Towards the Next Generation of Computer-based Interpersonal Communication Aids

G. Kouroupetroglou, C. Viglas, C. Stamatis and F. Pentaris
University of Athens, Department of Informatics, Panepistimioupolis, Ilisia, GR-15784, Athens, Greece
email: koupe@di.uoa.gr

Abstract. Commercially available interpersonal communication aids appear to lack a common technical ground to facilitate both user-adaptation and functional flexibility. The framework of an alternative solution is presented in this paper, concerning a novel approach aiming to affect the development of interpersonal communication systems. It utilises a new, open and modular software architecture as its functional core that considers communication aids to be consisting of a number of independently developed components. Potential products, accompanying tools, and likely users are also presented, focusing on the impact the new approach can have on the way communication aids are developed altogether.

1. Introduction

Computer-based communication aids have been in use since the late 1970s in all different shapes and sizes in an attempt to adequately cope with the crucial issue of interpersonal communication for the disabled [1-5]. However, commercial products have only realised partial solutions either too generic or addressing only specific communication problems to offer from little to none functional flexibility with respect to their adaptation to either different or evolving user needs [6-8]. Communication aids manufacturers, seem reluctant to construct vast numbers of different user-specific systems as this can prove time consuming and not market effective in terms of overall cost and quite often various user cases are left out. Furthermore, it is impractical to re-configure such an aid to match the specific preferences and needs of another user. In a similar sense any attempt to develop all-encompassing systems, that can be configured to meet individual needs, only results in aids that are rather complex and offer such a variety of features, rendering some of them redundant for quite a few users, not to mention difficult to operate effectively [9-11].

Within the ACCESS consortium, the aforestated situation dealing with Access to Interpersonal Communication (ATIC) was identified from the very beginning, and a new technical solution was conceived, aiming to alter the way communication aids would be looked upon and moreover affect the overall process of developing communicators into more effective products. The ATIC approach, meets specific users' needs, exploits their abilities to the maximum and offers only the set of required features. It endorses a modular design for communication aids complying to a general adaptable solution to serve a wide range of users, able to deal adequately with users having motor, perceptual and cognitive problems. A versatile technology is used [12], allowing for rapid changes, supporting multiple features in order to meet the physical abilities, cognitive and language levels and conversational needs of persons using these aids [13]. Any user language, symbolic or natural, is supported via a database of multimedia language elements, not only during face to face but also in remote communication and group conversations.

In order to reach the above goals, the ATIC approach, utilises, and is based upon:

- the provision of a novel component architecture (protocols, connectivity, building rules, and software tools inclusive);

- the acceptance and adoption of the architecture by the various developers of interpersonal communication aids;
- the implementation of components (modules) complying with the new architecture as well as their becoming available in the market.

2. Basic notions within the ATIC approach

The framework of the ATIC approach is realised by the provision of a novel, open, and flexible modular architecture (n.b. the ATIC architecture) towards the implementation of the software-oriented core of computer-based interpersonal communication aids. Products dedicated to meet the individual needs of a specific user can be assembled easily, rapidly and cost effectively, by combining reusable components, complying with the ATIC architecture, that can even be independently implemented by different developers.

The ATIC approach is the result of an in-depth analysis of the technical specifications and functionalities of currently available communication aids, and a thorough investigation and understanding of user needs and requirements [14]. The main aim was to be able to offer a more flexible, usable, customisable and maintainable way of doing things in the AAC domain and especially towards building software-based communication aids. More specifically, the identified user needs were mapped to appropriate communication functions and translated into the software-oriented domain. The main functions identified were then broken down into sub-functions leading to *elementary functional elements* (we would like to call *services*) that the communicator's modules would be expected to offer and serve. In this context, the following basic assumption has been introduced regarding the composition of an interpersonal communication aid:

A communicator is considered a system providing a number of ***functions*** *and/or* ***services*** *dependent on the particular user-needs, abilities and cognitive level. Each function may be implemented independent of others, either as a separate entity or as a set of elementary services. In this respect, the communicator consists of a set of such component entities (to be referred to as modules), which may be developed separately as individual components and then assembled in order to constitute a system that meets specific user needs. A module or a set of modules would be responsible for the implementation of a function or service in a way transparent to the architecture and the communicator itself. Yet, since different components, implemented by different developers independent of each other, will have to cooperate, some basic principles (i.e. the communication protocol and functional behavior of an underlying common architecture) will have to be respected.*

3. Users and Tools

In the framework of the ATIC approach, a set of software tools is also included, thus allowing to reach an final product (i.e. a communicator) that would behave correctly at runtime, support reuse, and free developers from routine work [15]. Potential users of these tools include those involved in the process of designing, developing and ultimately realising the design of an ATIC compliant communication aid:

- ***Developers of modules***. Notably software engineers or programmers that would undertake the task of implementing specific functions into ATIC compliant modules. Naturally this user class addresses -as a superset- companies with a firm knowledge and background on the implementation of communication aids and/or assistive technology in general.
- ***Suppliers/retailers***. Market-oriented in shops or user targeted organizations, who would acquire various components and put together the communication aid according to specific user needs as presented by the user/facilitator (marketing outlets of assistive technology manufacturers are included). They are system integrators, acting as the accumulating point of developed components and undertake the task providing the disabled user with a final working product.

- ***Facilitators/therapists***. The disabled user's therapist or facilitator needs access to some kind of tools either to decide and select as of what components the communicator should include, or configure the communicator to best suit the disabled user's preferences.

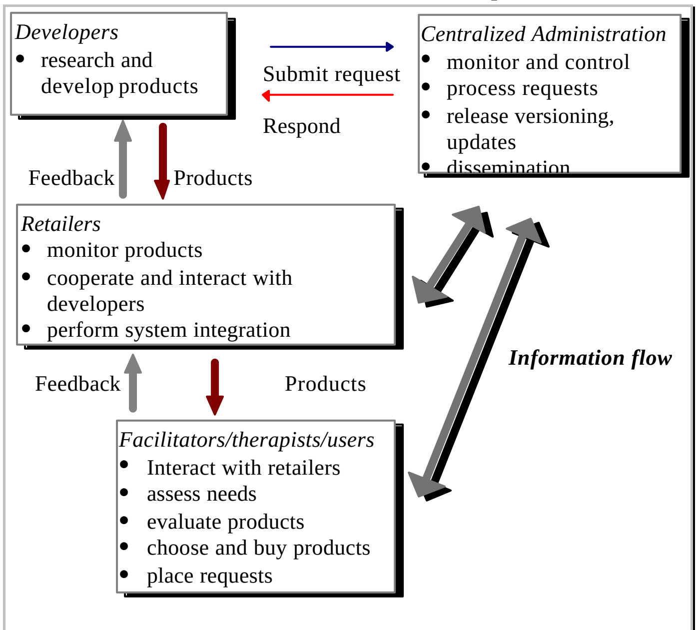

Figure 1 *The ATIC approach*

- ***End users*** (evidently the end-users of a communication device may indeed benefit - up to some point- by utilising some - simple- ATIC tools bundled as part of the ATIC architecture with their communicator).

Taking into account the above user classes, the tools of the architecture demonstrate such functionality that helps and enable their potential users in the following areas of interest:

- the administration of the architecture keeping libraries of services, components/modules, devices, manufacturers, etc.;
- perform any corresponding associations of the aforementioned entities;
- keep track of any function decomposition or module/service prerequisites;
- debugging information as far as the behavior of various components and modules (during the stages of software development);
- provide ultimately an easy way of finding and selecting the modules needed to assemble a particular communicator based on a set of needs and performing the assembly for the user.

In this fashion and at a high level of abstraction, the set of tools consists of -but is neither limited to nor constrained by- the following:

- A debugger of ATIC communicators at runtime (namely a means to monitor the existence and behavior of modules and their activity);
- A screen layout editor to be used with the runtime communicator (mainly it will enable to rearrange the spatial appearance of the visible interaction objects of certain modules of the communication aids).
- An inventory of various components/elements compliant to the ATIC architecture plus a flexible way of not only associating but also retrieving information on them, taking the form of an enhanced database;
- An installer of selected modules able to assemble and properly setup the software components needed to make the communicator a stable working product.

4. Impact on the market and manufacturing process

Up to now, the traditional way of developing communicators (de-picted roughly in Figure 2), had the AAC developers working separately. Each manufacturer had a group of designers and developers that would come up with a product concept (or concepts) based on appropriate market research and user need studies, and move forward into realizing their designs. Specialized hardware (I/O devices, cases and communicator machines) and software, all came from the same manufacturer, with little to none flexibility, let alone incompatibility with other manufacturer's products.

Within ATIC (Figure 3), while the initial concepts and ideas are still left to individual manufacturers to come up with, a larger degree of cooperation is encouraged aiming to more flexibility and reusability of designs and products. A higher degree of customization and chance of compatibility with other implementations in the field is also facilitated [16].

Developers implement components (modules and I/O devices) which the retailer assembles in fully functional communication aids according to the needs of specific clients. The disabled user stands a far better chance to acquire a product tailored to his/her needs. Note the a) increased degree in configuration (at the lexical level with the adaptability offered by the UI development, in the assembly process and at runtime with whatever configuration the developers have integrated to their modules), b) design with reusability in mind (feedback is present to/from developers, retailers and from end-users on the runtime behavior of components), and c) the large difference on the effort to alter a design; only components need to be modified, rebuilt or developed from scratch, and what's more, runtime components can be replaced making the call for a new design only a matter of realizing only modifications or missing parts.

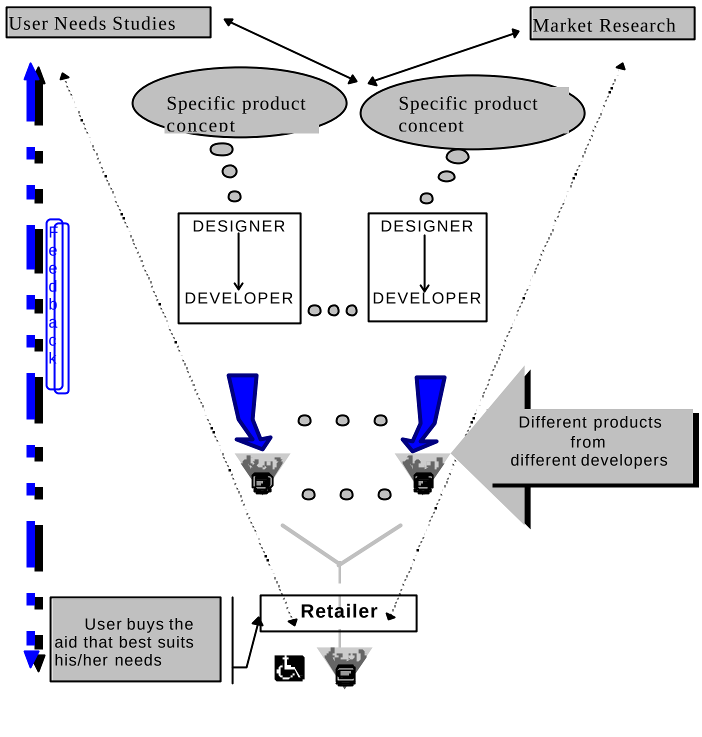

Figure 2 *The traditional development process of an interpersonal communication aid.*

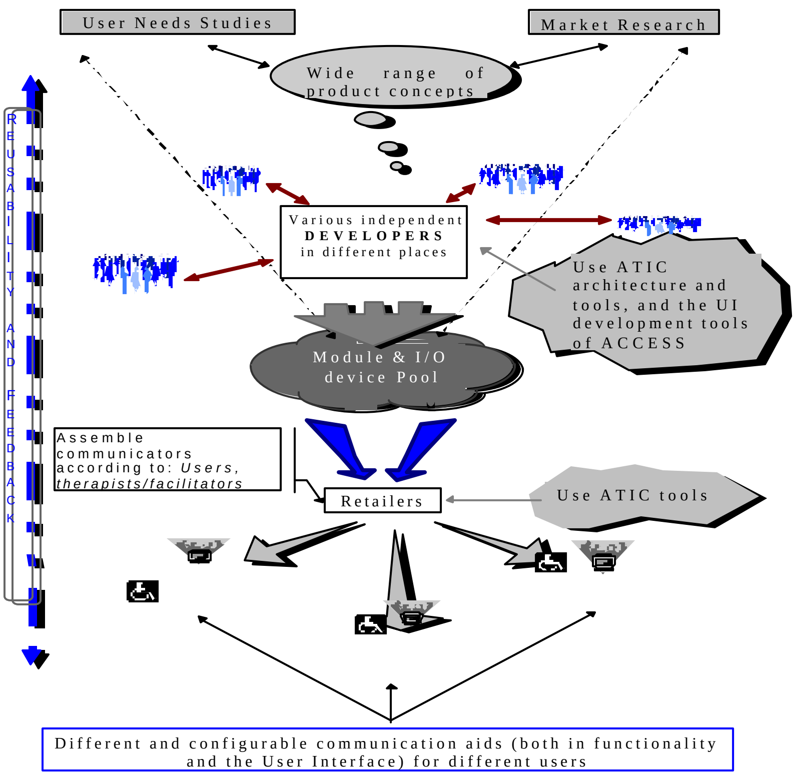

Figure 3 *The ATIC approach towards developing interpersonal communication aids.*

5. Administration policy on the use of a components architecture

In order to provide a more stable ground towards acceptance of the ATIC approach, effort has been put in having a development process that will be as well defined as possible. Mature disciplines are dependent upon well-understood technologies that have been standardized. One step closer to the aforementioned goal, is the provision of the ATIC tools to aid in a number of occasions. Another is to strive towards a standard procedure when it comes down to building modules (new ones especially). Hence, it was felt that the need to have a *centralized administration* of the overall process was imperative. The benefits from such an approach could be summarized in the following points:

- A more thorough monitoring is ensured since each new or modified component has to be first of all accepted and then officially reported to the community (i.e. anyone belonging to the aforementioned user classes);
- unnecessary or duplicate work is avoided or at least minimized;
- all the information on what is available in the community is officially recorded, updated, and disseminated to the parties concerned;
- few chances are left for accidental errors or deliberate -but unacceptable- policies since a formal way has to be followed for every new component to be released in the public and put in use;
- lead developers adopt a path that enables design with reusability of components in mind, encouraging fair competitive market behavior and cooperation;
- last but not least, a quality that will result from the coexistence of the *centralized administration* and the *ATIC architecture and tools*; to oblige developers to provide a more consistent, thorough and firm description of their "products", thus enabling: a) retailers, be aware of what they can have in stock and offer, and b) clients (disabled end-users) stand a better chance of actually acquiring what they really want and need.

Acknowledgments. The work reported in this paper was carried out within the framework of the ACCESS project, partially funded by the TELEMATICS for the Integration of Disabled and Elderly people (TIDE) Programme of the Commission of the European Union. Partners in this consortium were: CNR (Italy), FORTH (Greece), University of Athens (Greece), RNIB (U.K.), Seleco S.P.A. (Italy), MA Systems and Control (U.K.), Hereward College (U.K.), NAWH (Finland), VTT (Finland) and Pikomed (Finland).

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