance levels, for each goal

IS Goal	Affirmative responses	Significance level
improve accuracy	60	0,001
aid competitive advantage	60	0,001
benefits outweigh maintenance costs	51	0,01
improve effective decision-making	63	0,001
improve presentation of output	55	0,01
improve timeliness of output	63	0,001
improve reliability of information	63	0,001
improve security of sensitive information	60	0,001

in the questionnaire were counted, and a measure was thus obtained of agreement per item with the literature. Treating these as binomial proportions, the significance level of each of these was determined for a 70% response in the population. In other words, a property would be considered significant if there were no statistically significant reason to deny that 70% of the population would be in agreement with the property. The results are summarized in Tables 3 and 4.

With regard to the properties or goals of an information system, there were highly significant measures of agreement ($p << 5\%$) found between academics and practitioners amongst themselves and the totals for each group with the other (See Table 5).

As is evident from Table 5, in the group of 32 academics, mostly highly significant ($p << 5\%$) consensus was found between the IS properties listed from the literature and the opinions of the respondents as to their validity. The same applied both to the group of 32 IS practitioners, and between these groups. This further confirms hypotheses 2(a) – 2(c) and 3(a) – 3(c). In short, little doubt exists that these IS professionals have a very well developed idea of what an IS should exhibit in terms of properties and goals enumerated in recent IS literature. However, very little ability actually to define an IS, even in simplistic terms, was observed.

7 Concluding Discussion

The main achievement of this study has been to highlight the fact that most current IS literature confuses the listing of goals and properties with the attempt to define *information system*. Additionally, a successful telephonic instrument to measure attribute (goal, property) agreement amongst respondents has been developed. No others similar were identified in current IS literature.

Beyond this, however, the present study can claim but little in a quest for more than a bland definition of an information system. An interesting, but intractable dichotomy emerges; strong empirical agreement as to the properties and goals of information systems, but no unified definition. As has been noted earlier, the lack of definition must stem from an inability adequately to define the system concept itself. Consequently, one might conjecture, academics and practitioners are avoiding the issue and "practising IS" within their own, and frequently private, notions of what an information system really is.

There is, however, room for one bland definition, which is missing from all the literature surveyed:

An information system is a mechanism which is used by an organization to process its through-put of information.

It is of significance that this simple definition, or one like it, escaped most IS academics and practitioners selected as part of the sample, as well as the literature. With the difficulties identified with system definition, further research is

Table 5. Agreement with Group Opinions

PROPERTIES			
p	# respondents		Group Agreement
>20%	2		
11%–20%	7		Academics vs Total Group $p = 0{,}1\%$
6%–10%	3		Practitioners vs Total Group $p = 0{,}1\%$
1%–5%	49	Significant	Academics vs Practitioners $p = 0{,}1\%$
<1%	3	Highly Significant	
sample size = 64			

GOALS			
p	# respondents		Group Agreement
>20%	2		
11%–20%	7		Academics vs Total Group $p = 0{,}1\%$
6%–10%	3		Practitioners vs Total Group $p = 0{,}1\%$
1%–5%	49	Significant	Academics vs Practitioners $p = 0{,}1\%$
<1%	3	Highly Significant	
sample size = 64			

ALL ITEMS			
p	# respondents		Group Agreement
>20%	1		
11%–20%	1		Academics vs Total Group $p = 0{,}003\%$
6%–10%	1		Practitioners vs Total Group $p = 0{,}003\%$
1%–5%	30	Significant	Academics vs Practitioners $p = 0{,}003\%$
<1%	31	Highly Significant	
sample size = 64			

probably best confined to the verification of generally accepted properties and goals of information systems. More specifically, an additional enquiry into the telephonic questionnaire is called for, as this pioneering instrument can hardly claim to be widely accredited, whatever its current success.

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Contents