Task analysis

What does this technique do?

Task analysis can be defined as the study of what a user is required to do, in terms of actions and/or cognitive processes, to achieve a task objective. The idea is that task analysis provides some structure for the description of tasks or activities, which then makes it easier to describe how activities fit together, and to explore what the implications of this may be for the design of products. This can be particularly useful when considering the design of interfaces to products, and how users interact with them. The following is a very simple introduction to some of the concepts of task analysis, and is illustrated by a design example. For a more detailed introduction to the use of task analysis a good source of information is Kirwan and Ainsworth (1992)

▶ **See Further Sources of Information**

Task analysis can be applied to studying how users use existing products, and such an analysis will assist in the process of understanding the difficulties they face in using existing products, and improvements that might be needed. Task analysis techniques can also be used in a predictive fashion to represent how users may operate products that are being developed. Such representations can act as a vehicle for communication between developers and others involved in the development process e.g. end users or their representatives. Task analysis techniques can also assist in the development of training manuals for products, as the structure that is implicit within the design of an interface is more easily revealed when represented in such a way. Task analysis techniques can also be used in the development of evaluation plans, as an understanding of what activities are the most important to the user or have critical consequences

for their safety, helps place priorities on any evaluation studies planned. Information on how often different activities need to be performed is also information which is particularly useful to have for these purposes.

An important point to be made is that in order to be maximally effective such an analysis should be extended to encompass the whole of the user's interactions with a product. In addition to everyday tasks more infrequent tasks such as maintenance and cleaning, as well as known types of misuse, should be included in the analysis.

All forms of task analysis are concerned with the description and representation of tasks or activities, and provide organisation and structure to that description. This can be useful when describing an existing set of activities performed by a person, but also is of value when trying to design a new product. Thinking through the sequences of activities that a person would need to go through to use a product can assist in identifying whether these are organised logically or not, and can assist in designing and redesigning the operations needed to use a product.

Two processes are usually followed when a task analysis is conducted. The first of these is some understanding of sequence or dependency between different activities. Thus it is important to understand a particular activity in the wider context. For example a person using a communication aid may want to communicate hunger, but first needs to draw the attention of the person with whom they want to communicate. After they have communicated hunger there is a need for them to be fed.

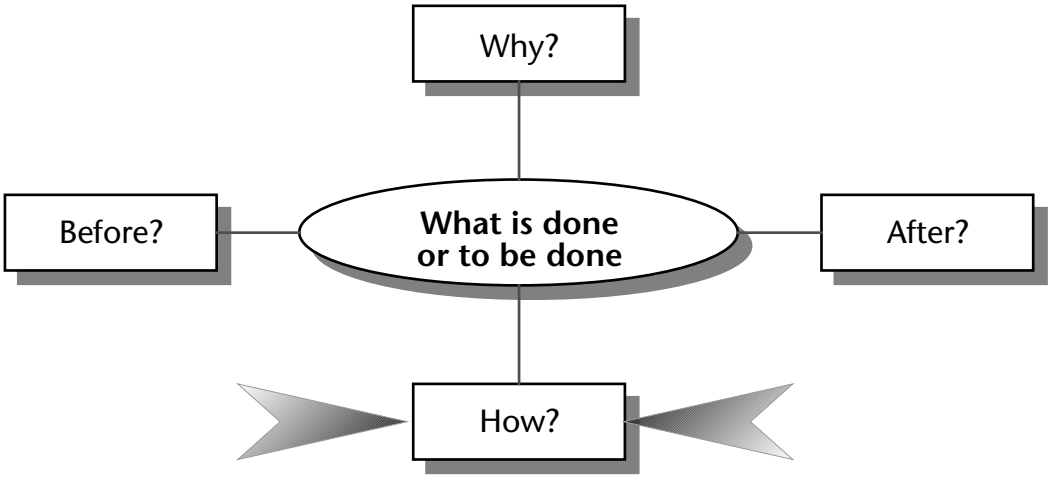

Fig 1 Overview of the technique.

The second process is one of representing how activities or tasks fit together. This is a process of representing how large tasks can be decomposed into smaller components, and the logical relationship between these. A common technique used is called hierarchical decomposition,

which means breaking larger activities into smaller activities until a sufficient level of detail is reached. A good way of achieving such decomposition is to repeatedly ask the question "how" to break activities into smaller units. For example in a communication aid where an identified activity is to draw the attention of the teacher, this might be further decomposed into the child having to press a specific button on the communication aid, repeating the key press in the event of no response by the teacher etc. One well known approach which breaks tasks or activities down into smaller units is the Hierarchical Task Analysis (HTA) technique developed by Shepherd (1989) .

In addition to decomposition it is also common when using task analysis to explore how activities fit into a wider context. It can be useful to repeatedly ask the question "WHY" in order to assist in this process, with activities becoming increasingly more abstract. For example in a communication aid where an identified activity is to draw the attention of the teacher, the question "why" would lead to the answer "to communicate", which is sufficiently abstract not to need further elaboration.

To recap what we have discussed so far: The analysis can start with a description of any particular activity, and begins with a rough description of what the user is doing or is going to do. Thereafter the questions direct the analyst towards a clear description of the task. The "HOW" question directs the analyst towards breaking a particular activity into smaller elements or sub tasks. In this way the tasks can be broken down to the level of detail felt to be needed for the purpose of the analysis. The "WHY" question conversely forces the analyst to think of the wider context in which the activity is taking place in, and can assist in identifying any higher level activities which need to be considered. The analyst is also led to thinking about activities within their context, by identifying what activities take place before the particular activity being looked at, and what activities take place afterwards.

It should also be noted, that even if not used in any formal way the principles of task analysis can be of considerable value in focusing attention on relevant things to consider when designing products for a person. The approach can help a developer think about the wider issues of a products use, and it is often valuable to take time to consider how a product will be used, and how it is likely to fit into the wider environment that the person operates in. Even just taking time to consider what a product will be used for can provide insights as to possible requirements that users may have.

The reader should be aware that task analysis can be a very time consuming activity if used with a high degree of detail on complex problems. It is very difficult to provide specific guidance on the use of such tech-niques, as they can be used in a variety of ways and for

different purposes. In addition it is possible to get caught in what is loosely termed 'analysis paralysis', where more and more detail is investigated.

There is no real substitute for practical experience in using such techniques, and the level of detail to go into in such an analysis is largely a matter of judgement. Our advice would be to experiment with using the approach before trying it on a full scale problem, and also initially be more concerned with using the technique to get an overview of the activities involved rather than getting bogged down with too much detail at first. One simple way to do this is to concentrate the analysis initially on the high level structure of the activities or semantics, rather than the fine details of what the user actually does at a microscopic level. Activities can be broken into smaller and smaller components, but for many purposes a relatively high level description is often sufficient, and a good starting point is to describe activities which have some level of meaning as independent units. For example, using a communication aid to express a need for food can be considered a higher level activity than the sets of activities making up that action. e.g. identifying the correct button to press, moving the arm, pressing the key with a finger, waiting for feedback from the communication unit etc.

When to use it

The technique should be used during the analysis phase of design to ensure proper description of user activities. It can be used to analyse interactions with an existing system or as a means to structure discussions about a hypothetical product. Task analysis data can be used as input to the detailed design of interfaces to products, and can also be used in planning evaluation studies. In later stages of the development the current solution can be checked against the original task or activity analysis to see how the design deviates from the intended solution, and what consequences this leads to.

Who can use it

Using simple task analysis techniques is relatively easy. The more structured or formal use of task analysis techniques take some time and effort to master however, as the analyst has to get used to using the particular notation adopted and also has to learn how to cope with any situations where it is unclear how to use the notation. For this reason it is recommended that developers experiment with using the technique before using it in earnest. In many cases the involvement of experts in task analysis can also be useful, as such skills do take time to learn.

Who are the informants

Helpers, users, experienced designers, domain experts can be valuable informants for task analysis. It is often advisable to use more than one informant to ensure that the task analysis represent the activities covered by the whole user population. If the purpose of the analysis is to adapt a product to a particular user, there is no need for additional information from other users, but in such cases it might be useful to obtain additional information about activities from helpers and other relevant parties who know the user.

Procedure

Task analysis commonly follows the procedure given below when it is being used to assist in problem definition. The first part of the analysis is to understand the activities to be represented. This is followed by the representation of the activities in some way, and a process of verification with users that this represents the actual state of affairs. This is then fed into the design process.

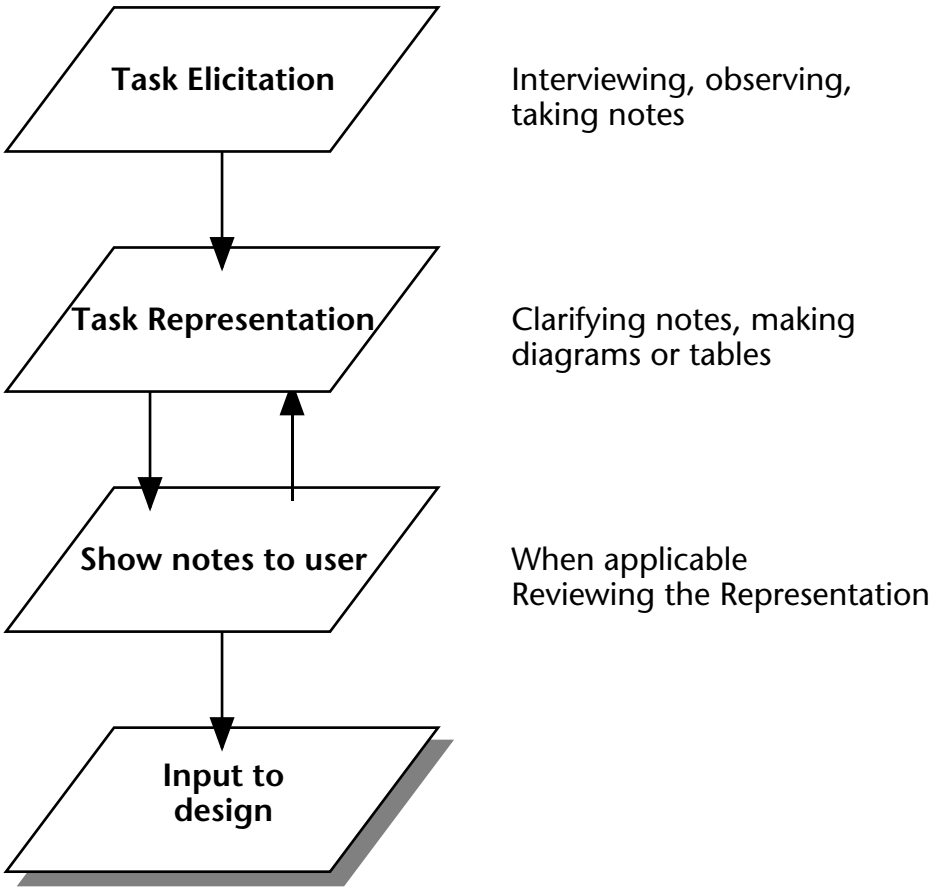

Fig 2 Overview of the procedure

First, information needs to be collected. This is done through interviews, or observation of users in their natural environment. Thereafter the information needs organising and structuring in some way. To ensure that this is accurate it is advised to check this with informants and make changes according to their comments. Sometimes several iterations are needed in order for an analyst to understand complex activities.

Preparations

Not much equipment is needed to perform a task analysis apart from writing materials and a large amount of paper. Many analysts also use tape recorders to record interviews, as otherwise it is difficult for a single person to both interview and make adequate notes at the same time. An alternative is for two analysts to be present, with one taking notes and the other asking questions. Where tape recording is used it is important to ensure that permission is obtained in advance. Another slightly more sophisticated method of data capture is to take video recordings of users' activities and to then analyse these in detail later. This however is particularly time consuming, and is normally only considered for the analysis of products with a largely physical component e.g. physical aids such as wheelchairs or walking aids.

One aspect of preparation which can be time consuming, however, is in organising the investigation, identifying and arranging to meet appropriate users. It is important to carefully consider who is appropriate to consult, and where possible that they represent any variation in the user group. If resources are limited it is a good advice to select parties who will represent the extremes in terms of user variation. Where possible it is a good idea to gather information in the user's own environment, as they will be more relaxed than in an unfamiliar setting, and in addition will be able to demonstrate how activities are performed in the wider context of their home or work environment.

Task Elicitation and Representation

Information can be gathered using interview techniques (see Interviews). Where possible structured interviews should be used, and should focus on the activities considered of central relevance to the development. With this approach the interview is performed as a series of questions. The starting point for this is to ask the person to describe how they perform the particular activities that are of interest to the analyst, and to explain how they are performed. A fairly high level activity can be used as a starting point e.g. communication, and this can then be broken down into smaller components or scenarios e.g. asking for assistance, communicating with a friend etc. Asking the question "why" assists in identifying

the appropriate levels of analysis, as the answers to the question why soon become abstract and no longer cover activities.

Activities can be broken down into smaller and smaller components (hierarchical decomposition) by asking the question "how" at each stage. However it is important not to get too bogged down with detail. It can be very easy to get caught up with increasingly detailed levels of analysis, and skill is needed in knowing when sufficient analysis has taken place. A good rule of thumb for the beginner is not to go down to a level of analysis where the activity elements cease to have any meaning as independent activities.

A series of "what happens before" and "what happens after" questions can be asked at each stage of the analysis in order to ensure that any task dependencies are understood. Task representations can then be constructed based on any interview notes or observation. It is recommended to establish a graphical representation of the activities as it can be much easier to get feedback from users when communication is facilitated in this way.

The choice of representation technique is very much up to individual choice, and Kirwan and Ainsworth (1992) provide a number of examples. In addition the choice of "building blocks" is determined to some extent by the purpose of the analysis. However most task analysis techniques have at least two elements, namely activities (represented in boxes or circles) and relationships between activities (often represented as arrows or connecting links). In addition it is common to read such diagrams from left to right if a time sequence is being represented, and where decomposition is being shown the higher order activities are shown above the lower ones. This is illustrated in the worked example, which shows the use of a very simple representation technique. The use of task analysis diagrams will make it possible to represent the range of activities that can be carried out with the device and show how they interact with each other. Organising the activities into simple flow charts can be particularly useful, to show how activities relate to each other. It is wise to experiment with different ways of representing activities to find the technique you are personally comfortable with.

Flow charts, hierarchical decomposition and state transition diagrams are all techniques which have been successfully applied in representing actions and the interested reader should consult Kirwan and Ainsworth (1992) for more details.

However, the novice should not be afraid of experimenting with different notations as it is common for individual analysts to make up their own, often taking the features they like best from the way that other people have carried out similar activities. The important thing to

remember is that the notation should help the analyst understand the problem better, and should act as a suitable vehicle for communication.

Show notes to user

To ensure that the representation is correct it is advisable to go through the preliminary descriptions with the users. If misunderstandings or errors are identified they can then be corrected before the final task analysis is represented.

Usage of Results

The task analysis diagrams can be used directly in discussions about the system being considered. Changes in system design or new functions might influence the users' activities. It is recommended that the consequences of such changes are identified and represented as new tasks in the task analysis diagrams. In this way a clear and easily communicated representation of the intended design is established.

The task analysis can contain information about task dependencies, frequencies, the context of the task and might expose aspects of the task that need consideration. Some examples of the outcome of a task analysis might be:

- The task representation describes how activities fit together in terms of dependencies. These dependencies might have direct implications for the design of the new system. In our example the user needs to get the teacher's attention in order to communicate a need to go to the toilet. Discussions with carers concluded that users were often embarrassed by this which meant that there needs to be some means of doing this in private. One solution would be to have an alert function which only the teacher would hear or see when it was pressed by the user.

- Consideration about frequency of the activities might help in deciding on the importance of design support for them. In some cases solutions other than a technical device might be considered. For example, if it is decided to use a device to support the user, but its functions are likely to be used very infrequently, then it needs to be extremely easy to use.

- The context of the tasks might have important implications. For example, if a communication device is used outdoors it needs to be water proof and may also need an adjustable volume control.

Within USERfit, task analysis is of particular value in providing information for the Activity Analysis (AA) aspects of the USERfit methodology. The USERfit analysis requires high level activities or usage scenarios to be identified, and these are then broken down into the smaller activity components that need to be supported. Task analysis assists in the process of understanding these activities and the implications this may have for design. Such analysis can also feed into the Environmental Context (EC), Product Environment(PE) and Product Analysis (PA) tools, where an existing product is being described. In addition such analysis is also of value for Usability Evaluation (UE) planning, assisting in determining priorities for subsequent evaluation.

The following demonstrates in more detail the use of a simple task analysis technique in the case of a communication device for a child suffering from cerebral palsy, and examines how this can feed into the USERfit methodology. A very simple notation is used which represents activities within circles and relationships between activities as connecting arrows. In this case task analysis techniques were used to represent how a new product was expected to work in school, and this was used as a basis for discussion with a sample of children, their carers and teachers.

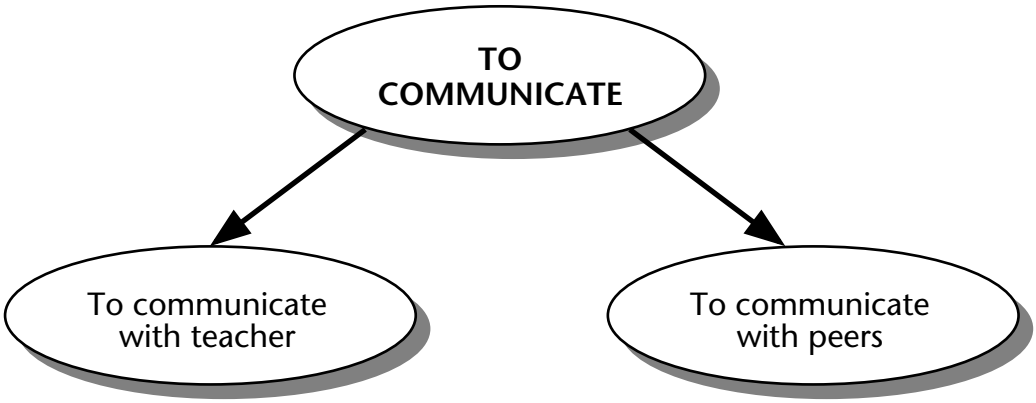

Fig 3 Overview of communication tasks

Figure 3 shows the high level activities to be supported by the communication aid. There is a high level activity to communicate, and in school this can be broken down into two main areas, namely communication with a teacher, and communication with peers.

For the purposes of illustration "Communicate with teacher" can be further broken down to show the range of communication activities involved with that person. The decomposition of this activity revealed

that a very simple aid was planned which would allow communication regarding basic needs i.e. hunger, thirst and pain, and would also allow simple questions to be answered, as well as communicating greetings and good-byes (figure 4).

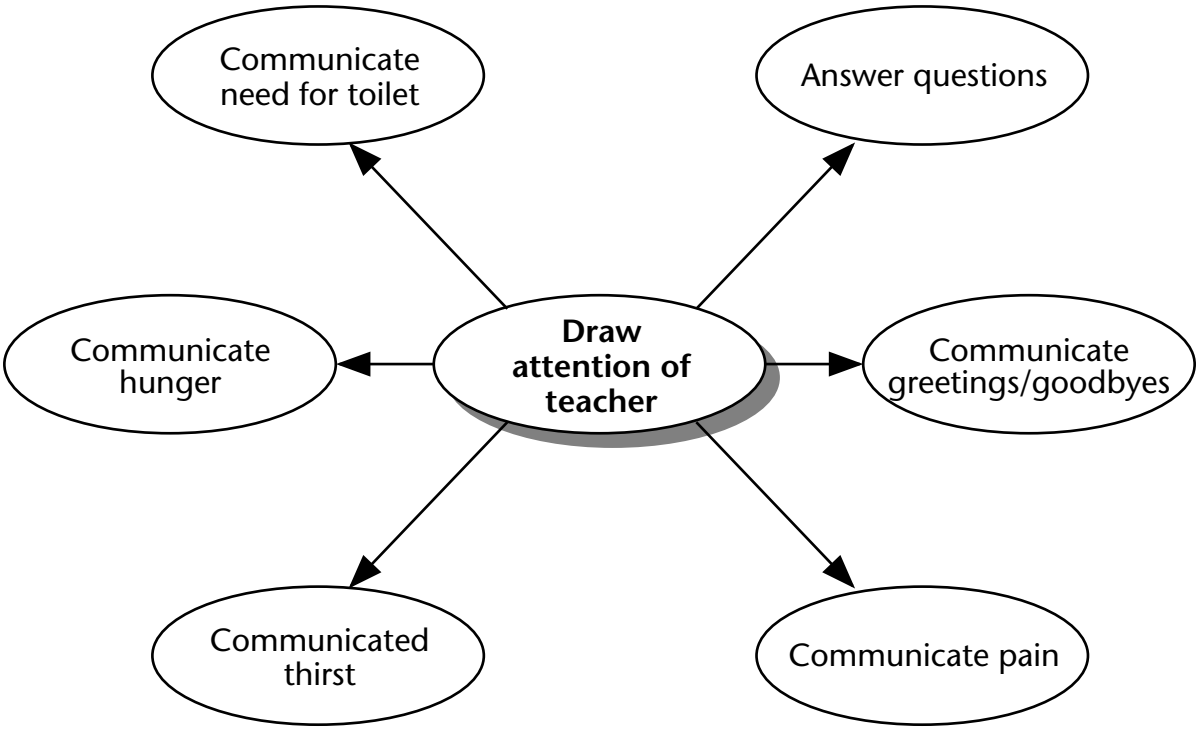

Fig 4 Range of communication activities with teacher

The first sub activity identified was for the user of the aid to be able to draw attention of the teacher that they wanted to communicate with them. These high level activities also identify the usage scenarios for subsequent inclusion in the USERfit Activity Analysis . A usage scenario can be described as a high level activity or set of activities which fit together to form an identifiable function of a system. Thus in this example there are specific scenarios regarding communicating the need for the toilet, for food , making greetings etc. However it can be useful to group some of these scenarios together if they have identical attributes, as this will make subsequent use of the analysis simpler. Thus communicating hunger, thirst and pain could be seen as having similar attributes and could therefore be described as one global activity.

For the purposes of illustration Draw Attention of Teacher and Communicate Need for Toilet are also decomposed further. As the activities also involved the use of technology i.e. the communication aid, the analyst decided to make the distinction between activities carried out by people and machines clear. In these simple diagrams the activities

performed by people were placed in circles, whilst those performed by the technology were put in boxes. The arrows are used to show how activities are linked together and the logical sequence of activities.

In some cases it may also be necessary to label the arrows and to list the conditions which lead from one activity to another. This is particularly important if one action has a number of different consequences (an OR function) , or one action leads to a number of simultaneous consequences which are logically different from each other (an AND function).

Figure 5 shows that to draw the attention of the teacher the child has to press a dedicated button on the unit. This causes a light on the unit to switch on, and a separate alarm on the teacher's desk to be raised. This can lead to two different consequences. The first is that the teacher acknowledges the alarm by pressing a confirmation key on the console mounted on her desk. The second is that if no key is pressed on the console within twenty seconds then a siren in the child's unit sounds.

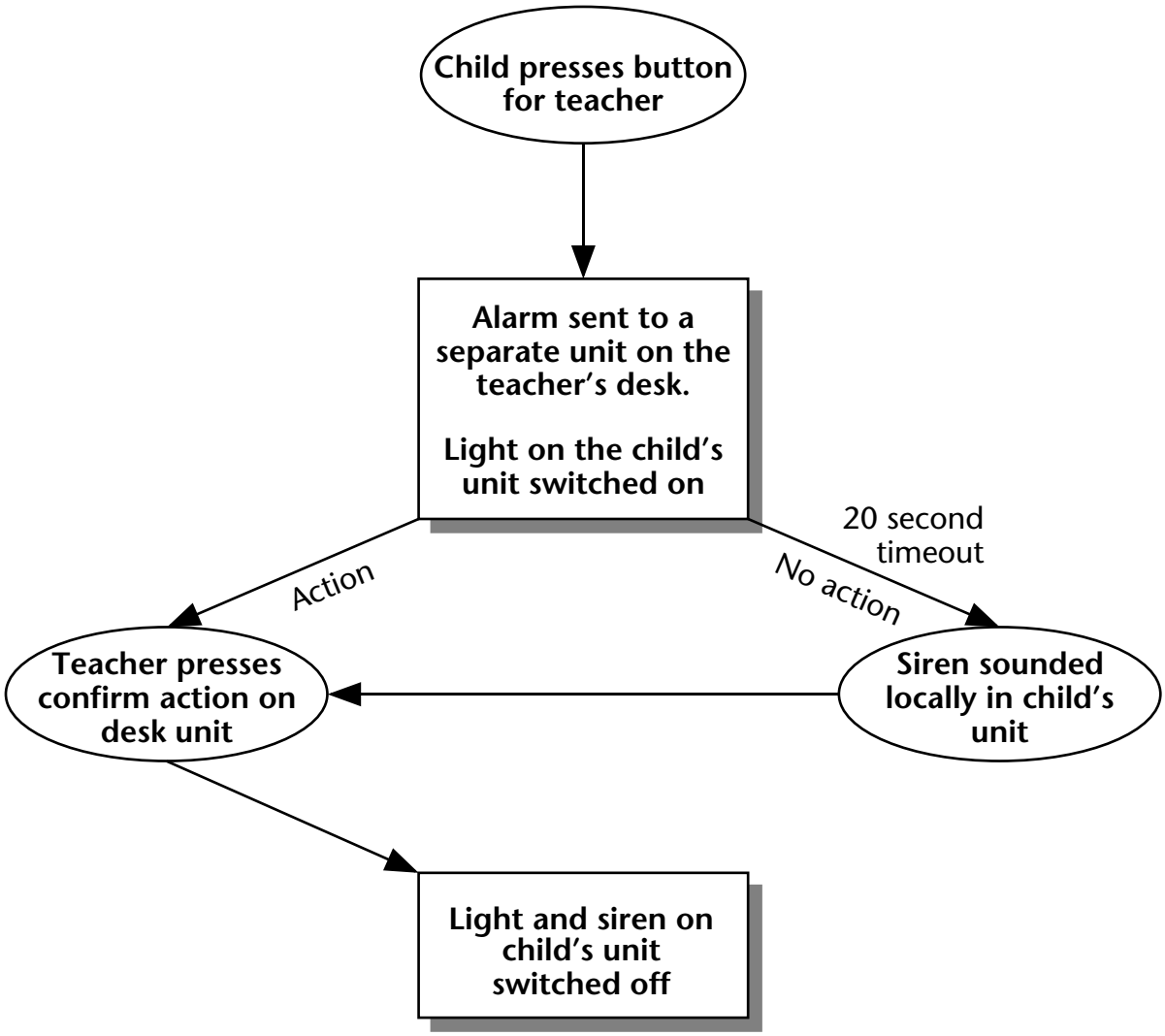

Fig 5. Getting the teacher's attention

In either case the teacher has to confirm receipt of the message which also switches off the light on the child's communication unit and switches the local siren off.

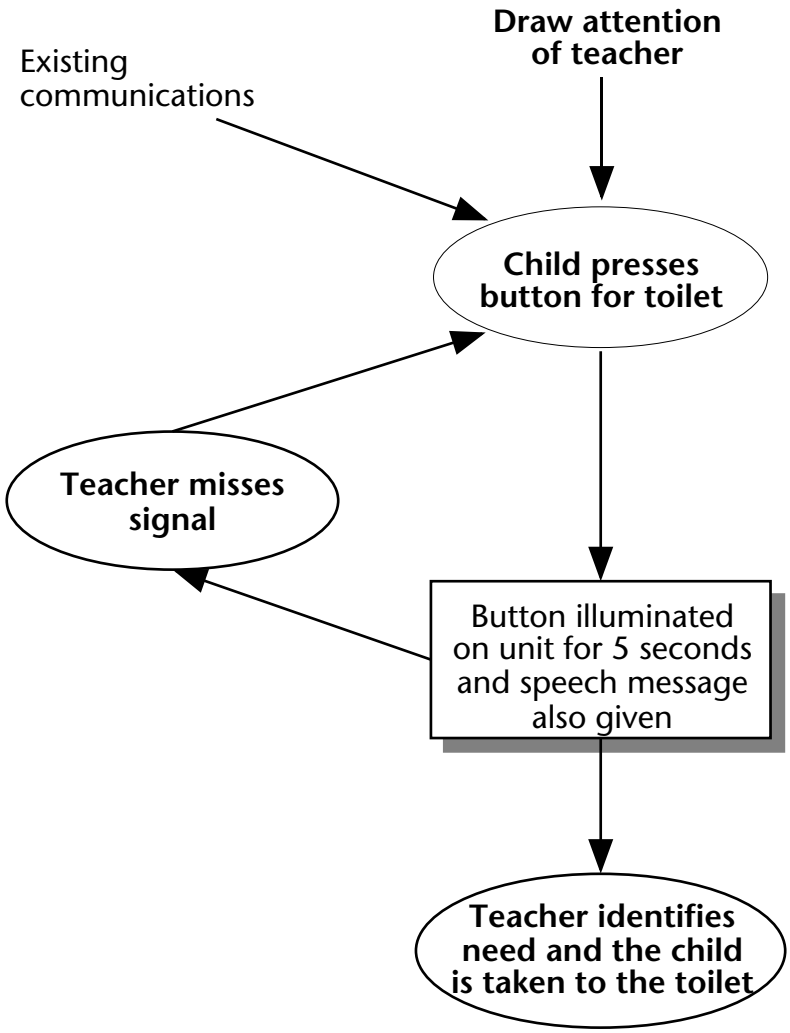

Fig 6. Communicating the need for the toilet

Figure 6 shows the breakdown of the activity "Communicate need for toilet". This activity can be entered from having first gained the attention of the teacher or as a result of an existing communication having been established e.g. a greeting or other request. In each case once the attention of the teacher has been obtained, the child can communicate their needs. The diagram illustrates that the child presses the toilet icon on the unit, which causes the unit to light up for 5 seconds and a speech message given. Normally the teacher will see this and then take the child to the toilet, but in the event of it being missed the communication cycle has to be repeated. In this particular example the children consulted found the proposed design unacceptable, as the

system made it very clear to everyone who might be present that the child wanted to go to the toilet. The consensus reached was that this part of the interface should be redesigned.

Sources of Further Information

Wilson, Welbank and Ussher, (1990) utilised a task analysis in parallel to other requirements capture techniques, aiming to examine current service provision, current videotelephony usage and the usage of other communications devices by people with special needs. The result of this analysis was a description of service tasks at the level of procedural sub tasks that was then included in the requirements definition document. These sub tasks were organised into several levels: overall tasks (such as activating the system), function lists, (adjusting brightness, adjusting camera angle), and a qualifying statement that describes the reason for the task and the functions. Overall, the analysis was used as a tool to assist the designers in understanding the requirements of the end users.

Task analysis can also be used diagnostically to determine aetiology of system failures by tracing these failures to specific actions that cannot be performed, for example due to a physical inability to perform a specific action, or excessive workload leading to errors. Andrich (1993) for example describes the use of task analyses being used as part of a functional assessment of a person's disability. Andrich describes the approach used by SIVA in Italy, in terms of their consultation procedures, whereby SIVA provides an assessment service for disabled people, discussing their problems and providing them with aids to try out. A functional assessment of disability is used along with detailed task analysis relating to the clients' objectives, e.g., independence in the bathroom. Thus, when the user finds a given task impractical to perform, the task analysis would describe their problem in precise terms.

Brief mention should also be made of some of the additional task analysis techniques that have been developed for studying human computer interaction as these are often very complex, and are not recommended for developers who are not prepared to expend a considerable amount of effort in both the training and use of such techniques. In addition their practical value is often unproved, particularly when applied to new areas such as assistive technology. However for completeness examples include: Command Language Grammar (Moran 1978), Task Action Grammar (Payne 1985), and Task Analysis for Knowledge Descriptions (Johnson et al 1985). Such techniques can be very difficult to understand, and their practical value is largely unproved.

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