Toward an Information Society for All: An International R&D Agenda

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This article introduces the visionary goal of an *Information Society for all*, in which the principles of *universal access* and *quality in use* prevail and characterise computer-mediated human activities. The paper is based on the outcome of the first meeting of the International Scientific Forum "Towards an Information Society for *All*", which took place during the Seventh International Conference on Human Computer Interaction (HCI International '97). The objective of this meeting was to define a short-, medium-, and long-term international R&D agenda in the context of the emerging Information Society, based on the principle of *designing for all* users. The proposed agenda addresses technological and user-oriented issues, application domains and support measures, which are necessary for the establishment of a favourable environment for the creation of an Information Society acceptable to *all* citizens.

1. INTRODUCTION AND BACKGROUND

The radical technological changes in the Information Technology and Telecommunications (IT&T) sectors of the industry have contributed towards a more information- and interaction-intensive paradigm for computer-mediated human activities. This has been a direct derivative of continuous and evolutionary changes which rapidly transform society, from one based on the production of physical goods, to one where the main emphasis is on the production and exchange of information. Such a trend, which is expected to continue, raises a whole new range of human, social, economic and technological considerations, regarding the structure and content of societal activities at the turn of the 21st century. In this context, the requirements for universal access and quality in use for the broadest possible user population progressively emerge into first order objectives for an Information Society for *all* citizens.

The term *Information Society*, although attributed with different meanings and connotations, is frequently used to refer to the new socio-economic and technological paradigm likely to occur, as a result of an all-embracing process of change that is currently taking place. This process is expected not only to alter human interaction with information, but also to affect individual behaviour and collective consciousness (Danger, Huizing, Walker, Rowland, Anderson & Sciaccaluga, 1996). The Information Society is neither the mere effect of radical technological progress brought about by research and technological development (RTD) work, nor the result of incremental demand-driven innovation in a particular sector of the industry. Instead, it is a product of a *technology-fusion* (Kodama, 1992) of IT&T[1].

This far-reaching effect of combining incremental technical improvements from several previously "separate" fields of technology brings about radically new opportunities and market windows. As Kodama (1991) reported, marrying optics and electronics technologies produced optoelectronics, which gave birth to fiber optics communications systems; fusing mechanical and electronics technologies produced the mechactronics revolution, which has transformed the machine tool industry. In a similar fashion, the fusion of IT&T technologies is expected to introduce radical changes in the society, as well as far-reaching organisational and institutional changes in all aspects of human activity (e.g. workplace, leisure, shopping, commerce, education).

Such a progressive transformation introduces new challenges and requirements (European Commission, 1994; National Research Council, 1997) regarding the content of

[1] Some also include the media sector (see Spectrum Strategy Consultants, 1997).

information being communicated, the range of information services available, the telecommunication services for access to information, the media used for the presentation of information, etc. These, in turn, have direct implications on the structure and organisation of human activities at the turn of the 21st century (European Commission, 1997), and necessitate new means for computer-mediated human activities.

One important issue, in this context, is that the goods likely to proliferate in the emerging information age (i.e. information-based commodities), should be made available to anyone, anywhere and at anytime (Stephanidis, 1995b). This challenge does not only apply to computers and their interfaces, but also to information itself, and how it is created, collected, represented, stored, transferred from one place to another, and used. The Information Society has the potential to improve the quality of life of citizens, and increase the efficiency of our social and economic organisation. At the same time, it may lead to a "two-tier" society of "haves" and "have-nots", in which only part of the population has access to the new technology, or is comfortable using it, and can thus fully enjoy the benefits (European Commission, 1994). It is in this context, that the principle of *design for all* becomes an important vehicle towards ensuring social acceptability of the emerging Information Society.

In many ways, the term *design for all* (or universal design, the terms are used interchangeably) is not entirely new. It is well known in several engineering disciplines, such as for example, civil engineering and architecture, with many applications in interior design, building and road construction, etc. This is not to say that the built environment we all live in has been designed for *all*, but merely points to the fact that universal design is not specific to Information Society Technologies. However, while the existing knowledge may be considered sufficient to address the accessibility of physical spaces, this is not the case with Information Society Technologies, where universal design is still posing a major challenge.

In the context of this paper, *design for all* in the Information Society is the conscious and systematic effort to proactively apply principles, methods and tools, in order to develop IT&T products and services which are accessible and usable by *all* citizens, thus avoiding the need for a posteriori adaptations, or specialised design.

This paper reports the process used to collect and consolidate experts' opinion on the issue of universal access in the emerging Information Society. The result of this process is an international R&D agenda towards the development of an Information Society accessible and socially acceptable to *all* citizens. The current effort, which aims to provide a first milestone in this direction, was undertaken by a group of experts sharing the concerns regarding the issues of accessibility and social acceptability of the emerging Information Society.

The paper is structured as follows. The next section reviews and describes some of the prominent characteristics of the Information Society, the new research challenges already in place and the requirements that need to be addressed by future work. Then, *design for all* in the context of the emerging Information Society is introduced and discussed, in terms of the underlying rationale, and of different views regarding its feasibility and cost-justification. The subsequent section describes the process and instruments used to develop an international R&D agenda to facilitate the creation of an Information Society *for all*, and discusses the agenda in detail. The paper concludes with a summary of results and plans for future activities.

2. MAIN CHALLENGES AND REQUIREMENTS IN THE INFORMATION SOCIETY

2.1. The Shift of the Techno-Economic Paradigm

The emergence of the Information Society is associated with radical changes in both the demand and the supply of new products and services, resulting from the fusion of IT&T. The changing pattern in demand is due to a number of characteristics of the customer base, including: (i) increasing number of computer users characterised by diverse abilities, requirements and preferences; (ii) product specialisation to cope with the increasingly knowledge-based nature of tasks, resulting from the radical changes in both the nature of work and the content of tasks; and (iii) increasingly diverse contexts of use.

On the other hand, one can clearly identify several trends in the supply of new products and services, aiming to develop the required know-how and know-why to meet the above changing pattern in demand. These can be briefly summarised as follows: (a) increased scope of information content and supporting services; (b) emergence of novel interaction paradigms (e.g. virtual and augmented realities, ubiquitous computing); and (c) shift towards group-centred, communication-, collaboration-, and cooperation-intensive computing.

Figure 1 summarises the above shift in computing paradigms and illustrates the new role of computers in the emerging Information Society. In this context, one of the problems that need to be addressed, is the *design* (as opposed to programming) of information artefacts that inherently support the expanded range of computer-mediated human activities (Kapor, 1991; Winograd, 1995).

2.2. The Varieties of Context

The notion of *context* has traditionally been a crucial design factor for any type of computational system (Norman & Draper, 1986). Despite this, existing practice indicates that, in the majority of cases, the study of context is ignored, or bound to what is normally encountered by "typical" users (Nardi, 1996). This narrow and implicit view of context no longer suffices, given the broad range of computer-mediated human activities in the emerging Information Society. Instead, what is needed, is a new ground for the study of context in the information age, based on a multi-disciplinary protocol of exchange between research and technological development, as well as practice and experience.

Variety in the target user population and the nature of work

The radical innovation in the IT&T sectors and the increasing number of emerging application domains has broadened the range and type of the "target user population". As suggested by Figure 1, from the early calculation-intensive nature of work that was prevalent in the early 1960s, computer-based systems are progressively becoming a tool for communication, collaboration and social interaction. From a specialist's device, the computer is being transformed into an information appliance for the citizen in the Information Society. It follows, therefore, that designers will increasingly have to provide information artefacts to be used by diverse user groups, including people with different cultural, educational, training and employment background, novice and experienced computer users, the very young and the elderly, and people with different types of disabilities.

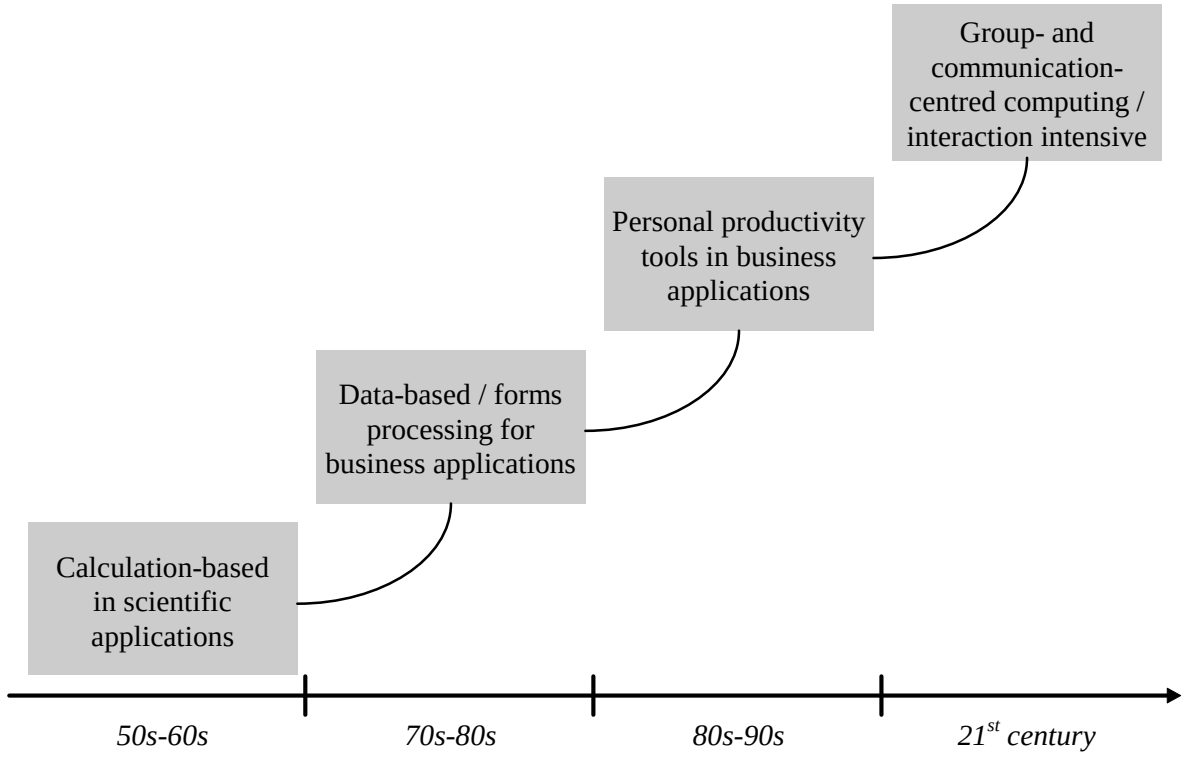

FIGURE 1 Shift in computer paradigms and forecast of trends for the 21st century

Variety in the context of use

Another dimension of variation is the *context of use*. In particular, the "traditional" use of computers (i.e. *scientific* use by the specialist, *business* use for productivity enhancement) is increasingly being complemented by *residential* and *nomadic* use, thus penetrating a wider range of human activities, in a broader variety of environments, such as the school, the home, the market place, and other civil and social contexts. As a result, information artefacts should embody the capability to interact with the user in all those contexts, and independently of location, machine, or run-time environment. Usability in such "non-traditional" usage contexts is likely to prove a harder target to meet, than in the case of the work place (Stephanidis & Akoumianakis, 1996).

Variety in the user access medium

In addition to the above, there will be also variation in the systems, or devices used to facilitate access to the community-wide pool of information resources. These devices include computers, standard telephones, cellular telephones with built-in displays, television sets, information kiosks, special information appliances, and various other "network-attachable" devices. Depending on the context of use, users may employ any of the above to review or browse, manipulate and configure information artefacts, at any time.

2.3. Universal Access and Quality in Use

Given the techno-economic paradigm shift and the variety in the context of computer-mediated human activities, it is important that *universal access* and *quality in use* are considered as prerequisites for an Information Society where *all* citizens have equal

opportunities for interpersonal communication, education, vocational training, employment, etc.

In the context of this paper, *universal access* in the Information Society signifies the right of *all* citizens to obtain equitable access to, and maintain effective interaction with, a community-wide pool of information resources and artefacts.

Universal access implies more than *direct access* or access through *add-on (assistive) technologies* (Vanderheiden, 1990), since it emphasises the principle that accessibility should be a design concern, as opposed to an afterthought. In other words, it is claimed that universal access entails the development of systems which can be used effectively, efficiently and enjoyably by *all* users. To this end, it is important that the needs of the broadest possible end-user population are taken into account in the early design phases of new products and services.

The notion of quality, on the other hand, has various meanings and connotations (Garvin, 1984; Bevan, 1995), and there are also different approaches to achieving product quality as part of the production process (e.g., International Standards Organisation [ISO]: ISO 9001, 1987; ISO 8402, 1994). In particular, quality in use is the high level design objective for a system to meet the real world needs of its intended users (Bevan & Azuma 1997; ISO/IEC 14598-1, 1998) and entails the consideration of a broad range of functional and non-functional attributes, which characterise the use of information artefacts by humans, in their various problem-solving, information seeking and communication-intensive computer-mediated activities.

This notion of quality goes beyond the "traditional" concept of usability (i.e. ease of use and learnability, etc), to include aspects (such as usefulness, suitability for the task, tailorability, etc) which are not easily measurable by current approaches based on performance criteria, such as effectiveness, efficiency, satisfaction, etc.

3. DESIGNING FOR ALL IN THE INFORMATION SOCIETY

3.1. Introducing Design for All

As already pointed out, *design for all* in the Information Society is the conscious and systematic effort to proactively apply principles, methods and tools, in order to develop IT&T products and services which are accessible and usable by *all* citizens, thus avoiding the need for a posteriori adaptations or specialised design. The rationale behind universal design is grounded on the claim that designing for the “typical” or “average” user, as the case has been with “conventional” design of IT&T products, leads to products which do not cater for the needs of the broadest possible population, thus excluding categories of users (Bergman & Johnson, 1995). Contrasting this view, the normative perspective of universal design is that there is no “average” user and, consequently, design should be targeted towards *all* potential users.

The vision of *universal design* has underpinned recent work, predominantly in the fields of Human Computer Interaction (HCI) and Assistive Technology. The main results today vary in context, scope and applicability across application domains. Nevertheless, they constitute a useful repository of experience and best practice that can influence future developments.

In particular, recent advances towards *universal design* in HCI have provided a design wisdom in the form of *universal design* principles and guidelines (TRACE R&D Centre, 1997), platform specific accessibility guidelines, e.g. for Graphical User Interfaces (GUIs), or the WWW (Gunderson, 1996), or domain-specific guidelines, e.g. for text editing, graphic manipulation (HFES / ANSI, 1997). The systematic collection, consolidation and interpretation of these guidelines is currently pursued in the context of international collaborative initiatives, such as the Web Accessibility Initiative - WAI of the World Wide Web Consortium (W3C, 1997) and the ISO TC159/SC4/WG5 (Stephanidis, Akoumianakis, Ziegler & Faehnrich, 1997).

In addition to the above, in recent years, several technical research and development projects have provided insights towards new user interface development frameworks and architectures that account (explicitly or implicitly) for several issues related to accessibility and interaction quality. Examples include the EC funded projects TIDE-ACCESS TP1001 (Stephanidis, Savidis & Akoumianakis, 1997) and ACTS-AVANTI AC042 (Stephanidis, Paramythis, Karagiannidis & Savidis, 1997), as well as the Japanese FRIEND21 initiative (FRIEND21, 1995).

Moreover, efforts towards universal design in the fields of IT&T have met wide appreciation by an increasing proportion of the research community, including (see also Muller, Wharton, McIver & Kaux, 1997): research consortia in the context of various Programmes of the European Commission, such as the ERCIM[2] Working Group on User Interfaces for All (Stephanidis, 1995a); industry, such as the USA Telecommunications Policy Roundtable, Microsoft Active Accessibility and Java Accessibility; scientific and technical committees, such as Association for Computing Machinery (ACM's) USACM public policy committee; legislative acts, such as the Americans with disabilities Act, 1993, USA Telecommunications Act 1996 - sec.255; the United Nations General Assembly Standard Rules (United Nations, 1995).

3.2. Universal Design Deliberations

In contrast to the above supporting initiatives and efforts, there is also scepticism concerning the practicality and cost justification of universal design. In particular, there is a line of argumentation raising the concern that “many ideas that are supposed to be good for everybody aren’t good for anybody” (Lewis & Rieman, 1994, Section 2.1, Paragraph 3). However, universal design should not be conceived as an effort to advance a single solution for everybody, but as a user-centred approach to providing environments designed in such a way that they cater for the broadest possible range of human needs, requirements and preferences.

Another common argument is that universal design is too costly (in the short-term) for the benefits it offers. Though the field lacks substantial data and comparative assessments as to the costs of designing for the broadest possible population, it has been argued that (in the medium-, to long-term) the cost of inaccessible systems is comparatively much higher, and is likely to increase even more, given the current statistics classifying the demand for accessible products (Vanderheiden, 1990; Bergman & Johnson, 1995; National Council on Disability, 1996).

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[2] ERCIM: The European Research Consortium for Informatics and Mathematics (www.ercim.org)

It is important, however, to underline that any particular technology (in the broad sense of the term) towards universal design should satisfy much more than mere demonstration of technical feasibility, in order to be acceptable. Strictly speaking, even technical efficiency, which presupposes both technical feasibility and technical reliability, may still not be sufficient. What is really needed is economic feasibility in the long run, leading to versatility and economic efficiency (Vernardakis, Stephanidis & Akoumianakis, 1997). In this context, considering universal design practices within a user-centred process of system development (Bevan & Azuma, 1997) is likely to provide a successful business case for universal design, and a framework for realising its promises in an effective and cost-efficient manner.

3.3. The Need for a New R&D Agenda

From the above, it follows that there is a compelling requirement for greater awareness of the premises and challenges of universal design; in order to advance universal design towards new frontiers and promote its practice, a closer international collaboration is necessary between the fields that drive the development of Information Society technologies. Figure 2 provides an indicative illustration of the levels of concern relevant to universal design, emphasising Human Computer Interaction, the telecommunications infrastructure, as well as the content level.

To this effect, there is a compelling need to critically review recent accomplishments in the relevant disciplines, with a renewed focus on the issues that prevail as a result of the new requirements. It is important that the existing inventory of wisdom is assessed against new criteria, which characterise computer-mediated human activities in the context of the Information Society. The normative perspective of this effort lies in the notion that any advances towards an Information Society for *all* citizens are likely to be made as a result of a purposeful, multidisciplinary approach to the appropriation of reciprocal investments in cross-sector RTD work, leading to fusion-type innovation.

In this context, an international R&D agenda is required for an Information Society acceptable to *all* citizens; such an agenda would facilitate the fusion of theoretical perspectives into a common ground, so as to inform and improve design practice, and promote a deeper understanding of how humans interact and communicate with other humans and with information artefacts. The multidisciplinary focus necessitates not only cross-sector commitment, but also a conscious effort to ensure a broad scope of the envisioned R&D activities empowered with new concepts, tools and techniques from different (and up to now rather dispersed) scientific disciplines, technological strands, and socio-economic and policy perspectives.

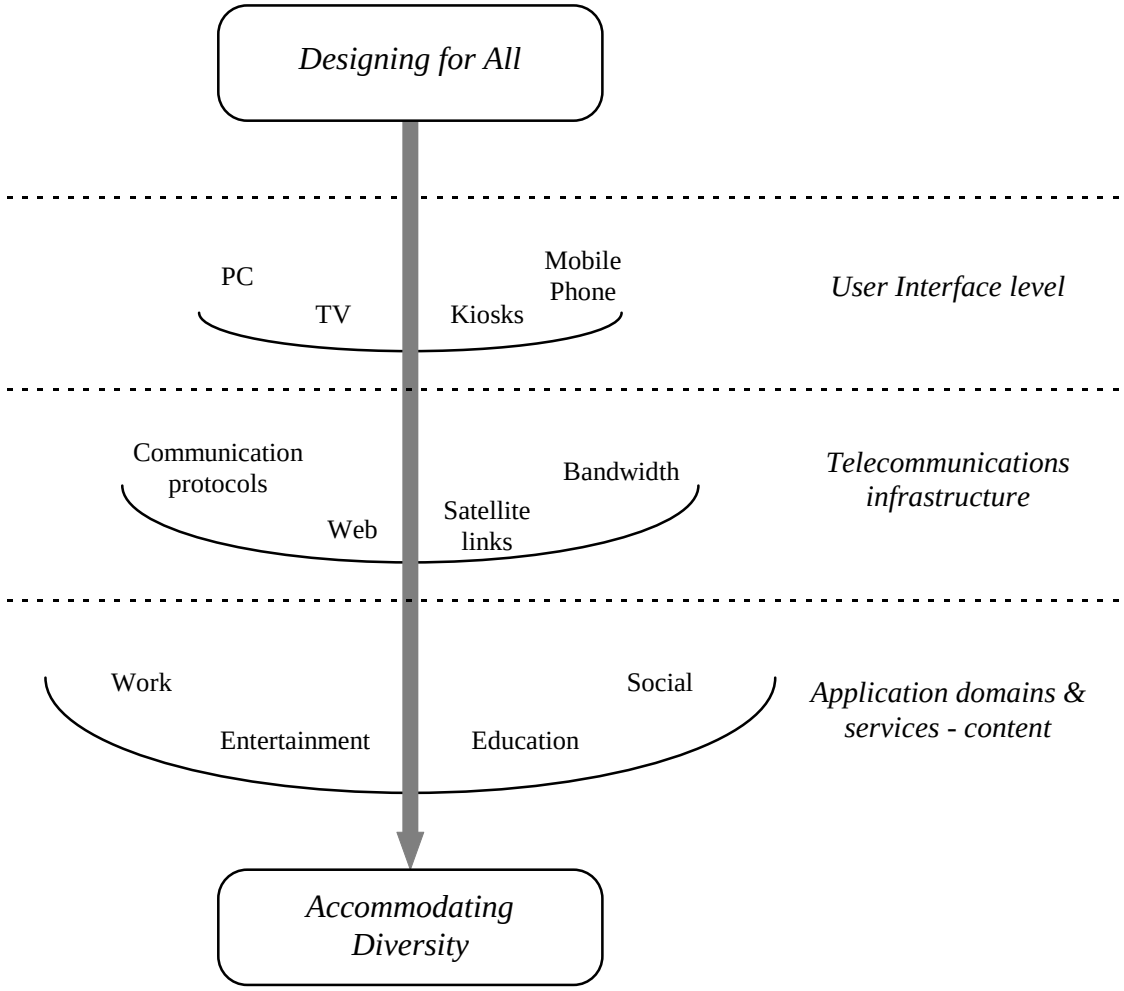

FIGURE 2 Levels of concerns and implications of design for all

Bridging the gap across relevant scientific disciplines

At the scientific level, the intention is to establish a cross-discipline agenda for collaborative research, fostering potential synergies amongst relevant disciplines and the appropriation of the resulting benefits. Such a requirement is now widely recognised and, in some cases, it is also actively pursued.

For example, in the field of HCI there have been efforts in the direction of revisiting existing approaches to design (in view of the new requirements), such as the human factors evaluation paradigm (O'Brien & Charlton, 1996) and cognitive science (Norman, 1986). The intention has been to specialise the HCI science base, or to facilitate better utilisation of information processing psychology, or to extend the scope of information processing psychology, or to broaden the range of psychology being applied (Carroll, 1991). Advocates of these proposals claim that enriching the available HCI theories, design methods and tools with suitable concepts from the social sciences (e.g. developmental approaches to psychology, anthropology, sociology) can provide the means to overcome well-known problems associated with more traditional approaches, and facilitate more powerful frameworks for HCI design. Examples of recent efforts to this end include the development of an *action-science* for HCI, advocated by Carroll and colleagues (Carroll & Rosson, 1992), as well as new frameworks for HCI based on *activity theory* (Bodker, 1989; Bodker, 1991), *situated action models* (Suchman, 1987) and *distributed cognition* (Norman, 1993).

Synergies, such as those driving recent developments in the field of HCI, can be promoted across other scientific disciplines, such as information theory, behavioural and organisation science, etc, as well as the natural sciences, in order to bring about a new conceptualisation of computer-mediated human activities within the Information Society.

Bridging the gap across relevant technological fields

The role of technology is equally critical, as it is the sole provider of the required tools through which humans will interact with information artefacts. Though much can be achieved with the current pool of technological wisdom, it is expected that the convergence postulated in the previous section, and a more effective linkage with design theory and practice, will help technology provide solutions that meet pragmatic requirements, in various contexts of use. To this effect, it is imperative that contributing technologies cover the whole range of information management activities, including information generation and extraction, storage and tracing, retrieval and presentation, communication, as well as the broad range of issues pertaining to human interaction with information artefacts encountered in various contexts, collaborative structures and virtual spaces.

Bridging the gap across social, economic and industrial policy

Socio-economic and policy issues are relevant to the extent to which they cover RTD planning, industrial policy and innovation, assessment of the products and services envisioned in the information age, cost factors, diffusion and adoption patterns, standards, legislation, technology transfer, etc. An important requirement to be observed is that of cross-industry collaborative research and development, which, in turn, involves reciprocal investment decisions and joint R&D efforts towards fusion-type innovations (Kodama, 1991). Policy makers should take appropriate measures to promote and facilitate RTD work, grounded on promising technology synergies, identified and selected on the basis of suitable criteria and assessment protocols. To achieve this, however, requires deep and detailed knowledge of possible synergies, how they are to be appropriated, the nature of the collaboration needed, and the type of collaborators who should be involved. In this context, “traditional” economic theory no longer suffices (Vernardakis, Stephanidis & Akoumianakis, 1997). Instead, a broader view of economic, social and technological factors and their inter-relationships is required, in order to enable the specification of the type and nature of the envisaged products and services, the requirements which they should satisfy, as well as the way in which industry should respond to the changing patterns of demand. These issues reflect upon a complex of research challenges, related to the economics of innovation, technology management and industrial policy.

4. THE INTERNATIONAL SCIENTIFIC FORUM

The call for closer collaboration across disciplines and a holistic approach covering scientific, technological and policy issues advocated in the previous section, would facilitate a common research and practice agenda, for the advancement of an Information Society that is acceptable to *all* citizens. Such an effort needs to be carried out in a co-ordinated and timely fashion, so as to provide input to current and future initiatives across the world (e.g. the Fifth Framework Programme of the European Commission and the National Information Infrastructure in the USA).

The International Scientific Forum "Towards an Information Society for *All*" held its first meeting with the aim of addressing these challenges, as well as exploring and exploiting the new opportunities in this direction. The following sections outline the preparatory work leading to the meeting, and present the consolidated results of this meeting.

4.1. Objectives and Themes of the Meeting

The overall objective of the meeting was to elaborate an international R&D agenda that would contribute towards the establishment of a favourable environment for the creation of an Information Society accessible and acceptable to *all* citizens. Such an agenda should address short-, medium- and long-term issues, based on the consolidation of recent progress in the identified scientific fields, and should specify the support measures necessary to stimulate future R&D activities at the international level. In addition to this aim, during the meeting, participants unanimously agreed on the potential of the International Scientific Forum to continue as a *Network* for collaboration and exchange of experience between researchers, industrialists and policy makers, aiming to advance the existing wisdom and stimulate new developments towards universal access and social acceptability of the emerging Information Society.

The driving themes of the first meeting of the Forum centred around three major topics: *technological and user-oriented challenges, critical application domains and services,* and *support measures*. Participants contributed towards the identification of the relevant issues in each of the themes, the assessment of the available scientific and technological knowledge providing the foundations for further work, and the definition of an R&D agenda covering specific areas of critical importance for the short-, medium- and long-term.

The *technological challenges* included for discussion in the agenda of the meeting were: assessment of current design approaches and practice, advanced interaction technologies, user interface software, architectural models for interactive systems, supporting tools, novel interactive environments, etc. The *user-oriented challenges* included for discussion were: user participation in the design process, frameworks of evaluation and assessment of end-user opinion, user modelling approaches, experimentation, reports on practice and experience, frameworks for studying computer-mediated human activities, etc.

The theme of *application domains and services* covered critical areas to be addressed, such as health care, education, social interaction, banking, electronic commerce, public-access information kiosks, as well as application domains and services built on top of the WWW.

Finally, the theme of *support measures* identified issues related to standardisation, legislation and policy, which are necessary to establish and sustain a favourable environment for industrial innovation, technology transfer, awareness raising, consensus, networking and diffusion, etc, towards an Information Society for *all*.

4.2. Preparatory Activities

A number of preparatory activities were undertaken leading up to the meeting. These facilitated more focused and targeted discussions during the meeting, as well as the formulation of a common ground for discussion. In particular, a short questionnaire was used, together with accompanying background material, to facilitate targeted response and the collection of preliminary data on a number of issues pertaining to the agenda of the meeting.

The questionnaire and the background material were circulated to participants prior to the meeting. The background document included the meeting's objectives, rationale, structure, agenda, as well as specific guidelines.

The questionnaire was primarily intended to elicit "high-level" responses from the experts. It intentionally did not include technical questions, since the meeting was not intended to provide a discussion forum advocating specific technical solutions, but instead, to provide a medium for knowledge exchange, experience sharing, identification of challenges and formulation of targets. The questionnaire collected expert opinions on the present state of the art, the current impediments and industrial challenges, aiming to identify and prioritise alternatives, and to develop an action plan in the form of an R&D agenda for the short-, medium- and long-term. The questionnaire and the accompanying documentation were subject to a small trial run with three experts, whose comments and remarks were incorporated in a final version. This final version was subsequently circulated to all participants electronically, who were given two weeks to study the documents, respond to the questionnaire and provide position statements related to the themes of the meeting.

The participants' expertise was varied and included human computer interaction, assistive technology, user interface tool development, human factors, usability evaluation, standardisation, legislation and technology transfer. The affiliated organisations of the participants comprised three large industrial organisations (IBM Corporation, NOKIA Mobile Phones and SUN Microsystems); one high technology Small-Medium Enterprise (SME) (Aaron Marcus and Associates); one international consortium (W3C); representatives of the European Commission (the Information Technology ESPRIT Programme - DG III, and TELEMATICS APPLICATION Programme - DG XIII); five universities; and five research institutes.

4.3. Roundtable Discussion and Consolidation

The preliminary results of the analysis of the questionnaires were the basis for a roundtable discussion at the beginning of the meeting (see Tables 1 to 4). Several of the issues appearing in these Tables were also considered as short-, medium- and long-term targets. The remainder of this section outlines the responses and data gathered for each question.

Sufficiency of existing know-how

Table 1: Responses related to sufficiency of existing know-how

- In some cases, the existing know-how is sufficient, in other cases further work is needed
- Lack of co-ordination of international efforts impedes a detailed understanding of what is available
- Packaging and broader dissemination of available information is necessary to improve awareness of the existing know-how

The responses gathered on this question are summarised in Table 1. An important conclusion regarding the sufficiency of available know-how was that, in certain cases, the existing design wisdom is sufficient to facilitate a number of developments with clear benefits for the population at large. For example, several guidelines for universal design are available today, which, if followed, will bring about improvements in the accessibility and usability of popular information environments, such as the WWW. However, it was also pointed out that

further work is needed towards experimentation, as well as technological developments. As an example of the former, one can point to the need for better design foundations and the much needed experimental evidence of what constitutes "good enough" design. On the other hand, further technological developments are needed to provide suitable tools for different human needs.

Table 2: Impediments in developing an Information Society for *all* citizens

Current status of the mainstream industry	Assistive Technology prevalent practice	Attitude of consumers
• Large installed base of inaccessible building blocks • Lack of appropriate user interface software architectures • Lack of cost effective technology to deliver products that comply to design for all principles • Limited view of the user; traditional focus on average user • Prevailing competitive strategies • Limited awareness & appreciation of diversity • Lack of knowledge about specific disabilities and people with multiple handicaps • Currently prevailing view that existing technology, if used carefully, can provide effective solutions to all problems • Lack of usability training in Computer Science courses • Insufficiency of currently available design methods and tools	• Lack of well designed and user friendly systems • "Looking at the tree and not the forest" • Small and fragmented markets • Lack of understanding of user interaction with new technologies • High cost of accessibility in currently prevailing practices • Reactive nature of the Assistive Technology field • Lack of co-ordination of efforts / legal / regulatory frameworks • Lack of reference materials, documentation and research data • Lack of internationally co-ordinated, comprehensive, cross-disability research programmes	• Lack of user participation • Need for usability as product differentiation determinant, or as purchase determinant • Lack of appropriate education mechanisms for consumers so that they can participate in advanced technology discussion • Lack of appropriate usability and user-centred design techniques to elicit effectively consumer opinion

Some of the participants raised the concern that, in some cases, it is difficult to assess what is already available, since there is a lack of co-ordination of international efforts. This is further complicated by the inadequacy of traditional channels of dissemination of research results, practice and experience, to facilitate knowledge sharing and exchange in a timely fashion. As a result, in many cases, it is hard to know what has been accomplished, so as to avoid duplication of efforts.

Impediments in developing an Information Society for all citizens

In this question, participants provided a broad view as to the possible obstacles to achieving an Information society for *all* citizens (see Table 2). Some of the impediments identified pertain to the current state of the mainstream industry and the Assistive Technology field; others relate to consumers and their willingness and capacity to actively participate and articulate demand for accessible and usable products. In spite of these widely accepted shortcomings, it was also acknowledged that, as a result of recent initiatives, a number of these targets have begun to gain attention.

Role of non-market institutions

In recent years, a number of studies have reached the conclusion that non-market institutions can play a catalytic role towards universal design, especially in sectors of the industry that are known to be recipients, as opposed to natural generators of technology (Vernardakis, Stephanidis & Akoumianakis, 1997). This point was even more emphasised in the replies of the respondents. To this effect, the possible actions that such organisations could undertake are summarised in Table 3.

Table 3: Potential role of non-market institutions

- Establish effective strategies and legal frameworks
- Act as catalyst in bringing about a shift in perspectives
- Provide funding for R&D initiatives
- Provide incentives to both large industries and SMEs
- Regulatory role aiming to support accessibility in scientific, technical and social terms
- Identify technological potential
- Promote coherence in the market
- Support actions for standardisation and legislation
- Adopt policy measures ensuring that industries *design for all*
- Guide industry towards *design for all*
- Promote the generation of the required knowledge and facilitate access to research results
- Encourage strategic alliances
- Act as technology transfer intermediary
- Develop standards and guidelines
- Establish an international usability assurance scheme to facilitate consumer confidence of product usability

Industrial impediments

Table 4 summarises the responses of the participants regarding specific impediments which restrict the capacity and capability of the industry to develop products and services that comply to the principles and requirements of *design for all*. From these responses, a point which was raised earlier on becomes even more evident, namely that any technological push towards universal design should satisfy the criterion of economic efficiency, rather than mere technical feasibility and reliability, otherwise it will not be acceptable.

Table 4: Industrial impediments

- Lack of internal knowledge as to how to *design for all*
- Lack of legal framework to ensure / reinforce *design for all*
- Lack of awareness of potential longer term benefits
- Lack of effective / efficient technology transfer mechanisms
- Cost-benefit justification / lack of perceived market demand
- Fierce competition and pace of development
- Limitations of prevailing systems development practice
- Attitude that universal design is cost prohibitive
- Lack of standards
- Lack of consensus by disability groups (e.g. as to what is "good enough")
- Lack of skills and methods
- Lack of qualified people
- Reluctance to change in existing practice
- Lack of corporate commitment

5. THE PROPOSED INTERNATIONAL R&D AGENDA

Following an analysis of the results of the questionnaires, participants were subsequently involved in consolidating the available material for each of the three themes of the meeting. More specifically, participants were requested to contribute with research targets, a brief explanation of content, scope and purpose, as well as examples for reference.

5.1. Technological and User-Oriented Issues

The specific recommendations which were raised for this theme are summarised in Table 5 and are discussed below.

Design processes, methods and tools for computer-mediated human activities

It was recommended that further research is needed to provide enriched frameworks, theories and methodologies to facilitate the design of systems that exhibit a range of qualities which render them accessible and usable by the broadest possible end-user population (e.g. user-centred goals to design). Indicative quality attributes include: *software ergonomic criteria*, such as ease of learning and understanding, ease of use, adaptability, error tolerance, suitability to the task, etc (ISO 9241, 1995); *performance criteria*, such as effectiveness, efficiency, satisfaction, etc (Bevan & Macleod, 1994); and *non-functional quality attributes*, such as accessibility, scalability, reliability, reusability, portability, etc.

Table 5: Critical areas of research and development related to technology and user-

oriented issues			
	TIME HORIZON		
ISSUES	Short-Term	Medium-Term	Long-Term
Design Process, Methods & Tools	• Consolidate and disseminate available wisdom on universal design • Establish criteria that take account of accessibility and usability	• Use methods, tools and results from disciplines focusing on people and communication • Promote use of methods within a user-centred design process	• Advance new prescriptive instruments to facilitate design for scalability and modality independence
User-oriented challenges	• Study variety of user contexts and address requirements of tail population • Build upon and expand existing techniques from participatory design and ethnography to promote user involvement	• Develop standardised methods for eliciting end-user requirements	• Develop an empirical science base for the study of users
Input / Output Technology	• Speech input • Natural language input and processing • Multimodal language input • Flexible, portable, high resolution, compact displays • Haptic devices • Voice and synthesised sound • Multimodal output generation • Computer Supported Co-operative Work (CSCW) • Hypermedia	• Computer Vision • Gesture processing • High resolution, full page, tactile displays • Advanced / alternative interaction platforms • Embedded intelligence and agents	• Tools for abstraction, integration and expansion of interaction platforms • Building new forms of co-operative structures and virtual spaces • Integrated agency models
User interface architectures	• Enhancements to built new interaction facilities such as scanning into existing platforms (e.g. WINDOWS95) • Distributed object environments • Transportable software	• Requirements engineering methods and tools which incorporate accessibility issues • System development methodologies which take full account of accessibility and usability	• Tools for effort and cost effective integration of access into products • Appropriate user interface architectures • Architectures for collaboration • Toolkit interoperability • Architectures for collaboration

An immediate action should therefore be targeted towards the definition of criteria for design processes that take full account of accessibility and the desired quality in use attributes. The availability of such criteria would guide future developments and inform and improve practice. In addition to the above, as another short-term target, it is recommended that universal design advocates gather data to confirm, consolidate and expose the current design principles and guidelines known to be valid, so as to facilitate greater awareness and

wider adoption by designers. As a result, it is expected that industry will become more sensitive to delivering products and services for diverse contexts of use, and will eventually adopt the required science base to facilitate it.

In the short- to medium-term, emphasis should be on disciplines that focus on people and communication. More specifically, prescriptive frameworks are needed for deriving technical features for the study of activity orientation, collaboration, social awareness and social immersion, as well as the diversity of context resulting from cultural, physical and cognitive user characteristics, or technological proliferation. Equally important is that validated design criteria for user interfaces supporting interaction in the emerging Information Society are derived from such empirically confounded frameworks. To this effect, end-user participation is crucial and should be strongly encouraged by the methods and tools to be employed, or developed.

In the medium-term, the existing inventory of methods, techniques and tools for user-centred design (ISO 13407, 1997) should be suitably applied and enhanced as needed, by drawing upon accumulated knowledge and results in social sciences, to promote and facilitate the use of more developmental approaches to the study of computer-mediated human activities. In all cases, the tight evaluation loop advocated by user-centred design should provide the primary channel for timely feedback into the design process, so as to assure that design deficiencies are corrected at an early stage, while updates are less costly to make (ISO/IEC 14598, 1996).

In the long-term, efforts should be mainly targeted towards gaining an improved understanding of basic principles to support upward scalability to new technologies and modality- and medium-independence. Scalability, in this context, refers to the requirement that interactive devices should be extensible, so as to be capable of incorporating the next generation of technology. On the other hand, modality- and medium-independence imply that design artefacts are represented and stored in a form that is not bound to the specifics of any particular technology platform. Such representations can subsequently provide alternative instantiations to different modalities through different media.

User-oriented issues

In order to improve current design practice and guide the evolution towards new interaction and communication paradigms, it is necessary, in the short-term, to employ available methodologies from the fields of sociology, psychology, anthropology, physiology and other contributing disciplines. These would provide a more in-depth understanding of human interaction and communication with other humans and information, in the context of the emerging information age. It is argued that the user's experience with new Information Society technologies is more than likely to be different from that associated with the currently prevailing desktop embodiment of the computer. As a result, interaction with such technologies is bound to follow different metaphors and involve multiple human sensory channels. To this end, participation of diverse user groups is critical and should be encouraged, in order to provide a direct account of the range and implications of the combination of user abilities, constraints, skills, requirements, preferences, etc.

In the medium- to long-term, the emphasis should be on the development of a rigorous experimental science base pertaining to how diverse users interact with information artefacts. Such an endeavour should necessarily take account of users with disabilities and elderly people, as they frequently constitute the "cutting edge" in the assessment of the usability of a particular technology. Moreover, part of what is currently missing from this science base, is an empirical characterisation of how the physiology of specific user impairments dictates the

interaction strategies that can be employed by users with disabilities. There is also insufficient data concerning how (combinations of) impairments affect preferences for, and performance with, various types of technologies; understanding such relationships will allow a more systematic approach to matching individual end-user abilities, skills, requirements and preferences, with features of interactive systems.

Input / output technologies

Investment is also needed in further research and development in emerging technologies, which will carry the power of computing to people and environments not currently serviced. A broad range of technological developments is recommended in the short-, medium- and long-term. These include technologies for alternative input and output, expanding the current horizon of computer-mediated human activities beyond the conventional visual embodiment of the desktop metaphor, as well as technologies that improve the process and means by which individuals and groups of people communicate, co-operate and collaborate to accomplish common objectives.

Critical areas of technologies to facilitate alternative input include speech input, natural language input and processing, computer vision, gesture recognition and their combination with "traditional" technologies to facilitate multimodal input. On the other hand, technologies facilitating a wider range of output modalities include: flexible, portable, high resolution and compact displays; haptic devices; high resolution full page tactile displays; voice and synthesised sound and multimodal output generation; etc. A critical issue in undertaking such technological developments will be the integration of the resulting hardware and software components into mainstream operating systems, using suitable and reliable facilities. This would ensure the wide utilisation and interoperability of such technologies.

In addition to the above, technologies contributing to the creation of new information spaces for experience sharing, exchange of ideas and social communication should also be supported. Such technologies need to be advanced towards pragmatic needs and requirements of individual members in groups, thus appropriating the benefits of social engagement and collective decision making. Additionally, their combination with other emerging technologies such as hypermedia, interactive multimedia, and alternative interaction environments (e.g. virtual / augmented environments) should provide a new ground for supporting a wide range of computer-mediated human activities.

User interface architectures

Research on user interface architectures will be a crucial contributing factor towards a new generation of user interface software and technology for the broadest possible population (Stephanidis & Akoumianakis, 1997; Muller, Wharton, McIver & Kaux, 1997). The critical issue in the short- to medium-term, is to provide the components that will allow the development of integrated environments, which, amongst other things, are adaptable, personalised, co-operative, easy to learn, error tolerant and responsive to a changing environment and context of use. Such architectures should extend the current conception of the visual desktop metaphor, or the metaphors proliferating in Web-based applications. To this end, they should progressively enlarge the scope of computer-mediated human activities, to facilitate the attainment of communication-oriented goals, in addition to "traditional" task-oriented activities.

An important issue in this context is to enable human interaction with other humans and information artefacts through alternative access media, such as the telephone or the

television, which are becoming information appliances. Therefore, it is likely that neither the conventional desktop, nor the prevalent Web metaphors will suffice as a single solution to designing for the broadest possible end-user population (Winograd, 1997). Having said this, it is important to clarify that new interface architectures should not aim to replace visual user interfaces, but instead, to empower them with new capabilities, through the technological development efforts identified previously.

In the medium- and long-term, research on advanced user interface architectures should also be complemented by efforts to advance the tools currently available for requirements engineering, designing, implementing and evaluating interactive systems in a cost effective and efficient manner. As an example, recent trends indicate that, in order to advance the current generation of cross platform environments, research is needed to facilitate multiple toolkit platforms, supporting multiple / alternative interactive embodiments of the functions in a source application domain (e.g. the office, the market place).

5.2. Application Domains and Services

The theme on *application domains & services* identified, and provided an account of, critical areas to be addressed. The significance of the application domains does not only reflect their role in establishing a coherent and socially acceptable Information Society, but also the diverse range of human activities likely to be penetrated, as a result of the fusion in the IT&T sectors of the industry. Table 6 summarises the consolidated results, which are briefly discussed below.

Life-long learning is a critical area where emphasis should be placed, in the "knowledge" society of the future. It entails a continuous engagement in the acquisition of knowledge and skills to facilitate and sustain equitable participation in the Information Society (European Commission, 1997). New technologies may play a catalytic role in providing new educational mechanisms and structures, thus allowing learning to become an inseparable part of life-long human activities in the context of knowledge-intensive *learning communities*, and social interaction amongst groups of people.

Another important application area and a critical short-term target is the development of general purpose *public information systems*, *terminals* and *information appliances*, (e.g. information kiosks for access to community-wide information services). These are expected to be used in increasingly different contexts, including public places, homes, classrooms, etc, and provide the means for ubiquitous and nomadic access. *Environmental control* will also become increasingly important. *Smart environments* will progressively penetrate a wide range of human activities in hospitals, hotels, public administration buildings, etc. Tele-operation of such environments will also gain increasing attention to facilitate responsiveness to unforeseen events, enhanced mobility and security.

Finally, a broad range of *transaction services* (e.g. banking, advertising, entertainment), *social services for the citizens* (e.g. administration, health care, education, transport), and *electronic commerce* applications, will become increasingly important in reshaping business and residential human activities. These should also be addressed within a short- to medium-term time horizon.

Independently of any particular application domain or service, there are certain quality attributes and added-value functionality that should be accommodated into future services. For instance, *security*, *privacy* and *control* are central themes in the evolution of a socially acceptable Information Society and should receive immediate attention. At the same

time, they will increasingly constitute more complex targets to accomplish, as they span across different levels of the telecommunications infrastructure, from network services to application services (such as business transactions and entertainment), terminals and information appliances.

Additionally, important quality attributes to be observed include accessibility, intuitive operation and ease of use, as well as functionality to allow users to create, store and tailor available data into added-value information, and leave traces of their experience. Such quality attributes, and the extent to which they are satisfied, are likely to be important determinants of diffusion and adoption of emerging information services by *all* citizens. These factors are also likely to provide the primary explanatory variables of early versus late adoption rate by different user groups.

Table 6: Critical application domains and services

- Life-long learning
- Public information systems, terminals and information appliances (e.g. kiosks, smart home environments)
- Transaction services (e.g. banking advertisement)
- Electronic commerce applications and services
- Social services for the citizens (e.g. administration, elderly, transport, health care, awareness)
- Tools to allow for added-value information services (e.g. creation, storage, retrieval and exchange of user experiences, traces and views)
- Security

5.3. Support Measures

The theme on *support measures* identified a broad range of issues related to policy, which are required to provide a favourable environment for industrial innovation, technology transfer, awareness raising, consensus, networking and diffusion, for the evolution of an Information Society accessible and acceptable to *all* citizens. The results consolidated at the Roundtable discussion are summarised in Table 7 and are elaborated below.

Table 7: Support measures

ISSUES	TIME HORIZON: Short-Term	Medium-Term	Long-Term
Articulating demand for universal design	• Awareness raising	• New product concepts	• Development and delivery of new products and services
Supporting the industry	• Provide incentives for universal design • International standards co-ordination • Legislation	• Provide incentives for universal design • International standards co-ordination • Legislation	• Provide incentives for universal design • International standards co-ordination • Legislation
Awareness and knowledge dissemination	• Encourage qualified universal design practice • Consolidate and disseminate knowledge known to be true • Devise suitable international dissemination strategy	• Encourage qualified universal design practice • Consolidate and disseminate knowledge known to be true • Devise suitable international dissemination strategy	• Encourage qualified universal design practice
Technology transfer	• Promote advanced mechanisms for technology transfer • Establish a co-ordinating body to guide, facilitate transfers • Consider policy variables required for networking	• Consider policy variables required for networking	• Consider policy variables required for networking

Articulating demand for universal design

In the short-term, support efforts should be devoted to the articulation of a demand for *design for all*. In the recent literature (see Kodama, 1991), articulating demand has been defined as a two-step process: first, translate market data into a product concept; and second, decompose the concept into a set of development projects. It should be mentioned that such a two-step process is sufficient only in cases where a market already exists, and has reached a level of maturity whereby it can react and respond to the needs of its customer base. However, in the case of the emerging Information Society it is argued that there is an additional short-term need for creating awareness as to the new challenges likely to emerge, as well as the new opportunities offered.

Consequently, support measures are needed in the direction of raising consumer awareness, education and training. These should cover a broad range of the population, including "tail" populations, such as people with disabilities, and should be aimed towards building a *public expectation* for usable products and services, and intolerance of inaccessible forms of technology. Additionally, until a certain maturity level is reached and more effective end-user input into the design process can be attained, procurement guidance is necessary with regards to accessible and usable technology.

Regarding subsequent steps required for demand articulation, namely the translation of market data to product concepts and the decomposition of product concepts to development projects, it is important that a range of questions are addressed. These include what product types are needed in the market, how they could be produced, through which technologies, and what other characteristics should the envisaged technologies exhibit.

Supporting the industry

Another line of action should be targeted towards the creation of an environment favourable to industrial innovation. At the core of such activities should be the provision of incentives towards *design for all*. Industrial incentives need not necessarily be of a financial type, though this would be critical for SME. Incentives should also include access to research results that would be difficult to obtain otherwise, provision of a suitable infrastructure, collaborative R&D activities for technology transfer (see also below), as well as a favourable legal framework.

Additionally, participants recognised the compelling requirement for speeding-up current standardisation processes, as well as the need for internationally co-ordinated standards in the long-term. To this end, it is recommended that work already initiated in the context of research consortia (e.g., the W3C Web Accessibility Initiative Project, http://www.w3c.org/WAI/, and the ERCIM Working Group on User Interfaces for All, http://www.ics.forth.gr/at-hci/UI4ALL/), as well as in national (e.g. HFES / ANSI) and international standardisation bodies (e.g., the new work item on accessibility by ISO 9241 (http://scitsc.wlv.ac.uk/~c9584315/iso9241.html); ISO / TC 159 / SC 4 / WG 5should be co-ordinated and should exchange input so as to avoid incompatible standards. Another recommendation along the same lines, is to establish suitable assessment and certification measures for accessibility and usability of new products and services.

Legislation is also needed to provide the framework of operation, and the required incentives for both the consumer base and the industry. To this effect, recent experience in the USA with the Americans with Disabilities Act of 1993 and the Telecommunications Act of 1996 should be assessed, and similar actions should be encouraged internationally. Such efforts could also draw upon general rules and recommendations asserted by industrial consortia (e.g. The Telecommunications Policy Roundtable in the United States; ACM, 1994), technical committees (e.g. the USACM-Public Policy Committee of the ACM; http://jafar.ncsa.uiuc.edu/usacm) and international organisations (e.g. the United Nations General Assembly Standard Rules of 1995).

Awareness and knowledge dissemination

One of the critical impediments to the adoption of universal design practice is the lack of qualified practitioners who understand what is required to achieve universal access and quality in use. To overcome this, it is recommended that, in the short-term, usability is introduced as a mandatory component of university education; additionally, existing knowledge about the benefits of, and how to achieve accessibility and usability should be

systematically disseminated. This will progressively encourage the adoption of universal design principles by professional bodies and individuals in the medium- to long-term. To this effect, an international dissemination strategy to raise awareness and provide access to information and training would speed-up the transfer of knowledge into design practice.

Technology transfer

Effective and efficient technology transfer is another critical target, requiring a range of support measures to be effected. Technology, in this context, includes both embodied and disembodied forms. Embodied technology is evident in new products and services, machines, tools and research equipment. Disembodied technology appears as learning-by-doing, documentation, know-how and know-why. To facilitate successful transfers of technology, suitable mechanisms are needed in the short-term, to the effect of targeted and purposeful exchange of knowledge, know-how and know-why. It is recommended that, from the broad range of technology transfer mechanisms that can be considered, emphasis is on advanced measures (such as co-operative R&D, joint venture R&D agreements, joint ventures aimed at keeping partners informed, large-small firm agreements), rather than simpler ones (such as licensing, technical advice, technical support, contract of R&D). This is because the former cluster is better suited for the type of knowledge transfer that is required (Vernardakis, Stephanidis & Akoumianakis, 1997). In this context, it is important to mention that collaborative, inter-disciplinary, multi-national, multi-cultural and cross-industry R&D activities, involving industry and institutions, are of primary importance.

Moreover, given the broad range of technologies that will drive the emergence of the Information Society, it is recommended that any contemplated technology transfer effort should closely and carefully consider potential sources and recipients, and assess alternative technological performance thresholds. In principle, it is recommended that *design for all* should be the aim of all emerging technologies. The newer a technology, the greater are the chances of being influenced in the direction facilitating *design for all*. However, for such a condition to materialise, a "monitoring system" for critical emerging technologies should be established; this could be part of an extensive collaborative network, and should aim to identify potential synergies and possibilities for international collaborative R&D efforts.

6. SUMMARY AND CONCLUSIONS

The emergence of the Information Society creates new opportunities and challenges for *all* citizens. The progressive shift from physical goods to information-based products and services is likely to introduce new patterns for demand and supply of such products and services. One important issue in this transition is the extent to which the emerging Information Society advances in a manner which ensures non-discrimination and social and economic inclusion of the broadest possible end-user population. This question may be re-phrased to explicitly point out the requirement for a new society for *all* citizens. This paper has outlined the rationale for the argument that universal access and quality in use should be integral components of future developments in this direction, and that *design for all* provides a means to this end.

To this effect, the paper discusses new and forthcoming requirements for such a society, and proposes an R&D agenda based on the consolidated opinion of experts within the International Scientific Forum "Towards an Information Society for *All*". The agenda was advanced in the course of a one-day Roundtable discussion, which was preceded by several

preparatory activities. The objective of the Roundtable was to identify short-, medium- and long-term activities which would contribute towards the visionary goal of an Information Society acceptable to *all* citizens. Additionally, the Roundtable addressed critical issues and necessary steps to facilitate the implementation of the R&D agenda at an international level.

The agenda points out a broad range of required actions relevant to three main themes, namely technology and user-oriented issues, critical application domains and services, and support measures. Each recommended action was discussed in terms of target objective, tentative scope and likely time horizon. Under the theme of technology and user-oriented issues, the agenda highlights the need for additional work covering the development of critical technologies, the advancement of suitable design frameworks and the evolution of powerful user interface architectures. Critical application domains and services include life-long learning, public information systems, terminals and information appliances, transaction services, social services and electronic commerce, as well as global issues such as security, reliability, etc. Support measures that would facilitate a favourable environment towards an Information Society for *all* should cover the articulation of demand for universal design, support to industry, awareness raising and knowledge dissemination, and technology transfer.

In addition to the above short-, medium- and long-term targets, the Roundtable discussed alternatives in the direction of establishing a favourable environment for supporting and implementing the proposed agenda. One possible option in this direction would be for national governments and funding bodies to develop the required RTD policy mechanisms, in order to integrate and support future research, along the lines suggested in this paper. However, as already pointed out in the previous sections, many of the items and recommendations of the R&D agenda have either an explicit international dimension, or can be more effectively addressed at an international level. As a result, what is needed is international collaboration and co-operation, which, in any case, would provide the necessary input to national and trans-national RTD policy forums, as well as establish liaisons with the relevant special interest groups, fora, consortia and scientific committees.

To facilitate this effect, the Roundtable discussions concluded that a possible path for realising the proposed R&D agenda and supporting its implementation could be through the continuous engagement in on-going international collaboration efforts, tasked with the goal to undertake all necessary actions to promote the visionary goal of an Information Society for *all*, across academia, industry and policy levels. Such a strategy is currently being further investigated, and is expected to attract wider attention. At the core of these efforts should be the undertaking to implement several parts of the proposed agenda and to initiate and sustain co-operation with other international efforts (e.g. standardisation bodies), to ensure that medium- and long-term targets are accomplished. In the short-term, a number of the recommendations identified earlier can provide the ground for such international collaboration.

For instance, the International Scientific Forum has initiated, and is planning to define activities aiming to consolidate current practice and experience in the area of universal design, and make it widely available as reference material, or provide contributions to on-going national and international standardisation activities. Similarly, in the short- to medium-term, work can be directed towards the identification of key accessibility criteria or requirements to be met by products and services. These efforts can be consolidated into an appropriate form (e.g. accreditation scheme) that would guide subsequent efforts by both industry and academia, towards information products and services accessible and usable by the broadest possible end-user population. Furthermore, such activities can help industry to gain a renewed focus on the issue of universal design, and facilitate justification for the costs

and benefits of alternative technologies. Additionally, it can stimulate new developments, and establish the ground whereby universal design informs and improves practice.

The above are only some of the goals of international collaboration aiming to promote an Information Society for *all* citizens. They demonstrate the benefits resulting from an international, multi-disciplinary effort to advance the concepts and principles of universal design in the context of Information Society technologies, as well as the added value of undertaking this effort through a network of partners co-operating and collaborating towards a shared vision. Finally, it is also important that, for such a committee to be established and efficiently operated, support is provided by individuals, organisations, non-market institutions, national governments and international bodies.

In summary, this paper has combined the opinions of experts regarding the research requirements that should be addressed to facilitate the emergence of an Information Society for *all* citizens. The proposed R&D agenda is considered an important step towards this visionary goal, and it is presented in the hope that significant co-ordinated efforts will ensue. It is anticipated that such efforts will promote awareness, stimulate interest and initiate international co-operative activities, and make inroads towards establishing a favourable environment for the creation of an *Information Society accessible, usable and acceptable to all citizens.*

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