# Human Machine Interface Technology and Interpersonal Communication Aids

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**Abstract**

Current commercially available communication aids suffer from the lack of a general technical solution facilitating the implementation of user-adapted and functionally flexible systems on the basis of general criteria and tools. This paper aims to address some of the problems characterising existing communication aids and User Interface development tools, and to present a general solution under a common technical framework and through the introduction of a new approach. It describes and analyses a *modular* architecture for the development of the functional core of a proposed novel interpersonal communicator and a *unified* approach for the development of user-adaptable interfaces.

## 1. Introduction

Although interpersonal communication constitutes a crucial problem for various categories of disabled people, the functionality and the usability of existing technical aids are limited, providing solutions only to specific communication problems

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for specific users or user groups. Current problems in the development of interpersonal communication aids are attributed to a number of reasons: the increased demand for more flexible and adaptable systems; the considerable efforts that are required in order to maintain and further develop existing systems; the continuous development of new products based on similar concepts and functionality; the dependency of such systems on a specific technological platform.

Current commercially available communication aids suffer from the lack of a general technical solution exploiting the new possibilities offered by recent developments in hardware and software technologies and which facilitate the implementation of user-adapted and functionally flexible systems on the basis of general criteria and tools. The design and development of the next generation of interpersonal communication aids needs to follow new approaches, if the above difficulties are to be overcome.
With the objective of spurring the reuse and sharing of technical resources at the design and development phase, and increasing the functional flexibility provided to the user, this paper presents and analyses the need for a *modular* architecture for the development of the functional core of a proposed novel interpersonal communicator and a *unified* approach for the development of user-adaptable interfaces.

The concept of a *unified* approach for the development of user-adaptable interfaces eliminates the drawbacks associated with the traditional approach of custom-adapted interactive applications, according to the requirements of a given target user group. It also supports the development of tools which aid the construction of user interfaces adaptable to the particular end user abilities, requirements and preferences, and which are independent of any specific technological platform. In this context, the interaction requirements of the various user groups are analyzed at different levels following a new methodology. Abstract interface constructs (appropriate for all user groups) are described; these are realised at the lexical level

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of interaction according to the specific characteristics of the target user group(s).

The architectural framework aims towards the provision of a development environment for the construction of flexible and modularly extensible communication aids. Specialised functional modules for different users are therefore provided, supporting the integration of various special purpose devices which meet the requirements and preferences of individual users and which enable the definition of the target user language as well as a variety of communication modes.

# 2. Overview of the current situation

## 2.1 Interpersonal Communication Aids

Communication aids are meant to provide speech or language impaired users with adequate means for interpersonal communication, performing those functions of the communication process which the user cannot perform on his/her own due to his/her disability: for example, a communication aid can provide a symbolic language to a user who has difficulties with natural language, or a speech output to a natural language speaker presenting speech problems, or both, etc. For the communication process to take place effectively, a communication aid should therefore:

- provide adequate expressive means, i.e. an adequate language with respect to the communicative and linguistic competence of each individual user, and an adequate vocabulary size;

- provide adequate communication functions (message composition, sending, etc) with respect to user requirements;
- provide an adequate access to the language and to the communication functions with respect to the motor, sensory and cognitive abilities of each individual user, i.e provide adequate input/output devices, communication modes

(visual, aural, tactile, etc) and communication functions.

User needs, abilities and preferences with respect to interpersonal communication may vary highly according to a number of factors such as type of disability, age, literacy, occupation, etc. An ideal communication aid from the user point of view should be user specific, i.e. it should meet his/her specific needs, use his/her abilities to the fullest and show only the features required by the specific individual. As a consequence of this state of affairs, a variety of different systems have been designed and produced up to now providing limited solutions to specific communication problems of specific user groups (for example, communication aids using BLISS or other symbolic languages, etc.). The development of communication aids has followed so far a fragmented and ad hoc approach to the crucial problem of interpersonal communication, which shows several disadvantages: existing systems often require adaptations in order to be effectively used by individual users; they are difficult to maintain and further develop; they do not allow communication between users of different systems; user interfaces may not be adequate to user needs, i.e. the system may not provide a user-friendly and usable user interface or/and interaction techniques suitable for the particular user (groups), etc. A more effective solution can be provided by designing flexible and adaptable systems to be configured according to user requirements. In Section 3.1 we argue that a modular design architecture is best suited for the creation of flexible and adaptable communication aids capable of providing user-specific solutions by means of general approach and criteria to the problem of interpersonal communication.

## 2.2 User Interface Technology

In the field of Human-Computer interaction, the appearance of graphical user interfaces has been accompanied with the emergence of tools for developing User Interfaces. Usually, these tools are

provided by a set of software modules which implement a number of specific interaction techniques (e.g. menus, dialogue boxes, etc). However, each different tool imposes certain restrictions on the so called "look-and-feel" of the created User Interfaces. Also, the techniques for constructing the User Interface differ significantly for different tools; usually, such tools require a certain amount of expertise and considerable programming experience in order to be efficiently utilised for the development of User Interfaces. Additionally, most of these tools are tightly coupled to specific technological platforms and environments (dedicated tools for a specific environment).

Despite the advances in the User Interface Software Technology, the vast majority of the current available computer-based applications are still inaccessible to many disabled users. The present situation shows that commercially available products are built with traditional methods and tools addressing only the needs of able users without paying attention to the requirements of the disabled and elderly people. This is due to the fact that on the one hand software firms involved in developing applications do not demonstrate particular interest in moving in that direction, while more importantly on the other hand, the present lack of the necessary technical knowledge increases the resources required for investment on building advanced development tools which would enable the accessibility of the produced User Interfaces by disabled users.

Existing solutions for the provision of accessibility to computer-based applications by disabled users provide ad hoc procedures for the construction of User Interfaces addressing specific problems of specific users or user groups. The special purpose peripherals that exist, are utilised by a relatively limited number of dedicated interactive applications providing partial access to disabled users. Moreover, the existing User Interface development tools do not support integration of special purpose devices and

consequently do not enable the description of interaction dialogues for disabled users.

# 3. A proposed approach for developing user-adaptable User Interface for Communication Aids

## 3.1 A modular architecture for developing Communication Aids

A flexible and user-adaptable communication aid should include a variety of functions and features to be configured to best match user requirements. In particular, the system should:

- allow the possibility of defining and using any user language (ranging from natural language to universal symbolic languages like BLISS to especially designed set of symbols) with unlimited vocabulary size;

- ensure adequate communication functions and access to user language by accepting a wide range of input/output devices and communication modes, and by allowing the local configuration of the communication functions and of the user interface to better match user requirements.

Communication aid flexibility and adaptability eliminate the need of adaptations and ad hoc solutions, allow easy modification of the system according to user requirement evolution and enable communication between users with different types of needs and disabilities. A suitable architectural framework for the design and implementation of flexible and adaptable systems has therefore to be found out in order to overcome the present difficulties and give rise to a new generation of communication aids.

The following two basic strategies can be followed for the development of communication aids:

(a) develop all-encompassing systems that can be configured to meet individual needs;

(b) develop a modular architecture supporting a variety of specialised compatible modules.

Both approaches can potentially support the system flexibility and adaptability necessary for meeting the requirements of individual users. The first approach has the advantage of allowing the designer to maintain control over all aspects of the system thus ensuring quality control. It also enables the designer to develop a consistent approach to customization. On the other hand, however, such an approach would tend to produce large, complex and expensive systems, probably difficult to configure given the extended range of customisation features. Furthermore, the user would have to buy the whole package including the functions not required for his specific needs.

On the contrary, the modular architecture approach is best suited for the design of flexible and adaptable communication aids for a number of reasons. The user could potentially buy only the functions required for his specific needs. This would reduce costs by allowing the implementation of smaller hardware and software modules easier and faster to develop. Furthermore, customisation would be simplified since a more restricted range of functions would need to be taken into account, and the use of the system would be made less confusing by the reduced number of features. Also, design modularity would facilitate the maintenance and further development of individual modules as well as their reusability and sharing.

An adequate modular architecture for the design of communication aids will have to ensure the compatibility and consistency of different modules: the architecture should be such to allow the easy integration of new modules or features to the system. A user-friendly software tool will have to be provided to the communication aid designer in order to allow easy selection of modules. Also, modules will have to be classified into general categories according to their functions and goals, and each module will have to be designed in such a way to ensure the optimal balance between flexible

and fixed features in order to ensure maximum adaptability. However, given the complex and high specialised nature of some modules, it may still be difficult to design a "plug and go" system, and a minimum amount of overall integration could still be necessary. Furthermore, the modular architecture will have to address the problem of user characteristics changing over time.

## 3.2 Unified development of User Interface

The problem of accessibility to computer-based applications by people with disabilities is mainly attributed to issues related to enabling access to their User Interfaces. The inadequacies of existing user interface development tools for supporting the construction of User Interfaces for disabled users can be treated as a two-fold problem:

- on one hand is the fact that the interaction techniques they provide are not designed to address the interaction needs of disabled users, and

- on the other hand the underlying utilised technological platforms are not appropriate for supporting the development of user interfaces accessible by disabled users.

Hence, there is a need to address efficiently the above issues through an appropriate technological solution. The *unified* development of User Interfaces promotes the development of a new kind of User Interfaces adaptable to the particular needs, abilities and preferences of the different user groups. Only one User Interface needs to be built, which can be adapted to the particular target user group; the produced User Interfaces for the various user groups, may have many similarities regarding the way the user-computer dialogue is structured, but are always adapted to their particular needs, abilities and preferences (i.e. the same sequence of interaction tasks could be performed by different users, but utilising different special purpose devices according to their abilities). Following such an approach, the requirement for developing

user interfaces that are both "consistent" and allow the "integration" of the various user categories is achieved.

In this context, an appropriate development platform need to be specified and constructed, which is able to address all the issues stated above, and will allow the development of User Interfaces for disabled people. This can be achieved by

- designing appropriate "high-level" description methods that are capable of describing User Interfaces for the various user-groups, and by

- developing User Interface development tools which do not depend on any specific technological platform.

A prerequisite for constructing user-adaptable interfaces is the availability of a body of knowledge which declares the particular characteristics, abilities and preferences of a given user (or user group) with respect to a particular application. This knowledge needs to be formally described and effectively used for the configuration of the User Interface at the lexical level. Since the proper selection of input/output devices and interaction techniques is one of the most critical issues for the development of User Interfaces for disabled people, the availability of different knowledge sources, at the design phase of the User Interface, is considered necessary in order to address potentially conflicting requirements for the dialogue construction. For example, at the design phase, it is important to specify the devices that should be used by the user for identifying objects in the interface (e.g. a pointing device, a spoken description, etc).

In order to enable the specification of platform independent interaction, it is necessary to define and describe "unified interface constructs"; such constructs can be treated as generalisations of the "physical constructs" (e.g menus, buttons, etc) that are provided by conventional tools, and can be realised, at the development phase, at a specific

technological platform. The physical realisation of the "unified interface constructs" to specific interaction objects of the target technological platform is performed on the basis of the knowledge that has been described, analysed and stored for the different user groups. The provision of "high-level" description techniques for the design of User Interfaces, on the one hand enables the integration of the various user groups while on the other eliminates the drawbacks associated with the existing user interface development tools. Such an approach offers the possibility to interface developers to build interaction dialogues for different users in a more abstract and easy way, which can be mapped to any technological platform through the automatic translation of the "unified interface constructs" to physical implementations.

A fundamental concept of the proposed approach is that an interactive application can be conceptually split into two different layers: the user interface layer, which concerns the module of the system that deal with user-computer interaction, and the functional core which concerns the application internal functionality. As a result, user interfaces can be easily customised without requiring modification of the application functional core.

In this respect, user-adaptable user interfaces can be developed for communication aids. Based on the interaction needs, abilities and preferences of particular user groups and/or individual users, configuration of the user interfaces for the communication aids can be performed through the selection of appropriate interaction techniques and input/output devices (for the lexical level interaction).

## 4. Conclusions

A new approach to the development of flexible and user-adaptable communication aids has been presented with respect to both the system functional core and the User Interface. At the functional core level a modular design architecture allows the creation of

communication aids easy to implement and configure as for communication functions and user languages, while User Interfaces can be created through a unified approach which ensures the selection of the more appropriate input/output devices and interaction techniques for each individual user.

Furthermore, the proposed approach exploits the new possibilities offered by the recent developments in software and hardware technologies, and in particular in the field of User Interface Software Technology and allows the reusability and sharing of technical resources through the provision of generic interface constructs and flexible software modules.

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