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Abstract:
This report describes the analysis and results of cost-benefit data collected during the course of the project. The method was based on MAUT (Multi-Attribute Utility Technique) and assesses the (potential) utility of different communication media for end-users. The results can be used as a basis for recommending which telecommunication media are best suited for particular end-users and communication activities. Significant strengths of the method are: it quantifies not only how suitable or usable a service is for carrying out a particular communication activity, but also how important that activity is to the end-users; it is relatively simple to apply and the data collection method may be pragmatically chosen. This makes it a potentially powerful instrument for telecom manufacturers, network operators and content providers who aim to maximise the utility of (future) services and products for their end-users.

Keyword list:
Real-time text, telephony, audio conferencing, avatar-phone, videoconferencing, multimedia conferencing, face-to-face, quality of service (QoS), Human Factors, cost-benefit analysis, Multi-Attribute Utility Technique (MAUT)

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Executive Summary

This report is a deliverable of the Eye-2-Eye project that ran from April 2000 to March 2003. The main objective of Eye-2-Eye is to produce, disseminate and exploit fitness-for-purpose guidelines, a cost-benefit analysis tool and a fitness-for-purpose evaluation toolkit for real-time person-person communication services. The primary target audience organisations for these three exploitable results are network operators, service providers, content providers, equipment manufacturers and standards bodies.

The report describes the analysis and results of cost-benefit data collected during the course of the project. The method was based on MAUT (Multi-Attribute Utility Technique) and assesses the (potential) utility of different communication media for end-users. The results can be used as a basis for recommending which telecommunication media are best suited for particular end-users and communication activities. Significant strengths of the method are:

- it quantifies not only how suitable or usable a service is for carrying out a particular communication activity, but also how important that activity is to the end-users
- it is relatively simple to apply and the data collection method may be pragmatically chosen.

This makes it a potentially powerful instrument for telecom manufacturers, network operators and content providers who aim to maximise the utility of (future) services and products for their end-users.

Utility scores are presented for data collected for four laboratory tasks (joint problem solving, negotiation involving trust, simple negotiation, bluffing game) and field studies of business communication, use of videotelephony in delivering a support service at home and the selection of communication media for disabled people.

The requirements and specification of a software tool intended for use by target audience organisations are presented. The main purposes of this cost-benefit analysis tool are to assist users to understand the calculations and enable the input of new data. The tool shall be implemented as a publicly available Microsoft ® Excel file (Deliverable D5.3).

1 Introduction

1.1 Scope of the Eye-2-Eye project

Current and emerging real-time person-person communication technologies provide complex choices regarding the most appropriate media that are suitable for different communication situations. Telecommunication services include real-time text, audio telephony, avatar-phones and videoconferencing.

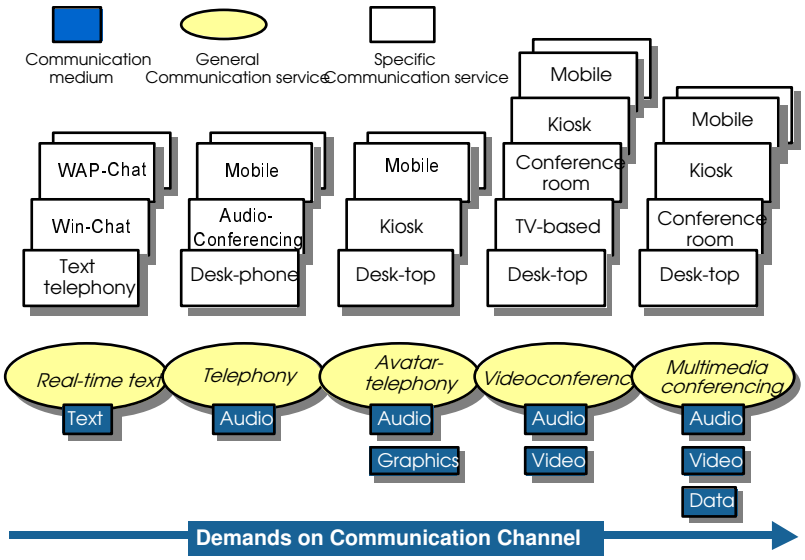


Figure 1. Primary real-time person-person telecommunication services and media

The communications industry needs to know which technologies have different uses & cost-benefits, the set-up requirements for different users & tasks and how rational business & service decisions can be made. Fitness-for-Purpose testing is required to assess requirements for Quality of Service of terminals and networks and effects on human communication efficiency and user satisfaction.

As illustrated in Figure 2, the Eye-2-Eye project provides fitness-for-purpose information based on empirical testing. Moreover, Eye-2-Eye translates its results into formats accessible to the telecommunication industry. To achieve this the primary objective of the project is to produce, disseminate and exploit:

- fitness-for-purpose guidelines
- a cost-benefit analysis (CBA) method and tool
- a fitness-for-purpose evaluation methodology.

Within this framework, the objectives of the cost-benefit work within Eye-2-Eye are to develop, disseminate and exploit:

1. A cost-benefit analysis method that focuses on the costs and benefits of various communication services from the point of view of end-users of these telecommunication services
2. A software tool to store and access information about these costs and benefits to end-users.

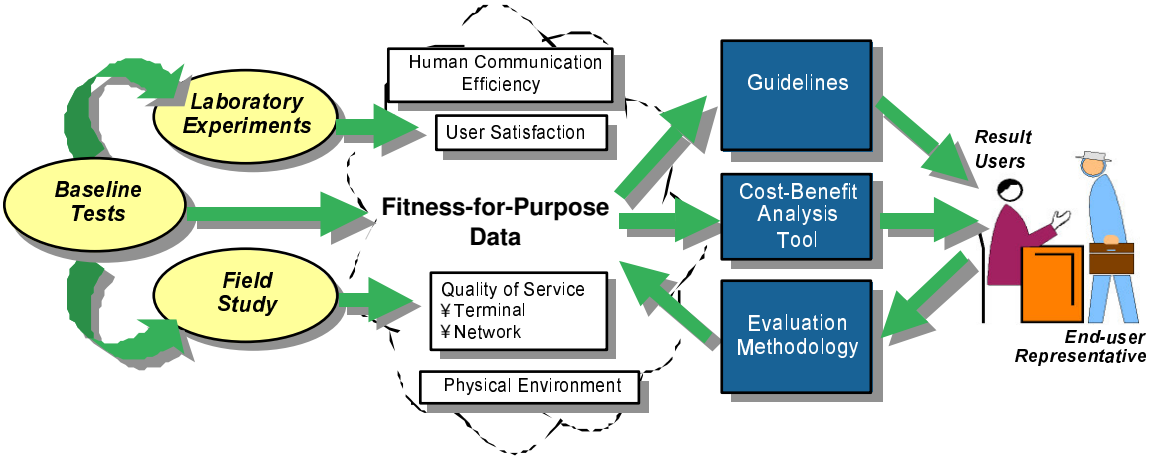


Figure 2. Translation of empirical results from three phases of tests to the Eye-2-Eye Guidelines and Tools

1.2 Terminology

A glossary of Eye-2-Eye terms and concepts is included in chapter 10.

In particular, the project focused on the concepts of "communication media" and "communication services" according to the following Eye-2-Eye definitions:

Communication media: Types of information with which humans communicate. Examples are text, audio and moving image (graphics and video). This is consistent with the "Nature of information" component of the ETSI definition of a *representation medium,* which has various possible coded forms (ETSI ETR 160, 1995). The terms **"medium/media"** is used as an abbreviation of 'communication medium/media' and also to include physical face-to-face communication.

Communication services: Services that are provided via a telecommunication network. Examples are audio-telephony, email, videoconferencing, avatar-telephony, audio-conferencing.

Most communication services are qualitatively different from the other on the basis of the communication media employed. This is summarised in Table I.

Table I. Mapping of communication media and real-time communication services

Communication media	Communication service
Text	Real-time text
Audio	Audio-telephony and Audio-conferencing
Audio + Graphics (Virtual Reality)	Avatar-telephony
Audio + Video	Videoconferencing
Audio + Video + Data	Multimedia conferencing

The term **"medium/media"** is used as an abbreviation of 'communication medium/media' and also to include physical face-to-face communication.

The term "**conference**" is used as follows:

- From a technical orientation it was always a point-to-point connection (i.e., there was no multipoint connection)
- From a service orientation it was always person (or group)-to-person (or group) communication.

1.3 Scope of the cost-benefit analysis work

This report is the second Eye-2-Eye deliverable on the cost-benefit analysis.
It describes the collection and analysis of cost-benefit data in:

- the laboratory experiments;
- the field study;
- a case study by IvD in collaboration with the IST@Home project; to pilot how a service content provider could assess the utility of a service for its end-users;
- another case study by IVD on selecting communication services for people with various types of communication disabilities.

On the basis of the results of these different studies D5.2 aims to arrive at general conclusions about costs, benefits and expected utility of different communication media.

In addition, D5.2 will specify the requirements for the final version of the cost-benefit software tool. A provisional version of this tool was produced earlier in the project and used for demonstration in interviews with potential users of the tool in Telenor and Tandberg. The results of these interviews are also reported in this deliverable and will contribute to the specification of the requirements for the final version of the tool. The implementation of the final version will be D5.3 Cost-Benefit Analysis Tool.

2 The MAUT approach to cost-benefit analysis

As specified in D5.1 the first Eye-2-Eye deliverable on cost-benefit analysis, the development of both the method and the tool was planned as an iterative process with the user test phases that provided empirical data on the costs and benefits for end-users (i.e., the baseline tests, laboratory experiments and field study).

Early in the project an *initial cost-benefit analysis method* was developed to incorporate the results of focus group discussions described in deliverable D1.1 (Heim et al., 2000). Although it was subsequently used in the Baseline study reported in D2 (Schliemann et al., 2001), a significant limitation of the *initial cost-benefit analysis method* approach to cost-benefit analysis was that its inventory of costs and benefits is descriptive rather than quantitative.
To overcome this limitation, an external peer reviewer of the project (Pedro Concejero) proposed that the project could benefit from using Multi-Attribute Utility Technique (MAUT) as a basis for the Eye-2-Eye cost benefit analysis.

MAUT is a decision analysis technique aimed at facilitating the evaluation of different alternatives on a set of attributes that serve as selection criteria. It measures the expected utility or value of each of a set of alternatives, taking into account all attributes that are relevant for choosing between alternatives. In essence, the expected utility is based on two measures: the relative importance or weight given to an attribute or criterion, and the value or suitability score of an alternative on that attribute. Having obtained the weight and the value score of each attribute on a given alternative, these measures are transformed by

a suitable technique so that they share a common scale, combined through multiplication, and summed to obtain a single overall utility score for that alternative.

In mathematical terms MAUT specifies the following model to find out the expected utility (*U*) for the j alternative (*y)* belonging to a set of (1,2, n) alternatives:

$$U(y_j) = \sum_{i=1}^{k} w_i x_{ij}$$

where
k is the number of attributes considered in the decision
x_{ij} represents the score of the j alternative in the i attribute
w_i represents the weight or relative importance of the i attribute

When choosing between different alternatives the rational decision would be to select the alternative with the highest expected utility (*U-score*).

When applying MAUT it is necessary to specify:

- the set of alternatives to be evaluated;
- the set of attributes on which these alternatives are to be evaluated
- a method to determine the relative importance or weight of these attributes
- appropriate measures for value scoring the set of alternatives.

A key advantage of MAUT is that it can quantify subjective as well as objective attributes. It has been applied in a range of areas such as medical decision making, the evaluation of alternative technological solutions, and the analysis of energy policy objectives. A key reference on MAUT is von Winterfeldt and Edwards (1986). For a brief introduction see Concejero (1994)

3 Applying MAUT to assess the utility of different communication media in laboratory tasks

3.1 Aim and objectives

Deliverable D3: 'Results of the Laboratory Experiments of Communication media' (O'Malley et al., 2002) already gives a full description of the Eye-2-Eye laboratory experiments and all the results apart from the cost-benefit data. The main purpose of the experiments was to investigate the effects of various communication services and service quality levels on user behaviour, communication processes and attitudes.

The application of MAUT for purposes of cost-benefit analysis was planned as an add-on to the design and procedure of these experiments. It provided an opportunity to find out if the application of MAUT in laboratory situations would lead to meaningful results, that on the face of it could be generalised to real users in real-life situations.

Specific questions addressed were:

- the importance (weight) of different criteria when selecting a communication service for carrying out a particular communication task
- the most likely criteria for selecting videoconferencing instead of ordinary telephony
- the effect of differences in parameters such as screen size and audiovisual delay, on the (potential) utility of videoconferencing for its end-users;
- the (potential) utility of a talking head (avatar) as an addition to person-to-person speech communication.

3.2 Experimental tasks

Map task (Joint problem solving task)

The Map Task was originally developed by Boyle (1994) as a means of looking at the development of communication skills. Each participant in a pair has a simple schematic map of the same location but, for any pair, some of the features depicted may differ. One member of the pair is randomly assigned to the role of instruction giver, and only his/her copy of the map has a route drawn on it. His/her task is to instruct his/her partner, the instruction follower, so that he/she can draw the route on his/her copy of the map. The map task has a clear goal and a well-defined measure of communicative success. The goal is to draw the route on the map as accurately as possible, given the differences between the instruction giver's and the instruction follower's maps. Successful communication is important since the goal can only be achieved by means of the exchange of information between the participants. The measure of communicative success is the extent to which the instruction follower's route matches the instruction giver's route.

Simple Negotiation task

This simple negotiation task was developed by SINTEF. A baker and a merchant share costs and profits on the shipping of goods from the Far East. They both have the same list of goods to choose from (with a predefined, common price), but the expected profit from each type of goods was varied between the two negotiators. The task aim was to agree upon a selection of goods to be shipped with the boat. The "hidden" task characteristics were: (i) the fact that most goods had a high vs. low profit for the baker and the merchant respectively, while some goods had a moderately high profit for both; (ii) the merchant had a slightly better "profit-matrix" than the baker, and hence a better chance of high profit.

Acquiring a company (AAC) (Negotiation task involving trust)

This task was developed by Samuelson and Bazermans (1985). It is a game involving two persons bargaining over the price of a company, where the 'seller' and 'buyer' start out with asymmetric information. The basic premise of the task is that the seller knows the value of the company, while the buyer knows the expected profit in relation to that value, but not the value itself. Neither the buyer nor the seller is aware of the information known by the other party. The participants may share any, all, or none of the information given to them. However, at no time must they show the other person their sheet of instructions. Therefore, any information passed between the 2 participants is subject to fabrication and deceit. It is down to the judgement of individual participants to decide: a) whether or not they believe the information they receive or b) whether they choose to be truthful with the information they give out.

Bluffing game

This was a task developed by SINTEF and consists of a simple "bluffing-game" with cards. Participants were given a "prepared" deck of cards, and played one by one each card against the other. A total of 20 cards were played, and the higher card in each round won a sum of money. Participants always had the option to lie about the card they were possessing. Calling and revealing a bluff would cause the bluffer to lose money.

3.3 Communication services

The communication services investigated in the laboratory experiments consisted of handsfree audio (audioconferencing), handsfree audio accompanied by an avatar (talking head or avatar-telephony), and videoconferencing with different levels of screen size, audio delay and video delay.

In the SINTEF experiments an analogue videoconferencing system was used with TV quality video, 7KHz bandwidth audio (G722) and no delay or audiovisual asynchrony. Cost-benefit data were collected in two communication services:

- high quality audio and video without transmission delay
- high quality audio without transmission delay.

In Nottingham cost-benefit data were collected in six communication service conditions all involving H263 video with a frame rate of 25 fps, 7KHz bandwidth audio (G722) and a transmission bandwidth of 3Mbit/s. The service parameters that were varied between the six conditions were:

- 'type of image': either the other person or a picture of a 'talking head' avatar
- screen size: either 29" or 3.5" :
- video resolution: either CIF or a camcorder monitor with 839 x 220 pixels
- video delay: either 200 ms, 400ms, 650 ms or 1000 ms
- audio delay: either 200 ms, 400ms, 650 ms or 1000 ms

Table II gives an overview of both the Nottingham and the SINTEF conditions. It pictures the combination of parameter levels presented in each of the four experimental tasks in both the Nottingham and the SINTEF experiments. The numbers of the Nottingham conditions are the same as in deliverable D3 (O'Malley et al., 2002). The letter combinations refer to the screen size and delay parameters, i.e.: LS = large screen, SS = small screen, ND = no delay, AD = asynchronous delay (400ms video and 200ms audio), SD = small delay (200 ms audio and video) and LD = long delay (650 or 1000ms audio and video).

In both the SINTEF and the Nottingham experiments, the communication service conditions were always varied between subjects. The experimental tasks were also varied between subjects in Nottingham, but in SINTEF they were varied within subjects. The number of subjects per condition varied in the Nottingham experiment between 18 subjects in C7a to 28 subjects in C5. In the SINTEF experiment both the audio and video groups had 18 subjects each.

Table II: Experimental tasks and communication services

Map task	Audio SINTEF	Video SINTEF LS-ND	C1 Nott LS-AD.	C1a Nott LS-SD
	N=18	*N=18*	*N=24*	*N=20*
type of image	audio only	person	person	person
screen size	n/a	29”	29 “	29”
video resolution	n/a	PAL	CIF	CIF
video delay	n/a	none	400 ms	200ms
audio delay	none	none	200 ms	200ms
Negotiation	Audio SINTEF	Video SINTEF LS-ND		
	N=18	*N=18*		
type of image	audio only	person		
screen size	n/a	29”		
video resolution	n/a	PAL		
video delay	n/a	none		
audio delay	none	none		
AAC	C2 Nott LS-LD	C4 Nott LS-SD	C5 Nott SS-LD	C7a Nott SS-LD
	N=22	*N=20*	*N=28*	*N=18*
type of image	person	person	person	avatar
screen size	29”	29”	3.5”	3.5”
video resolution	CIF	CIF	CIF	camcorder
video delay	650ms	200ms	650ms	1000ms
audio delay	650ms	200ms	650ms	1000ms
Bluffing game	Audio SINTEF	Video SINTEF LS-ND		
	N=18	*N=18*		
type of image	audio only	person		
screen size	n/a	29”		
video resolution	n/a	PAL		
video delay	n/a	none		
audio delay	none	none		

3.4 Data collection method

In order to apply MAUT and compute utility scores it is necessary to specify:

- the set of alternatives to be evaluated;
- the set of selection criteria on which these alternatives are to be evaluated
- a method to determine the relative importance or weight of these selection criteria
- appropriate measures for value scoring the set of alternatives.

To adapt this procedure within the context of the laboratory experiments, involved specific considerations and decisions for each step.

Specifying the set of alternatives

The aim was to determine the utility of the different communication services as set out in Table I. In addition to make these utility scores more meaningful, it was decided to measure the utility of face-to-face communication and ordinary telephony as reference points. Thus for each subject carrying out an experimental task, utility measures were determined for:

- the communication service used to carry out the experimental task
- ordinary telephony
- face-to-face communication.

Specifying and weighting the selection criteria

Eye-2-Eye focuses on cost-benefit measures from the point of view of the end-user. Specifying the selection criteria should therefore be based on the criteria that an end-user would take into account when selecting the communication services for his/her own use. However, because the subjects in the laboratory experiments were mainly University students carrying out laboratory tasks, it could not be assumed that in real life: (a) they would be potential users of the services (e.g. videoconferencing and avatar telephony), or (b) the experimental tasks were representative for the sort of communication activities they would be likely to carry out. For this reason, it was decided that meaningful selection criteria should be consistent with the 'as if' nature of the experiments, and should reflect communication goals or activities that were considered important for carrying out the task.

Specifying the selection criteria within this context, could either be done by instructing groups of subjects to specify a set of criteria (for instance in focus group discussions), or by offering the subjects a predetermined set of possible criteria from which they had to choose a subset. It was decided to adopt the latter of these two methods because it requires less work for the researchers, and it guarantees that all subjects consider the same criteria. The actual procedure was as follows:

- After the experimental task had been explained but *before the task was carried out* a subject was first instructed to: 'Imagine you have to choose between several communication media such as an ordinary telephone, SMS or videophone and you want to choose the communication medium that is most suitable for carrying out this task/ playing this game. I am now giving you a list of reasons for selecting one particular communication medium instead of another'.

- Subsequently, the subject was presented with a list in a table and asked to indicate the five most important reasons if he/she was to choose communication medium freely for this particular task. The indication was made by a yellow marker (see example in Table III).

- The subject was then asked to rate the importance of each of the five selected criteria by giving each one a rating from 1 (totally unimportant) to 10 (extremely important). The rating was done in the next column. Criteria that were not selected were given a weight of 0.

Suitability ratings

Because the selection criteria reflected communication goals or activities that were considered important for carrying out the task, the appropriate measure for valuing the communication media should reflect their suitability for achieving those goals or carrying out activities. After completing the experimental task the subject was asked to rate the suitability of:
- the communication medium used to carry out the experimental task
- ordinary telephony
- face-to-face communication.

This suitability rating was carried out for each of the five selection criteria rated on their importance before the experimental task. An 11-point suitability rating (from 0 to 10) was used and the subject could indicate this rating by using the table.

Table III : Form used by the subjects for weighting and suitability ratings (with illustration of subject selection of the five most important criteria)

Selecting and weighting criteria		**Suitability ratings**		
Suitability criteria (mark out 5 most important in yellow)	*Importance of criterion (0-10)*	*Communication medium used in experimental task*	*Ordinary telephone*	*Face-to-face*
.....is suitable for me making a *good impression* on the other person				
.....is suitable for getting the *right impression* of the other person	_____	_____	_____	_____
.....is suitable for discussions where you have to reach *agreement* with the other person				
.....is suitable for *persuading* the other person to change his/her mind	_____	_____	_____	_____
.....is suitable for judging whether or not the other person is *to be trusted*				
.....is suitable for giving or receiving *short messages*	_____	_____	_____	_____
.....is suitable for *explaining* or having something difficult explained				
.....is suitable for talking with *friends or family*	_____	_____	_____	_____
.....is suitable for giving or receiving *advice*	_____	_____	_____	_____
.....is suitable for discussing a *personal problem*				
.....is suitable for occasions where you may need *to lie*.				

3.5 Data analysis method

For each experimental task the data analysis method for each individual subject was as follows.

1. Normalised weights were computed for each selection criterion by dividing the weight of that criterion by the sum of all criterion weights. Thus the sum of the normalised criterion weights was always 1.
2. Normalised suitability scores were computed by dividing each suitability score by 10. Thus for each criterion the normalised suitability score for a communication medium could vary between 0 and 1.
3. The criterion Uscore for a communication medium was computed by multiplying the normalised weight of each criterion by its normalised suitability score.
4. The aggregate Uscore for a communication medium was obtained by computing the sum of criterion Uscores for that communication medium.

Subsequently the group measures were computed as follows.

1. The group weight was obtained for each criterion by computing the average of all individual normalised weights including those with a weight score of zero.
2. The group suitability score was obtained for each communication medium and each criterion, by computing the average of individual scores on that particular criterion. Subjects who had not rated on that criterion were not included, because we wanted a suitability score that was not confounded by the importance (weight) of the criterion. In addition, because we wanted the group results to reflect more than one individual score, all criteria that had only one score or none at all were omitted from the group suitability analysis.
3. The group criterion utility scores were computed for each communication medium by averaging all individual scores including zero scores.
4. The group aggregate Uscore was computed for each communication medium by averaging all individual aggregate Uscores.

The subsequent sections in this chapter give an overview of the results of the laboratory experiments. They are presented separately for the different tasks and different groups of subjects. For each of the tasks, each of the figures presents a set of group averages obtained for one group of subjects carrying out that task. The order in which the different measures are presented is the same as for the data collection and analysis: (1) the weightings, (2) the suitability scores, (3) the criterion utility scores and (4) the aggregate utility score.

3.6 Results in the Map task (Joint problem solving task)

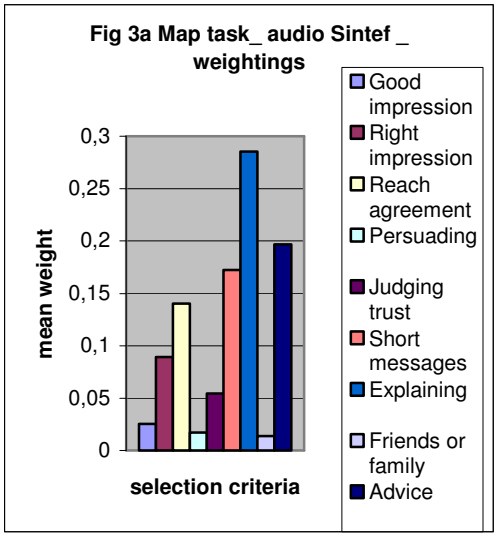
3.6.1 Map task _ weightings

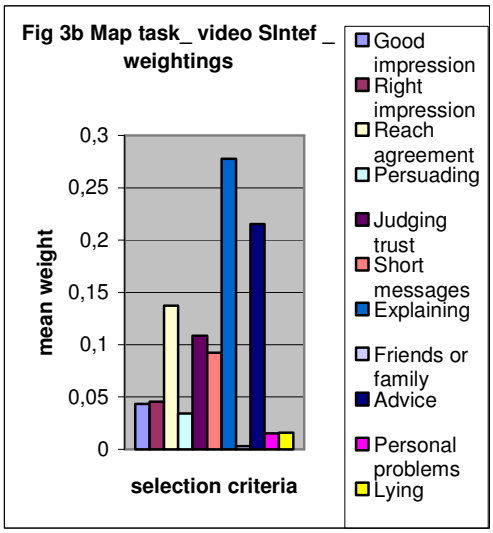
The weightings for four different groups who carried out the map task are presented in figures 3a,b,c,d. They show that:

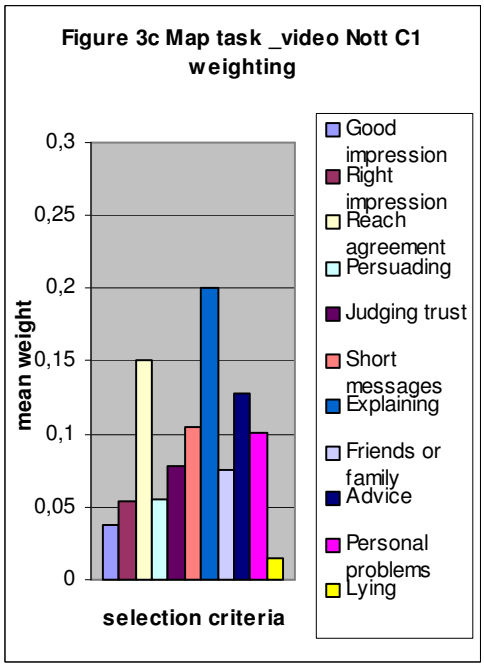
- 'Explanation' was the most important selection criterion for all four groups.

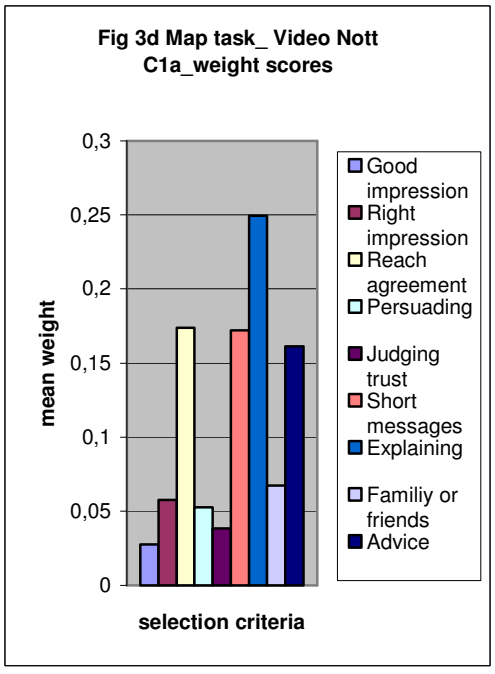
- ‘Advice’, ‘reaching agreement and ‘short messages’ were in the top five for all groups.

The common feature of these criteria is that they all have to do with information exchange, which is of course consistent with the nature of the map task.









3.6.2 Map task _suitability scores

The suitability scores are presented in figures 4a,b,c,d. The main points to note from these data are:

- There is little or no difference between handsfree audio and ordinary telephony (fig 4a)
- Video conferencing was rated as less suitable than face-to-face on all criteria (fig 4b,c,d)
- On most criteria videotelephony was rated as more suitable than ordinary telephony.
- A noticeable exception is 'giving or receiving short messages' where the video ratings were higher than telephony in one group (fig 4c) but not in the two other groups (fig 4b and fig 4d).
- For 'discussing personal problems' the video ratings were about the same as for telephony (figs 4b and fig 4c) and for 'lying' ordinary telephony was rated as more suitable than either videoconferencing or face-to-face (fig 4c). However, the mean scores for these criteria represent only a few subjects.

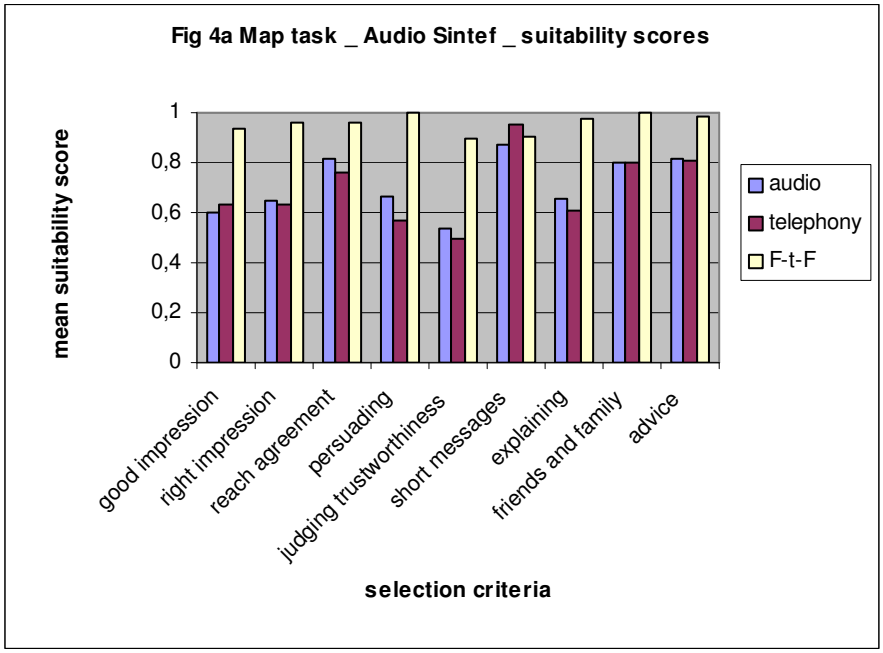


Fig 4a Map task _ Audio Sintef _ suitability scores
mean suitability score
1
0,8
0,6
0,4
0,2
0
audio
telephony
F-t-F
good impression
right impression
reach agreement
persuading
judging trustworthiness
short messages
explaining
friends and family
advice
selection criteria

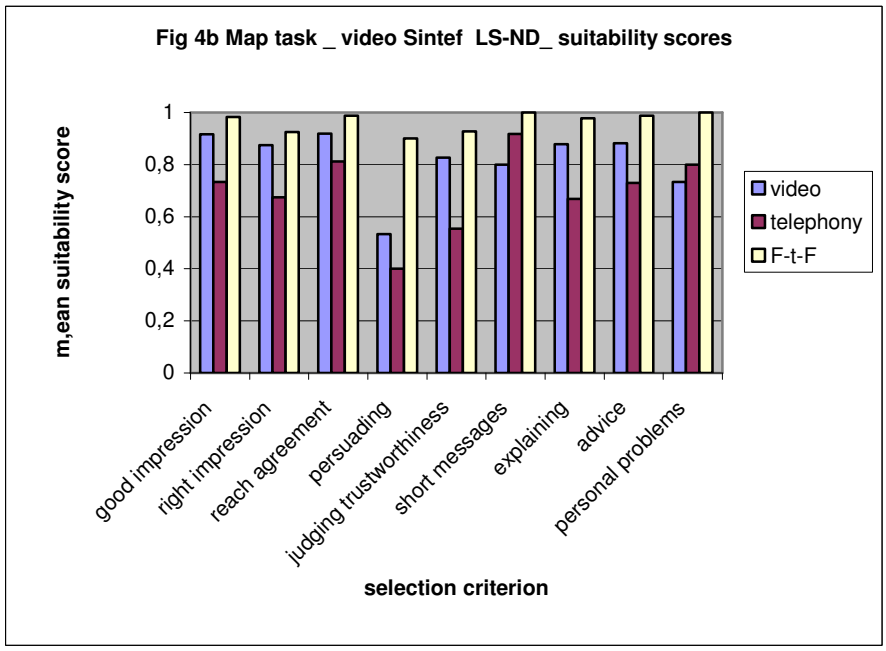


Fig 4b Map task _ video Sintef LS-ND_ suitability scores
m,ean suitability score
1
0,8
0,6
0,4
0,2
0
video
telephony
F-t-F
good impression
right impression
reach agreement
persuading
judging trustworthiness
short messages
explaining
advice
personal problems
selection criterion

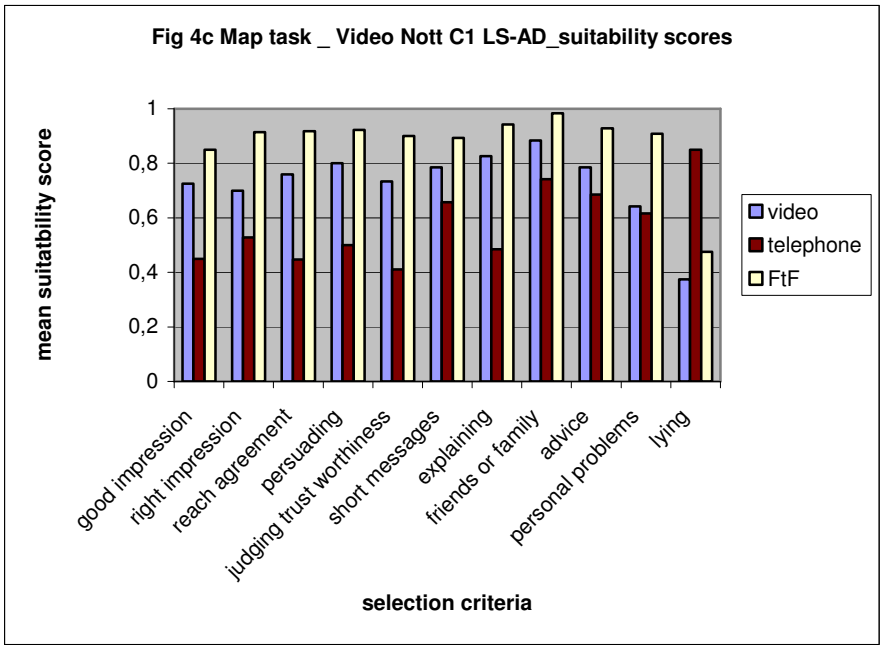


Fig 4c Map task _ Video Nott C1 LS-AD_suitability scores
mean suitatbility score
1
0,8
0,6
0,4
0,2
0
video
telephone
FtF
good impression
right impression
reach agreement
persuading
judging trust worthiness
short messages
explaining
friends or family
advice
personal problems
lying
selection criteria

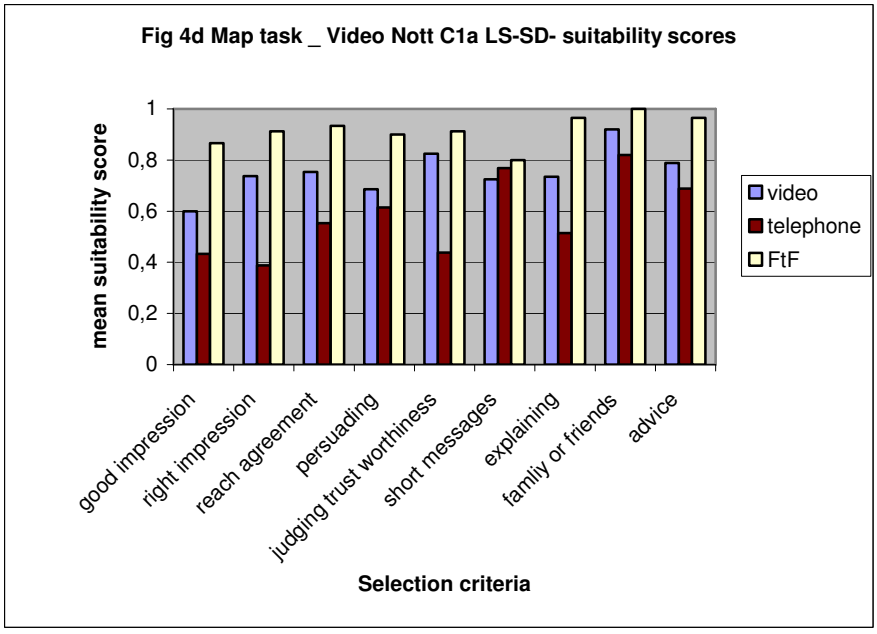
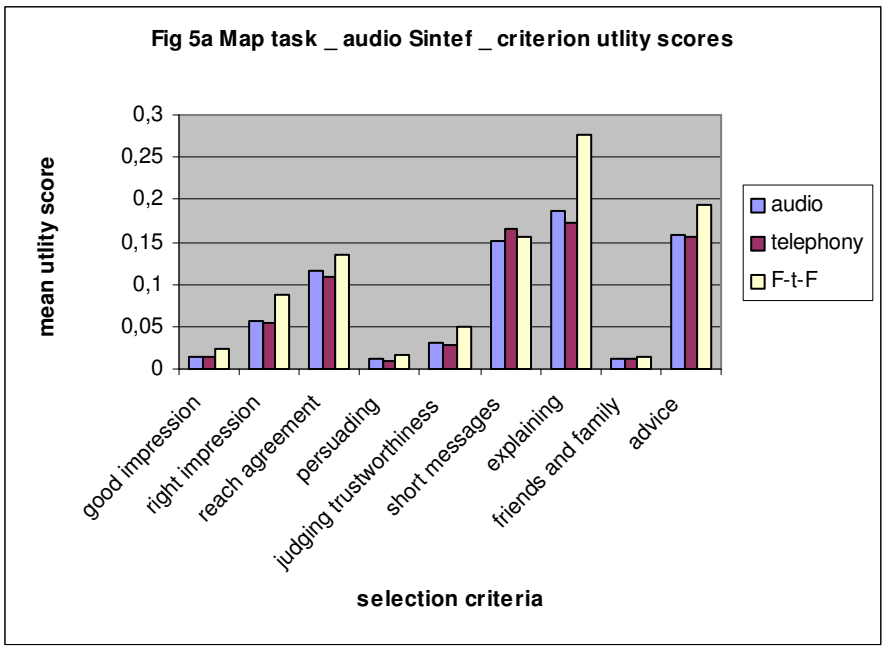


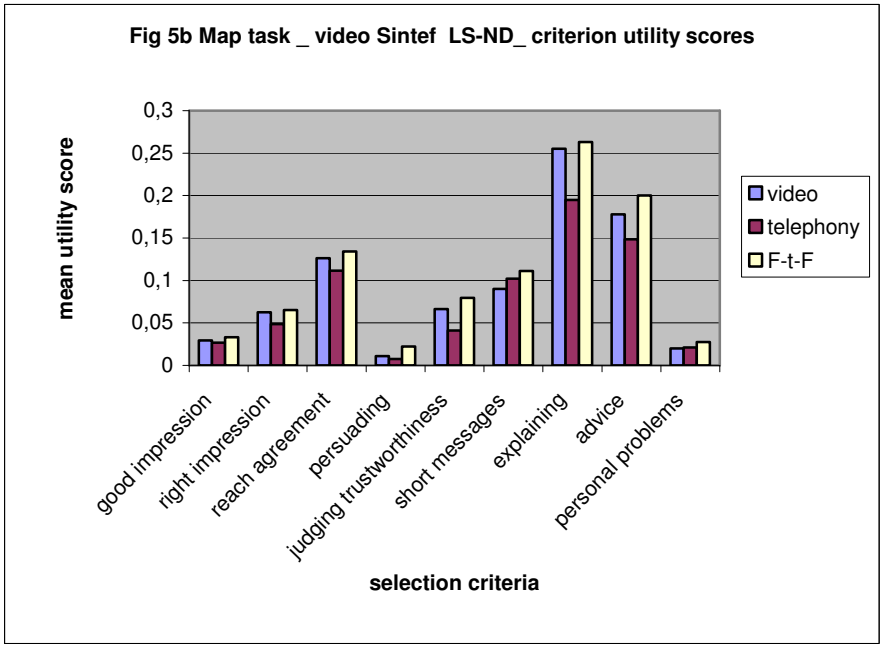
Fig 4d Map task _ Video Nott C1a LS-SD- suitability scores
mean suitability score
1
0,8
0,6
0,4
0,2
0
video
telephone
FtF
good impression
right impression
reach agreement
persuading
judging trust worthiness
short messages
explaining
familiy or friends
advice
Selection criteria

3.6.3 Map task _ Criterion utility scores

The criterion utility scores in Figures 5a,b,c,d reflect both the weights and the suitability scores. They indicate that:

- in communication situations where explanation and advice are important, videoconferencing is clearly more useful than ordinary telephony or audioconferencing (Audio);
- this finding applies to all three conditions of audio-visual delay or synchronisation.





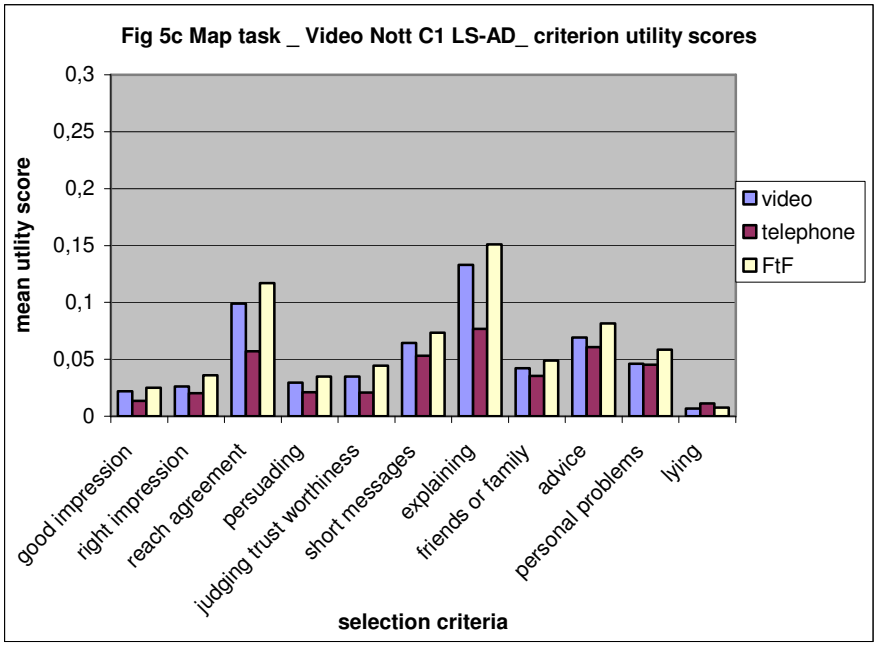


Fig 5c Map task _ Video Nott C1 LS-AD_ criterion utility scores
mean utility score
0,3
0,25
0,2
0,15
0,1
0,05
0
video
telephone
FtF
good impression
right impression
reach agreement
persuading
judging trust worthiness
short messages
explaining
friends or family
advice
personal problems
lying
selection criteria

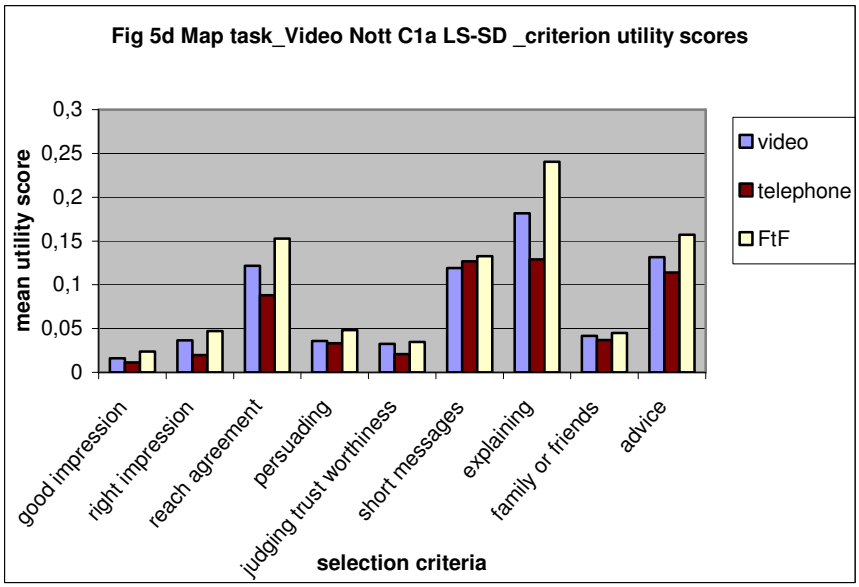


Fig 5d Map task_Video Nott C1a LS-SD _criterion utility scores
mean utility score
0,3
0,25
0,2
0,15
0,1
0,05
0
video
telephone
FtF
good impression
right impression
reach agreement
persuading
judging trust worthiness
short messages
explaining
family or friends
advice
selection criteria

3.6.4 Map task - Aggregate utility scores

The aggregate utility scores shown in figures 6a,b,c,d constitute the sum of the criterion utility scores. The main features of these data are:

- Each of the three video conditions videoconferencing had a higher Uscore than telephony but not quite as high as face-to-face
- Audioconferencing (audio) had about the same Uscore as telephony

Fig 6a Map task _ Audio Sintef - Aggregate Utility scores

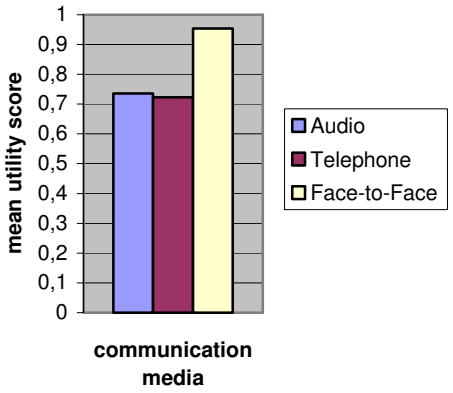


Fig 6b Map task _ Video Sintef LS-ND _Aggregate Utility scores

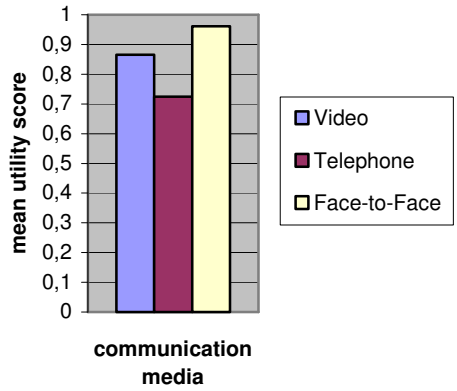


Fig 6c Map task _ Video Nott C 1 LS-AD_ Aggregate Utility scores

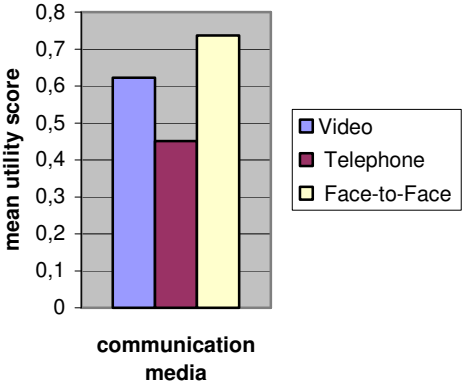
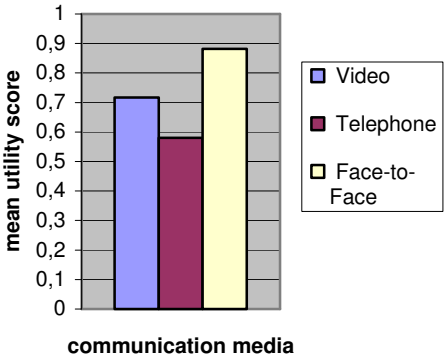


Fig 6d Map task - Video Nott C!a LS-SD_Aggregate Utility scores

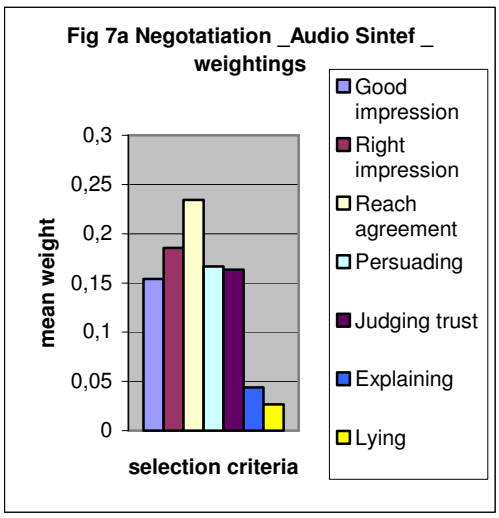


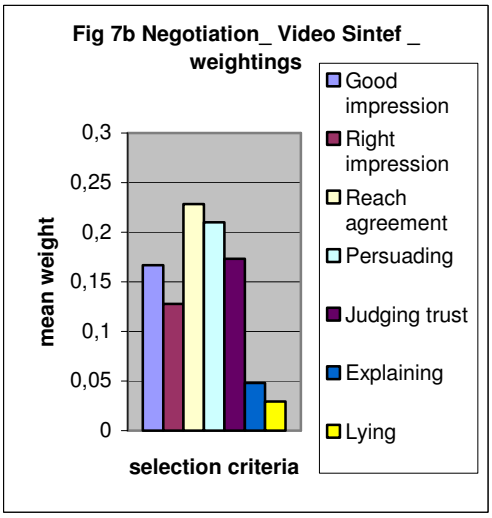
3.7 Results in the Simple Negotiation task

3.7.1 Negotiation task _ Weightings

Figures 7a,b show the criterion weightings by the two groups of SINTEF subjects. The main features are:

- 'Reaching agreement' was regarded as the most important criterion for selecting a communication media for the negotiation task.
- Other important criteria for both groups were 'persuasion', getting the right impression' and 'judging if the other person is trustworthy' and 'making a good impression'.

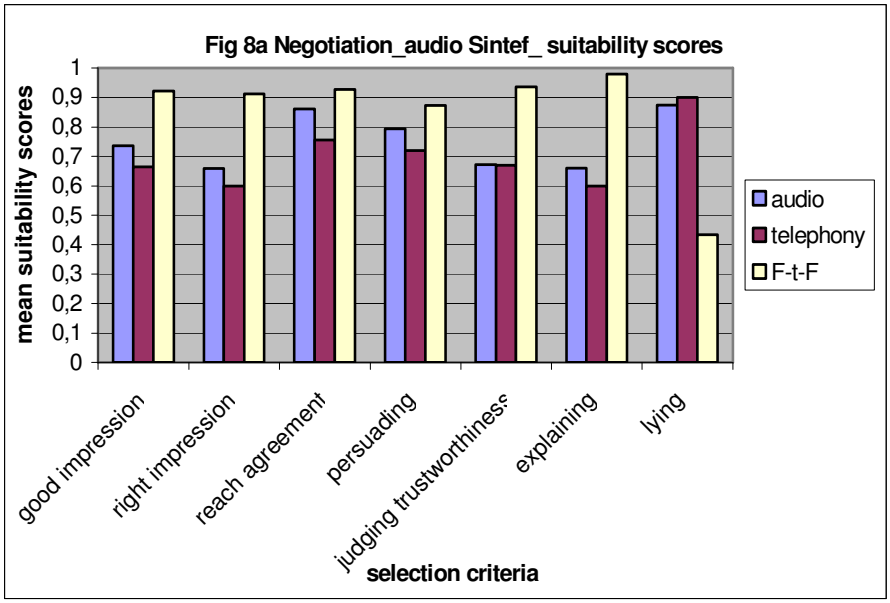


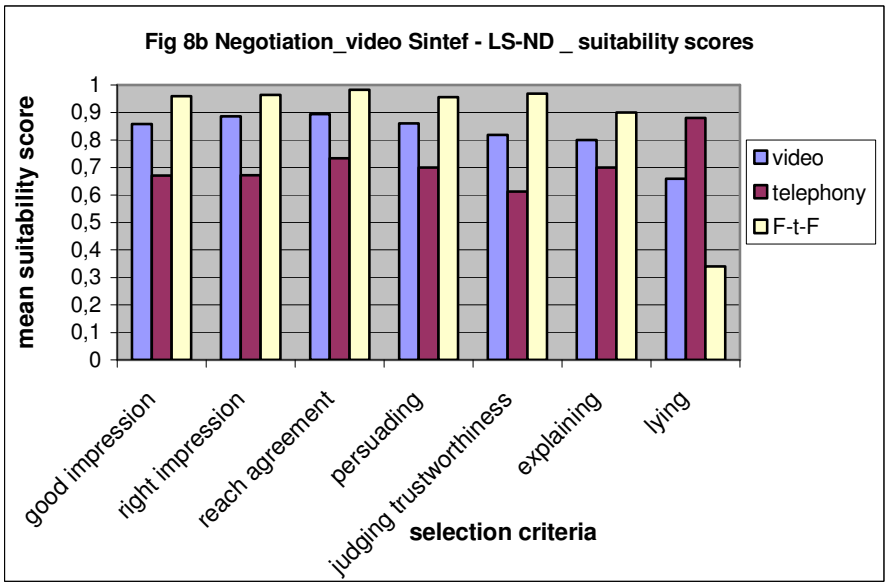


3.7.2 Negotiation task _ Suitability scores

The suitability scores are presented in Figures 8a,b. The most important findings are:

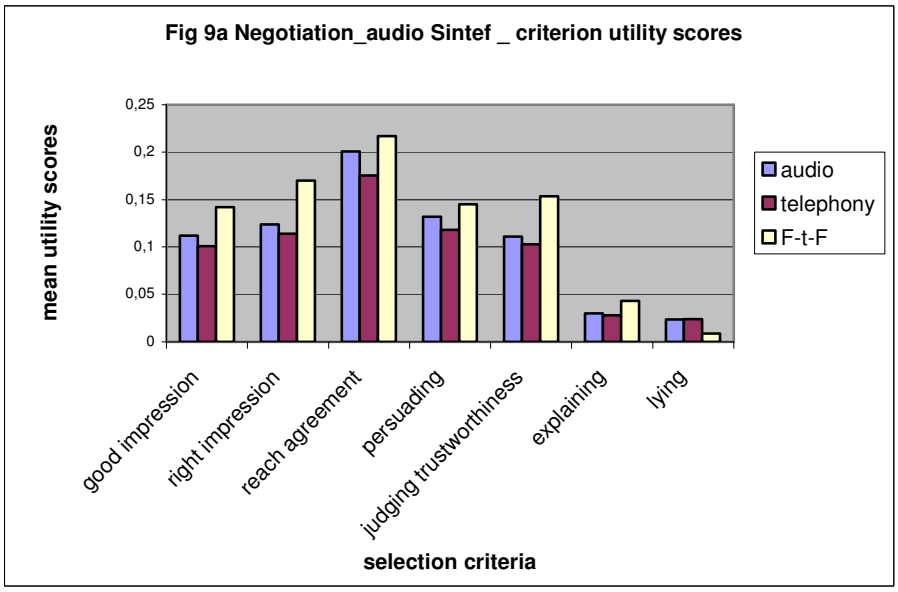
- video was rated as more suitable than telephony for all selection criteria with the exception of 'lying'
- video was rated as less suitable than face-to-face for all criteria except 'lying'
- for 'lying', telephony was regarded as most suitable and face-to-face as least suitable
- for most of the criteria, especially for 'reaching agreement', audioconferencing appears to be slightly more suitable than ordinary telephony.

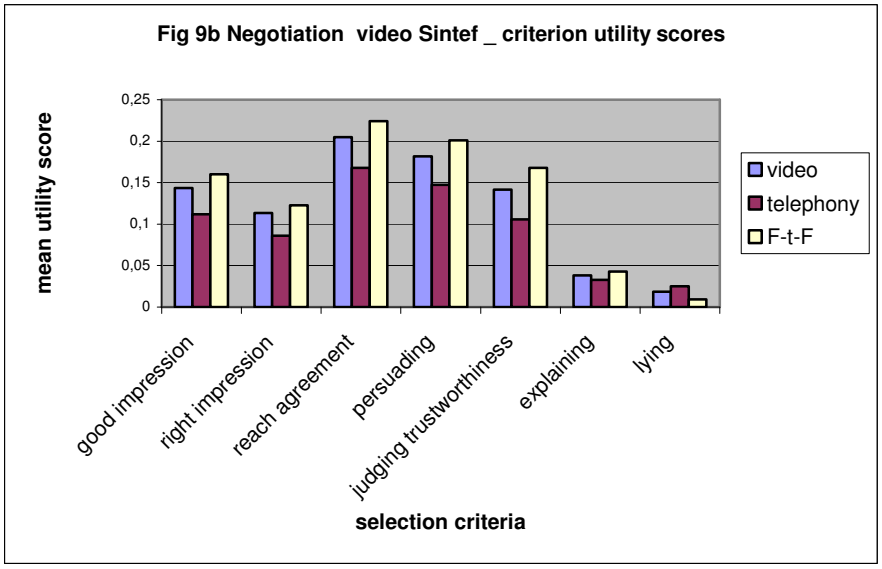




3.7.3 Criterion utility scores _ Negotiation task

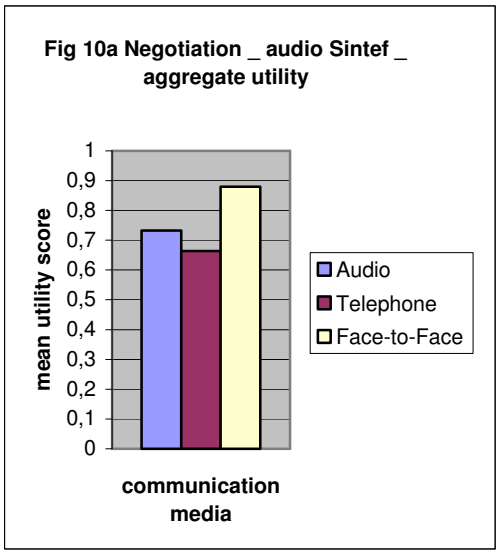
The criterion utility scores are presented in figures 9a,b. The main conclusion from these data is that when reaching agreement, judging or persuading the other person, and for making a good impression on the other person are important, both video- and audioconferencing are better media than the ordinary telephone, but the difference is greater for video- than for audioconferencing.

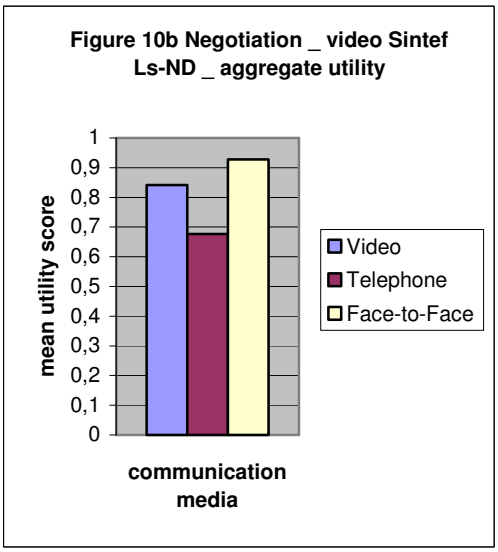




3.7.4 Aggregate utility scores _ Negotiation task

The aggregate utiltity scores in figures 10a,b confirm the conclusion from the criterion utility scores. Both audio- and videoconferencing have higher Uscores than ordinary but the difference is greater for videoconferencing. In addition, the aggregate Uscore for face-to-face was again higher than for videoconferencing.





3.8 Results in the Acquiring a Company (AAC) task (Negotiation involving trust)

3.8.1 Weightings _ AAC task

The weightings for the AAC task (acquiring a company) are presented in figures 11a,b,c.d. The most important criteria for selecting a communication service for the AAC task were the same as for the simple negotiation task, which of course is not surprising because tasks are simulations of business negotiations. Despite some differences between the four groups the five most important criteria for each group were: reaching agreement, getting the right impression of the person, judging the trustworthiness of the other person, making a good impression, explanation and persuasion. Less important criteria for each group were short messages, advice and lying.

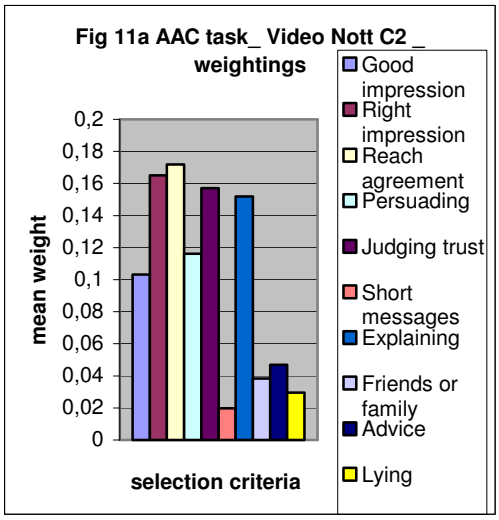


Fig 11a AAC task_ Video Nott C2 _
weightings
mean weight
0,2
0,18
0,16
0,14
0,12
0,1
0,08
0,06
0,04
0,02
0
selection criteria
Good impression
Right impression
Reach agreement
Persuading
Judging trust
Short messages
Explaining
Friends or family
Advice
Lying

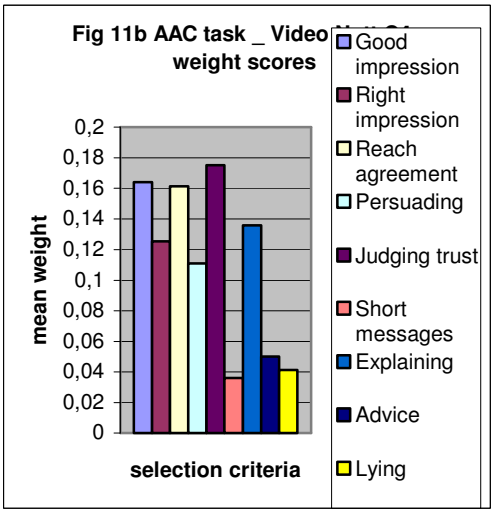


Fig 11b AAC task _ Video
weight scores
mean weight
0,2
0,18
0,16
0,14
0,12
0,1
0,08
0,06
0,04
0,02
0
selection criteria
Good impression
Right impression
Reach agreement
Persuading
Judging trust
Short messages
Explaining
Advice
Lying

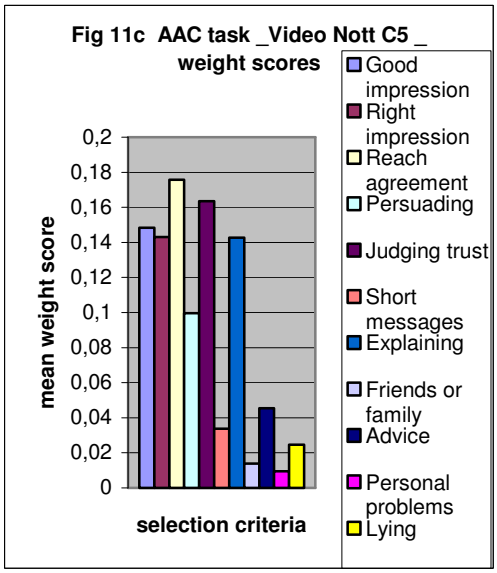


Fig 11c AAC task _Video Nott C5 _
weight scores
mean weight score
0,2
0,18
0,16
0,14
0,12
0,1
0,08
0,06
0,04
0,02
0
selection criteria
Good impression
Right impression
Reach agreement
Persuading
Judging trust
Short messages
Explaining
Friends or family
Advice
Personal problems
Lying

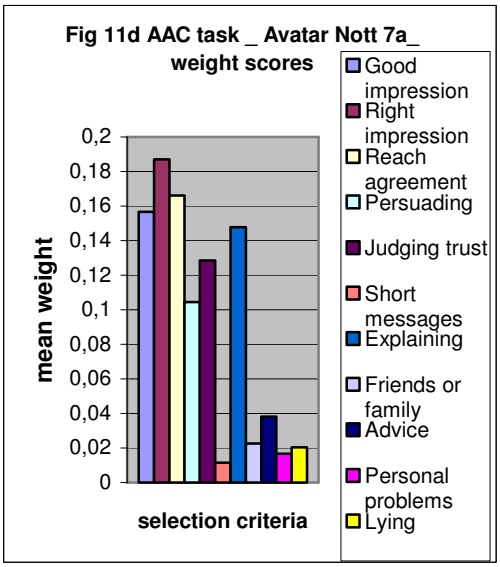
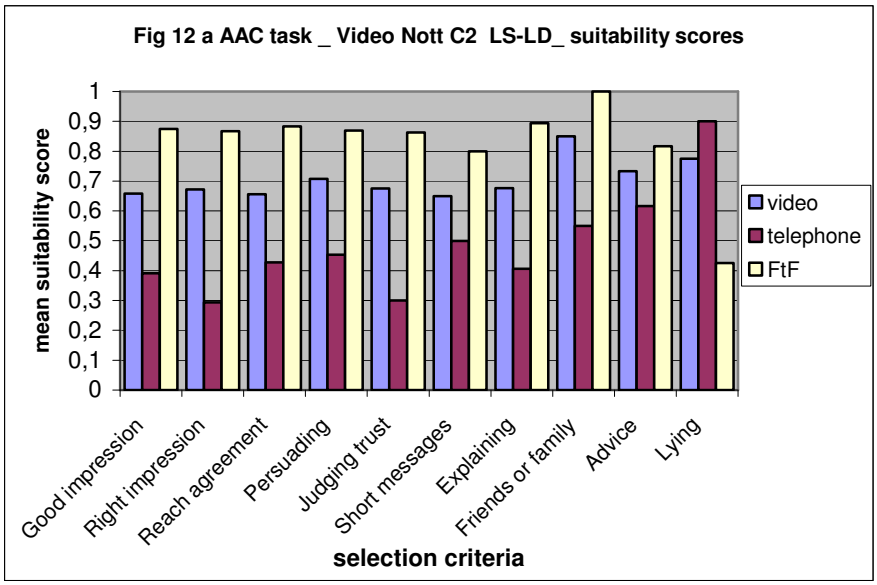


Fig 11d AAC task _ Avatar Nott 7a_
weight scores
mean weight
0,2
0,18
0,16
0,14
0,12
0,1
0,08
0,06
0,04
0,02
0
selection criteria
Good impression
Right impression
Reach agreement
Persuading
Judging trust
Short messages
Explaining
Friends or family
Advice
Personal problems
Lying

3.8.2 Suitability scores _ AAC task

Figures 12a,b show the suitability scores of videoconferencing for the subjects with a large video screen and audio-visual synchronisation. The only difference between the two conditions was the delay (LD = 650ms versus SD=200ms). Figure 12c shows the suitability scores of video communication with a small camcorder screen and a delay of about 1000 ms (simulating an application of mobile videoconferencing). Despite these differences in picture size and delay, there appear to be no consistent differences between the three videoconferencing conditions. With the exception of short messages and lying, video was always rated as more suitable than telephony and less suitable than face-to-face. Just as had been observed in the negotiation task, the pattern for lying was the most noticeable exception with telephony as the most suitable medium and face-to-face as the least suitable. For the avatar condition, pictured in figure 12d, the suitability scores suggest a small advantage of avatar communication over ordinary telephony, with the exception again of short messages and lying.



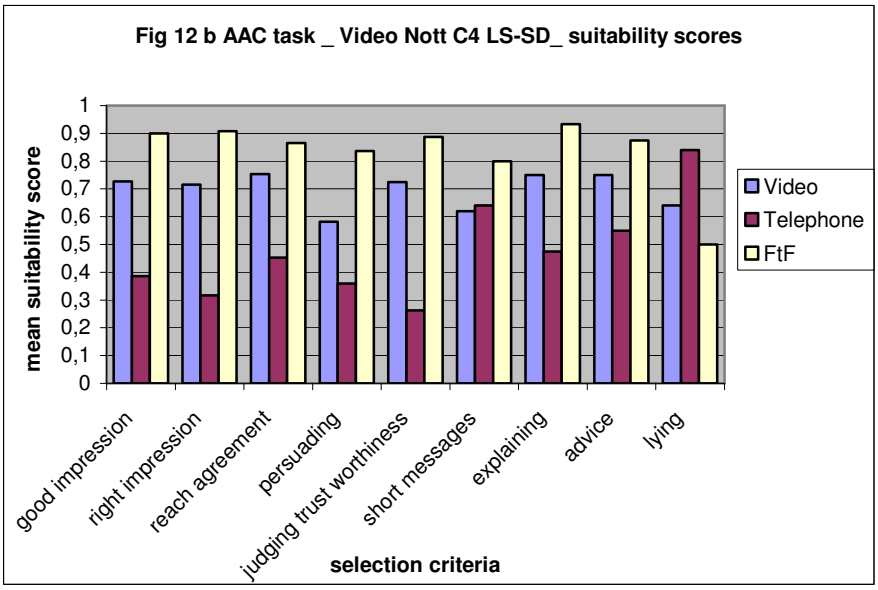


Fig 12 b AAC task _ Video Nott C4 LS-SD_ suitability scores
mean suitability score
1
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
Video
Telephone
FtF
good impression
right impression
reach agreement
persuading
judging trust worthiness
short messages
explaining
advice
lying
selection criteria

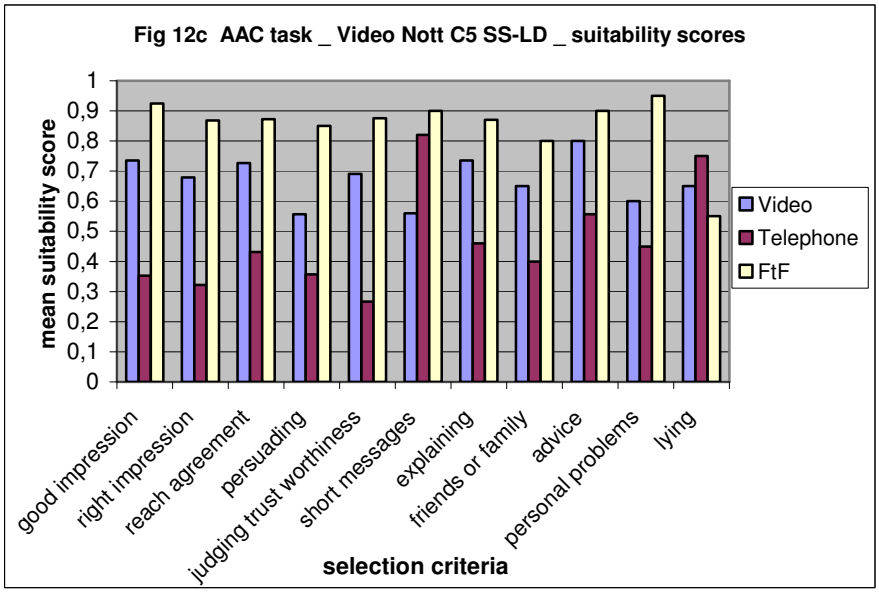


Fig 12c AAC task _ Video Nott C5 SS-LD _ suitability scores
mean suitability score
1
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
Video
Telephone
FtF
good impression
right impression
reach agreement
persuading
judging trust worthiness
short messages
explaining
friends or family
advice
personal problems
lying
selection criteria

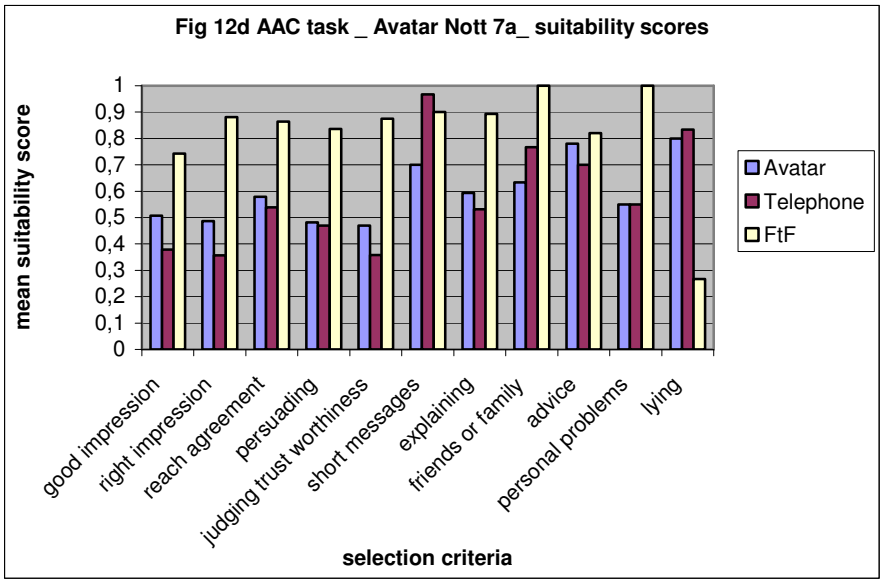
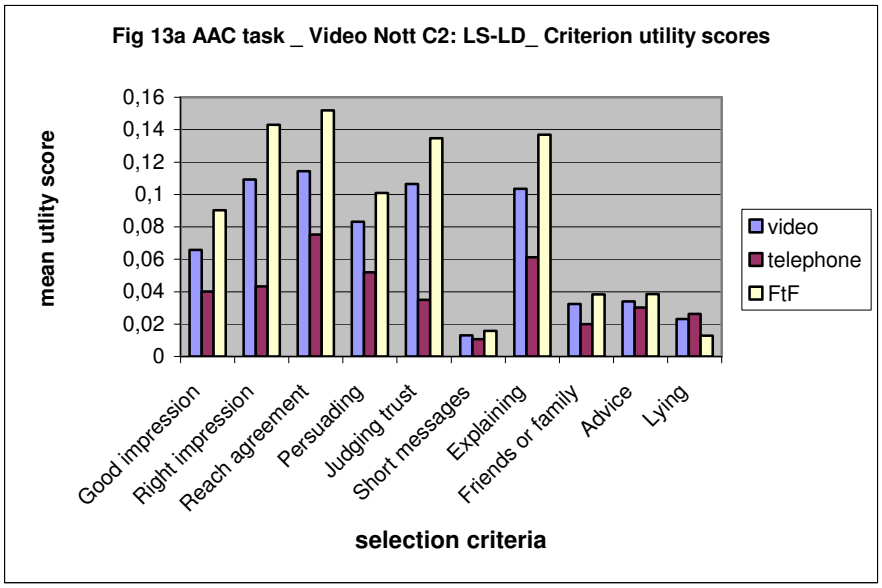


Fig 12d AAC task _ Avatar Nott 7a_ suitability scores
mean suitability score
1
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
good impression
right impression
reach agreement
persuading
judging trust worthiness
short messages
explaining
friends or family
advice
personal problems
lying
selection criteria
Avatar
Telephone
FtF

3.8.3 Criterion Utility scores _ AAC task

The AAC criterion utility scores pictured in figures 13a,b,c show results that are similar to the criterion utility scores obtained for videoconferencing in the simple negotiation task (see fig 9b). Again the results show that for tasks aimed at reaching agreement and being able to judge and persuade the other person, videoconferencing is more useful than ordinary telephony but not quite as useful as face-to-face.



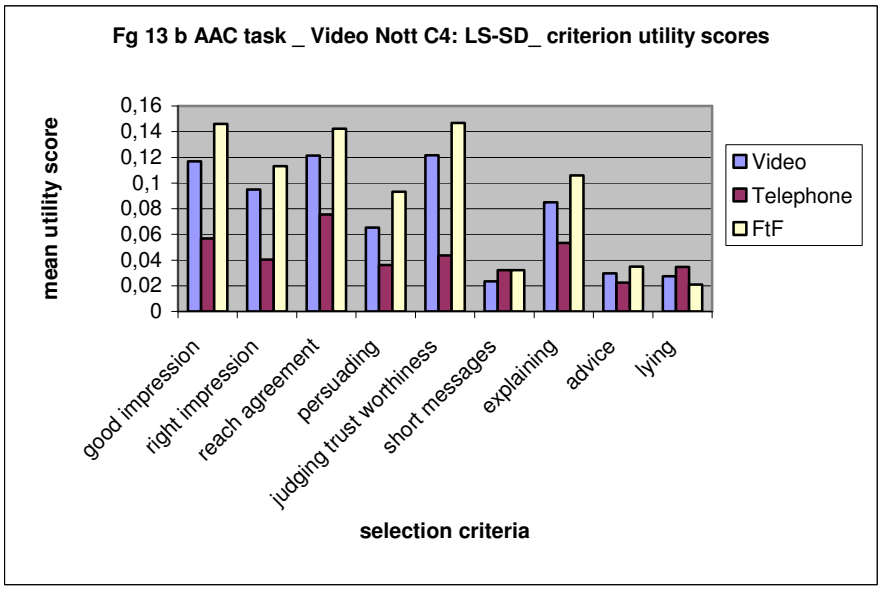


Fig 13c AAC task _ Video Nott C5: SS-LD _ criterion utility scores

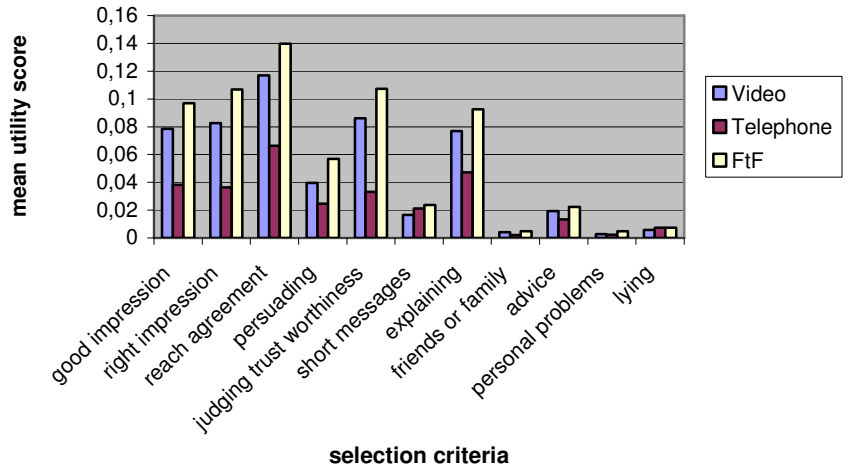
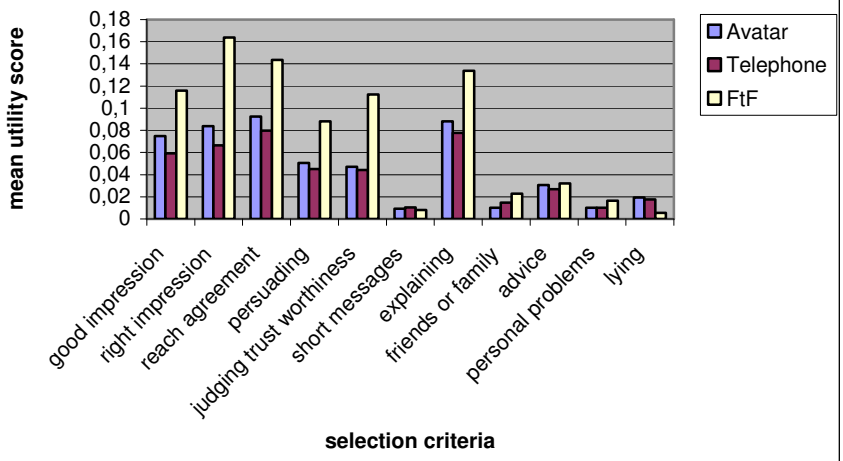


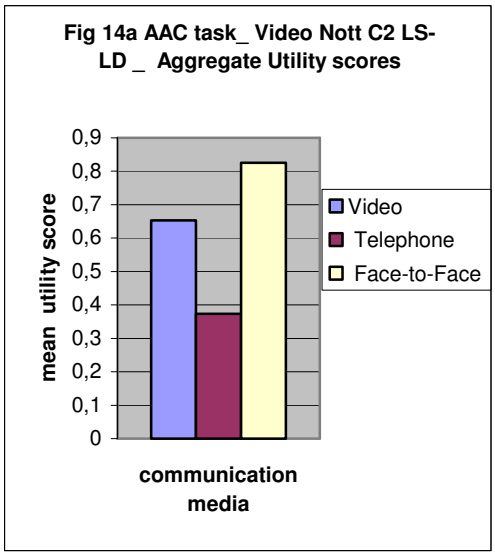
Fig 13 d AAC task _ Avatar Nott 7a _ criterion utility scores

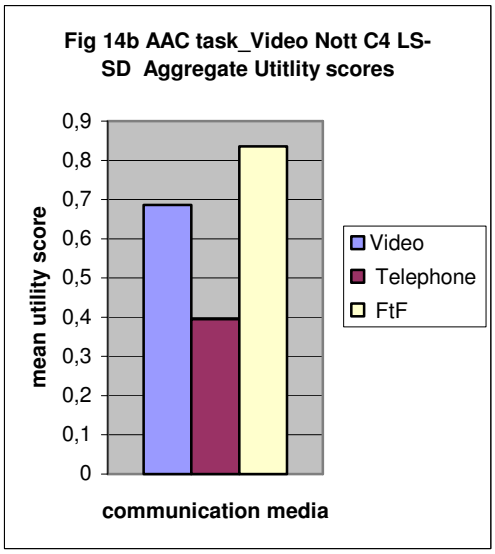


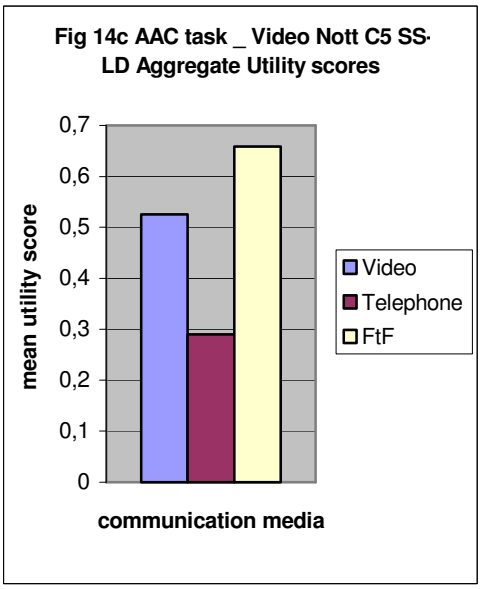
3.8.4 Aggregate Utility scores

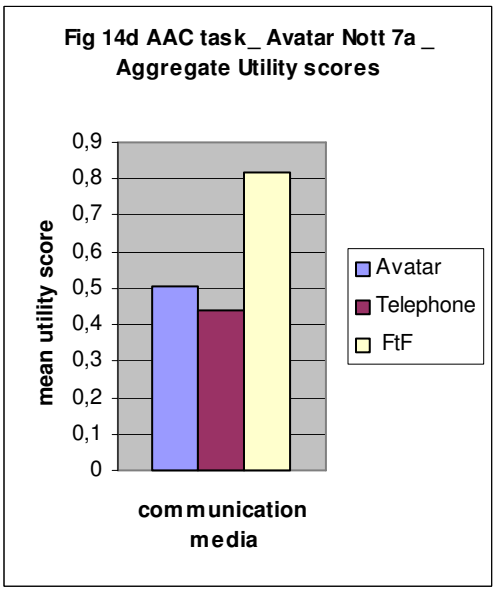
The aggregate utility scores for the AAC task are shown in figures 14a,b,c,d. The main conclusions from these data are:

- videoconferencing had a higher score than telephony but not as high as face-to-face
- screen size and delay appear to be have little influence on these differences
- the advantage over ordinary telephony was much greater for the videoconferencing conditions than for the avatar-phone.





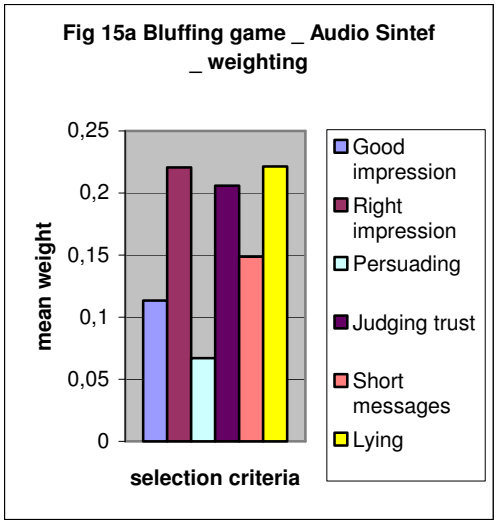


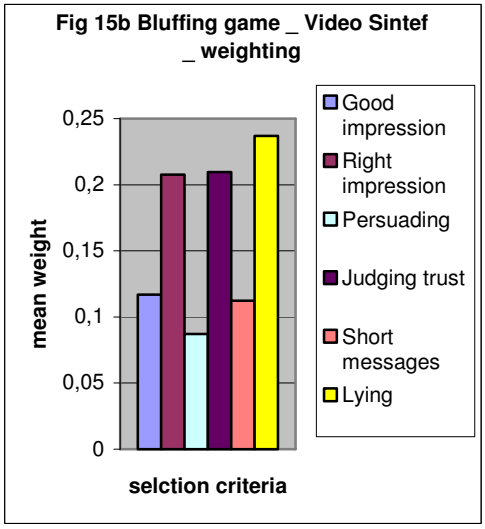


3.9 Results in the Bluffing game

3.9.1 Weightings _ Bluffing game

Figures 15 a,b present the weightings of the different criteria for selecting a communication medium to carry out the bluffing game. It is clear from these data that getting the right impression of the other person and judging his/her trustworthiness were regarded as more important than making a good impression on the other person. And in contrast to the two previous tasks, lying was also one of the three most important criteria. This difference is not surprising because in the negotiation and the AAC tasks, lying was not necessary, whereas it was an essential in the bluffing (i.e. lying) game.

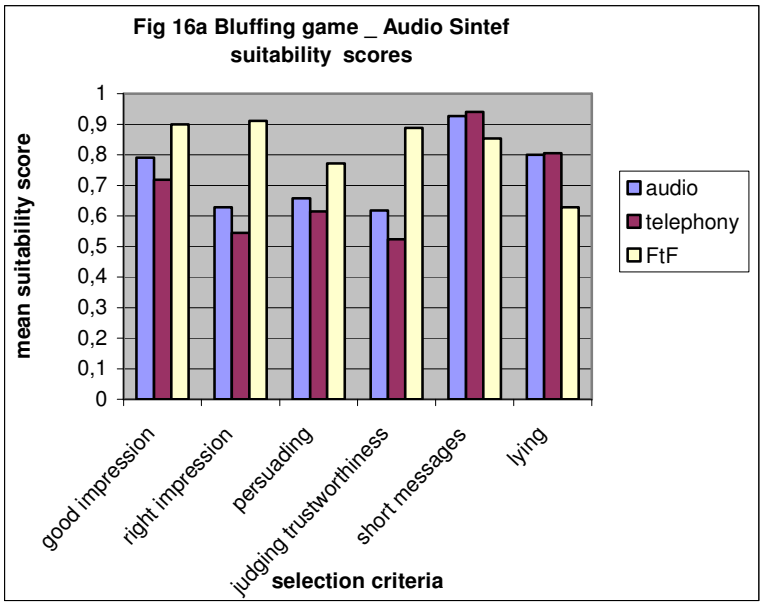


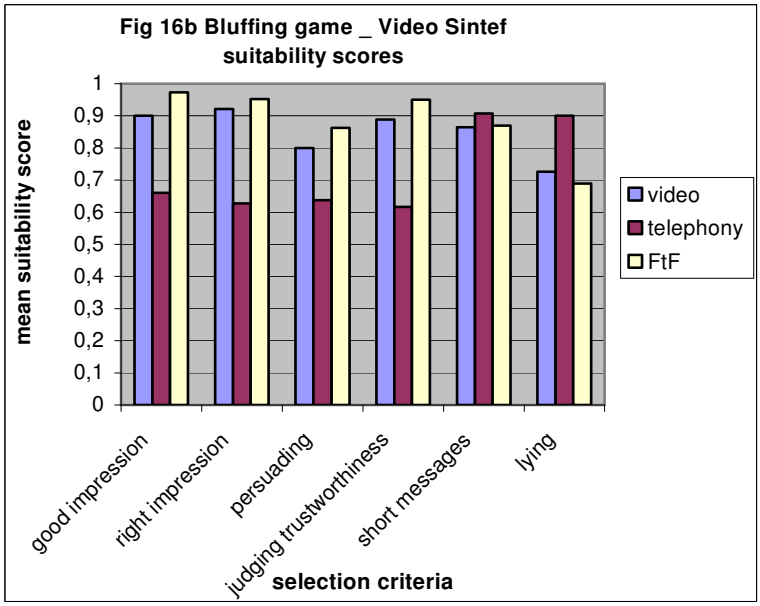


3.9.2 Bluffing game _ Suitability scores

The suitability scores of the different communication media are pictured in Figures 16a,b. They show that:

- handsfree audioconferencing was slightly more suitable than ordinary telephony on all criteria except 'short messages' and 'lying';
- videoconferencing was clearly more suitable than telephony and slightly less suitable than face-to-face on all criteria except 'short messages' and 'lying';
- telephony was the most suitable medium for 'lying' and face-to-face the least suitable.

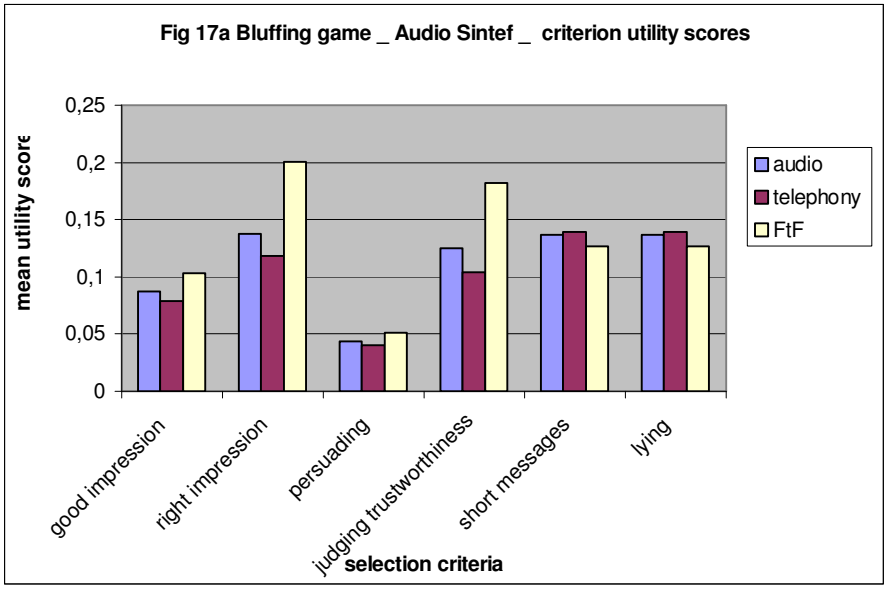


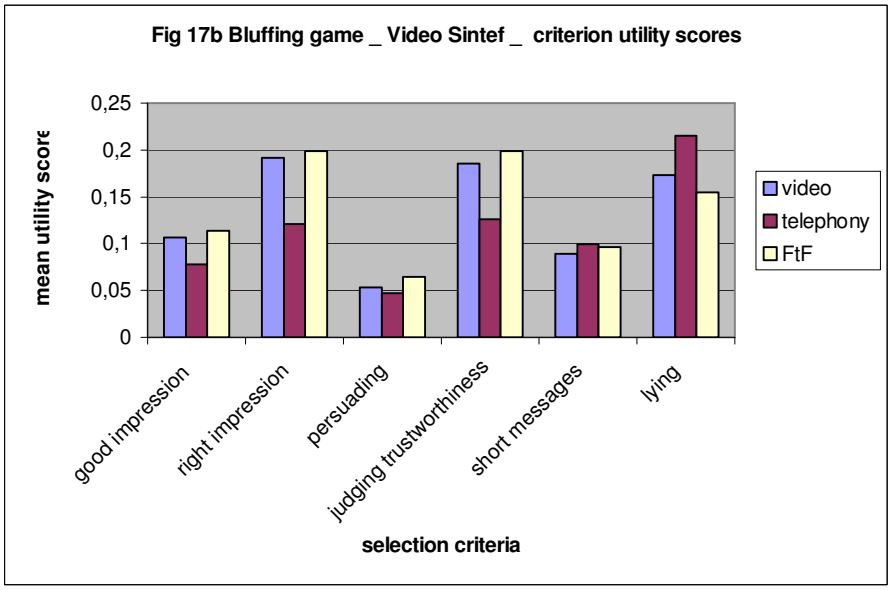


3.9.3 Bluffing game _ Criterion utility scores

Figures 17a,b picture the criterion utility scores of the different communication media in the bluffing game. They indicate that:

- the main reason for selecting video for such a task would be to get the right impression of the other person and to judge his/her trustworthiness;
- on the other hand the fact that lying is an essential part of this task would be reason for selecting telephony rather than video.





3.9.4 Bluffing game _ Aggregate Utility scores

The aggregate utility scores in figures 18a,b indicate that the differences between the media were not very great. Video was nearly as useful as face-to-face and that there was a small but clear advantage over telephony. Audio also appears be to slightly more useful than telephony.

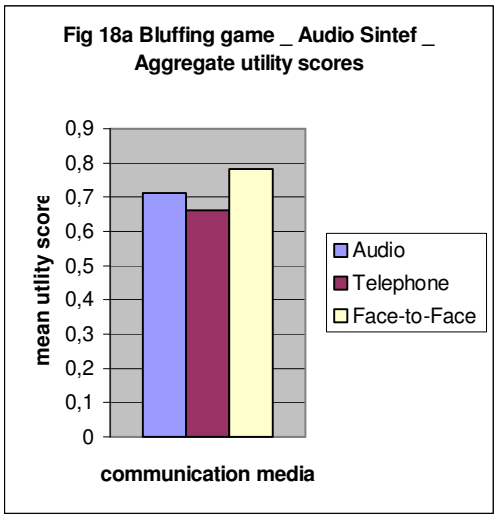


Fig 18a Bluffing game _ Audio Sintef _ Aggregate utility scores

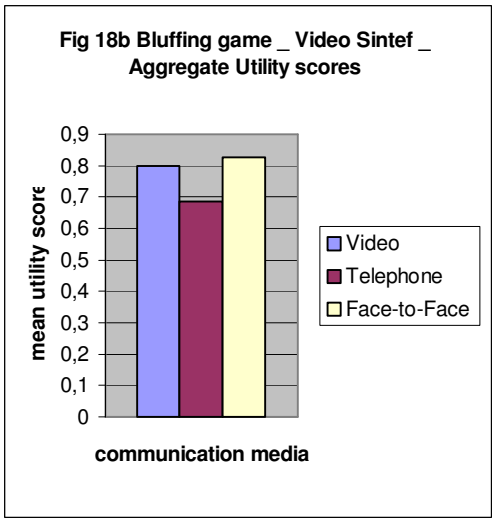


Fig 18b Bluffing game _ Video Sintef _ Aggregate Utility scores

3.10 Conclusions from the laboratory experiments

Specific questions addressed in the laboratory experiments were:

- the importance (weight) of different criteria when selecting a communication service for carrying out a particular communication task;
- the most likely criteria for selecting videoconferencing instead of ordinary telephony;
- the effect of differences in videoconferencing parameters such as screen size and audiovisual delay, on the (potential) utility of videoconferencing for its end-users;
- the (potential) utility of a talking head (avatar) as an addition to person-to-person speech communication.

Answers to the first two questions are summarised in Table III. Firstly, the table shows that different criteria were important in different tasks (e.g. 'map task' versus 'bluffing'), and that the same criteria are important if the tasks were similar ('negotiation' and 'AAC). Secondly, the table also shows that videoconferencing is more useful than telephony on all important selection criteria, with the exception of 'short messages' and 'lying'.

Regarding the other two questions, the results from the laboratory experiments showed little if any difference between the different forms of videoconferencing investigated in these studies. This is somewhat surprising because of there were quite large differences in screen size and audio-visual delay. It suggests either that these differences are not very important for the

usefulness of the medium or that our measurement method was not very sensitive. The same may be said about the utility of the avatar. On the basis of these data there seems to be little point in adding an avatar to speech, but again this may be because our measurement method was not sensitive enough. It is also possible that the quality of the avatar was insufficient.

Table III. Main selection criteria and reasons for selecting videoconferencing

Task	Main selection criteria	Video > telephony	Telephony > video
Map task	• explanation • advice • reaching agreement • short messages	• explanation • advice • reaching agreement	• short messages
Negotiation	• reaching agreement • persuasion • getting the right impression of the other person • judging the other person's trustworthiness • making a good impression	• reaching agreement • persuasion • getting the right impression of the other person • judging the other person's trustworthiness • making a good impression	none
AAC	• reaching agreement • getting the right impression of the other person • judging the other person's trustworthiness • making a good impression • explanation • persuasion	• reaching agreement • getting the right impression of the other person • judging the other person's trustworthiness • making a good impression • explanation • persuasion	none
Bluffing	• getting the right impression of the other person • judging the other person's trustworthiness • lying	• getting the right impression of the other person • judging the other person's trustworthiness	• lying

4 Applying MAUT to evaluate different communication media in business communication

4.1 Aim and objectives

Deliverable D4 'Results of Field Experiments of Communication Media' (Følstad et al., 2002) provides a full description of the field study. It studied the choice of communication media by business people working within SINTEF. During a period of five months, three SINTEF managers and two accountants who had to collaborate regularly while working at different locations, were provided with the following four new communication media on their desktop:

- avatar telephony
- audio conferencing
- videoconferencing
- multimedia conferencing.

They were free to use any of these new media as they wished and they could also communicate via email, ordinary telephony or face-to-face. The use of these media was monitored during the five months period via automatic logs, interviews and questionnaires.

The general aim of applying MAUT in this field study was to show how it could be used in a real-life business environment.

Specific objectives were to find out:

- which communication activities are most important for the selection of a communication medium
- how suitable are the different media for carrying out specific communication activities
- what is the overall usefulness of each of the different communication media.

4.2 Data collection method

As previously explained, to apply MAUT and compute utility scores it is necessary to specify:

- the set of alternatives to be evaluated;
- the set of selection criteria on which these alternatives are to be evaluated
- a method to determine the relative importance or weight of these selection criteria
- appropriate measures for value scoring the set of alternatives.

Specifying the alternative communication media
The set of alternative communication media in this study were:

- avatar telephony
- telephony
- videoconferencing
- email
- face-to-face.

This includes 'old' as well as 'new' communication media; but multimedia conferencing was not included it is not really a separate medium and audioconferencing was not included because it was regarded as the same medium as telephony.

Specifying and weighting the selection criteria

The selection criteria were based on interviews in which the participants had indicated for which communication activities they had used the communication media. These communication activities were then taken as possible criteria for selecting a medium.

The weighting of these criteria was done towards the end of the five months period. To determine the weight on a scale of 0 to 10, participants were presented with the list of activities presented in Table IV and instructed as follows:

'A communication medium such as a telephone, email or a videophone can be used for different types of communication tasks, such as short messages, meetings, planning, sharing information etc. For some communication tasks it does not really matter what medium you choose. For other tasks it is more critical to use the right medium. Now we will be going through the list of communication tasks collected in the interview. For each task you should rate how important it is for you to choose the right medium. Your ratings may range from 0 = totally unimportant to 10 = extremely important.'

Table IV Selection criteria for communication media in the field study (criteria in capitals are common to the groups)

Accountants	**Managers**
• INFORMATION SHARING • SIMPLE HELP AND PRACTICAL CLARIFICATION • MESSAGES AND YES/NO QUESTIONS • Planning and distribution of tasks • Discussion about economical question (with fellow accountant) • CLARIFICATION OF ECONOMICAL QUESTION (with manager) • Generating monthly report • Staff meetings	• INFORMATION SHARING • SIMPLE HELP AND PRACTICAL CLARIFICATION • MESSAGES AND YES/NO QUESTIONS • Thinking and process • CLARIFICATION OF ECONOMICAL QUESTION (with accountant) • Reporting and administration • Contracts and projects • Market and strategy • Management meetings

Suitability ratings

For each communication task the subjects was asked to rate the suitability of the five different media. Each medium was scored on a separate scale from 0 = totally unsuitable to 10 = ideally suitable. These scores were then divided by 10 to obtain normalised suitability scores on the same scale as the weightings and used for calculating the utility scores.

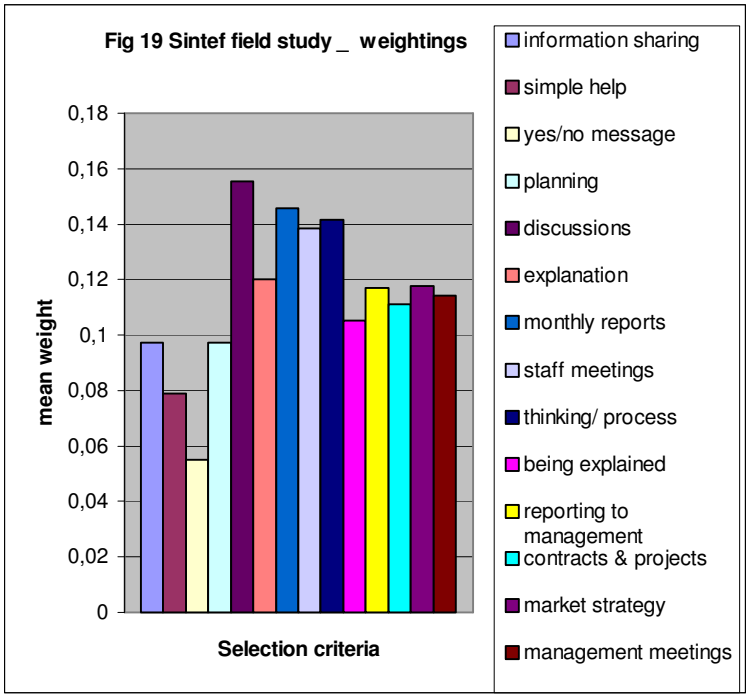
4.3 Data analysis and results

The various MAUT measures were computed in the same way as described in section 3.5 for the laboratory experiments. However, It should be noted that the group means from the field study only represent a small number of persons. Three managers and two accountants participated and one of the managers was excluded from the data analysis because he had rated all selection criteria as 10 = extremely important, which we interpreted as not having followed the instructions. Furthermore, because the managers and accountants had only three selection criteria in common (see Table III), the means for only those three criteria represent four persons while the means for the other criteria represent only two persons. On the other hand, unlike the subjects in the laboratory experiments, the participants in the field study could use the 'new' communication media' in their daily work and over a sufficiently long period to become well-acquainted with them.

4.3.1 Weightings _ SINTEF field study

The mean weights of the communication activities that served as selection criteria are presented in Figure 19. It shows that:

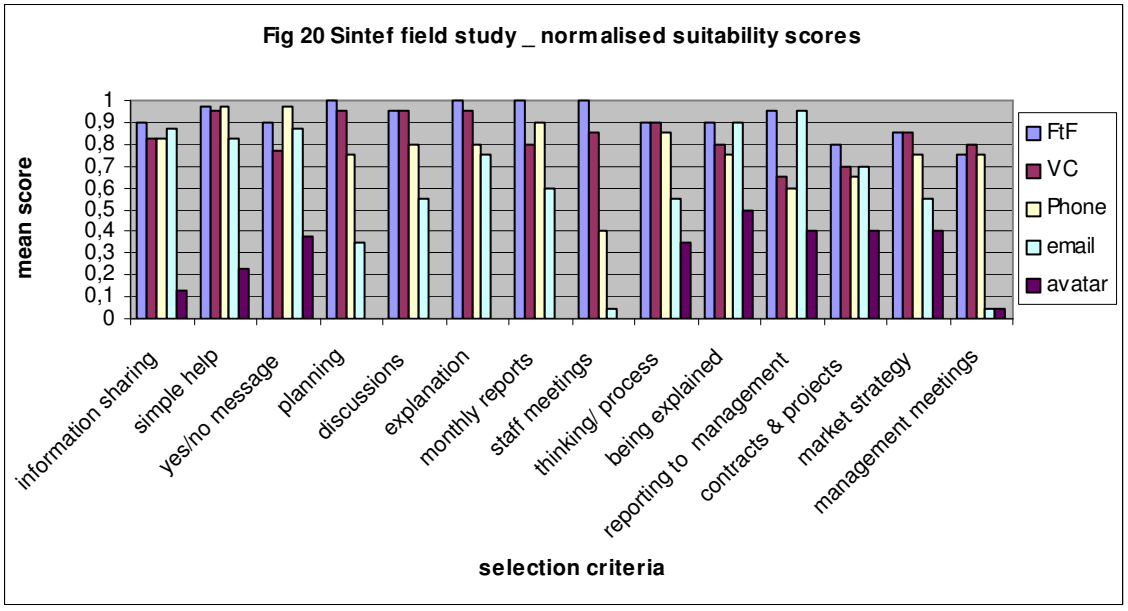
- discussions, monthly reports, staff meetings and 'thinking process', which are activities that take more time and may involve more than two people, were the most important criteria for selecting a communication medium;.
- yes/no messages which is usually a short duration activity between two people was the least important selection criterion.



4.3.2 Suitability scores _ SINTEF field study

The suitability scores are presented in Figure 20. The most noticeable features of these data are that:

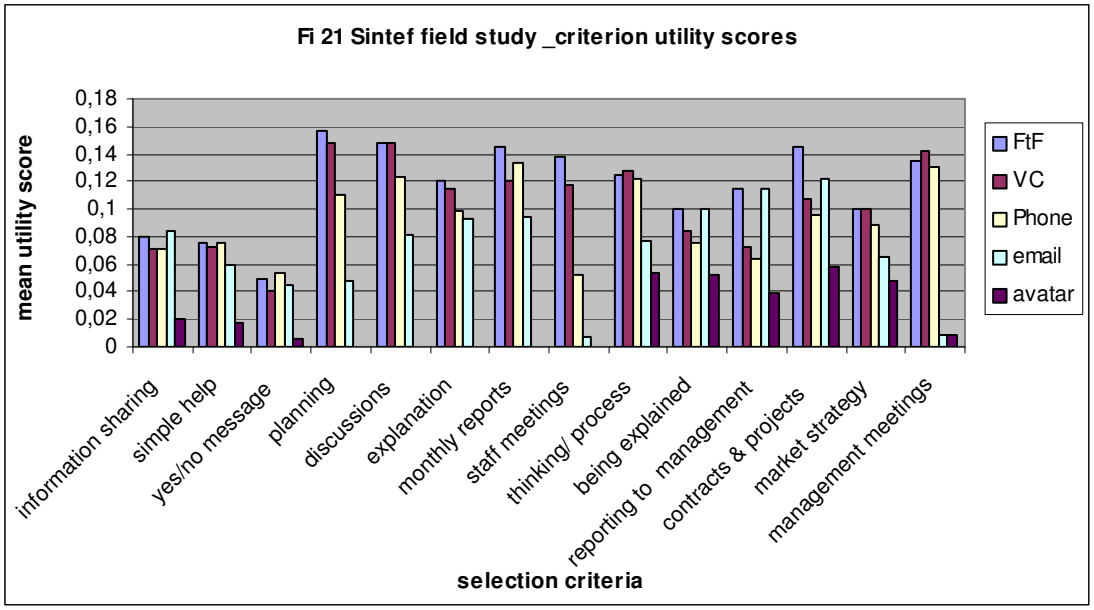
- for staff meetings, planning, discussions and explanation, videoconferencing was rated as more suitable than telephony;
- for the yes/no messages, the telephone was more suitable than videoconferencing
- for reporting to management, face-to-face and email were rated more suitable than videoconferencing or telephony;
- avatar telephony was clearly the least suitable medium.



4.3.3 Criterion utility scores SINTEF field study

The criterion utility scores are presented in Figure 21. The most noticeable conclusions from these data are that:

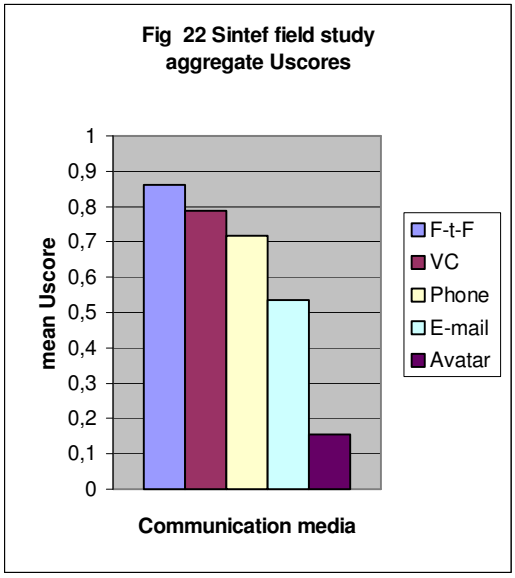
- the main activities where videoconferencing was more useful than telephony were: staff meeting, planning and discussions
- email was the most useful telecommunication medium for information sharing, being explained, reporting to management and communicating about contracts and projects



4.3.4 Aggregate utility scores _ SINTEF field study

The aggregate utility scores in Figure 22 show that

- face-2-face was more useful than videoconferencing
- videoconferencing was more useful telephony
- telephony was more useful than email
- the avatar phone was clearly the least useful.



5 Applying MAUT to assess the utility of videotelephony in delivering a support service at home

5.1 Aim and objectives

This chapter describes a case study carried out by IvD in collaboration with the IST@Home project[2]. The service provider was Telesenior, which is a joint venture between City of Kortrijk (Belgium) and the social welfare department of that city. The service activities consisted of:

- casual social contact
- information and consultancy about physical health and psychological and social matters
- information relating to practical matters such as housing and finances.

An important goal of the service provider was to enable elderly people to remain longer in their own home instead of moving to sheltered housing or a nursing home. Providing general care to an older person living in his or her own home typically costs some €300 per month. This increases to €750 per month when they move to sheltered housing, and then to €1.800 for nursing home care. Furthermore, experience has shown that isolation, lack of stimulation and on-tap support are important reasons for driving many older people rapidly toward the "cared for" end of the 'independent-dependent' spectrum. Hence, if remote services could counteract social isolation and provide easy access to support, it should also be cost effective.

Videotelephony was introduced as a new medium for service delivery, because it was believed to improve the quality of the remote services and diminish the need for home visits. A large screen TV with set-top box served as videotelephony terminal in the home of a client, who could with a simple push on a button set up high-quality audio-visual communication with a professional care provider (social nurse, social worker...) at the service centre. The client could also decide him/herself when his/her picture is being sent to the service centre; and of course he/she could also communicate with the service staff via telephone or during visits in his/her home.

The aim of this case study to provide an example of how a content service provider could use the cost-benefit analysis method to assess the usefulness of a communication service for the delivery of service content. The participants were 8 men and 7 women aged from 63 to 85 years old. They were all Telesenior clients with videotelephony installed in their home.

Specific objectives were to assess:

- the importance of the different service activities
- the suitability of videotelephony for these activities
- the usefulness of videotelephony in comparison to ordinary telephony and face-to-face communication in delivering these support services in the home.

[2] IST@Home is the successor of the HAS Video project. Both are IST projects funded under the Fifth Framework Programme. HAS Video (IST-1999-10523) has started the 1st May 2000 and finished the 31st January 2002. IST@Home (IST-2000-28406) started the 1st February 2002 with a duration of 24 months.

5.2 Data collection method

As previously explained, to apply MAUT and compute utility scores it is necessary to specify:

- the set of alternatives to be evaluated;
- the set of selection criteria on which these alternatives are to be evaluated
- a method to determine the relative importance or weight of these selection criteria
- appropriate measures for value scoring the set of alternatives.

Specifying the alternative communication media:
The alternatives to be evaluated were the communication media the clients used to communicate with the service centre staff, i.e.:

- telephony
- videoconferencing
- face-to-face.

Specifying and weighting the selection criteria
Because the aim was to evaluate the usefulness of the communication media in delivering the service, the components of the service (service activities) were taken as selection criteria. They were specified on the basis of the descriptions that the service centre staff had used to keep log records of their contacts with clients. On the basis of the records of the period from January 2001 until the end of June 2002, the following service activities were identified and grouped into three categories, i.e:

- Casual Talk /
    - keeping-in-touch
    - entertainment
- Consultancy
    - physical health
    - psychological
    - social
- Information
    - housing
    - financial
    - special aids services for elderly
    - service support of technical system
    - questions about other organisations.

Weighting the relative importance of these communication activities was based on the assumption that the relative frequency of requesting a service activity would reflect its importance. For each participant the normalised weight was computed for each activity by dividing the number of contacts for that particular activity by the total number of contacts with service centre personnel (i.e. including all activities). These normalised weight scores were then used for the computation of the utility scores.

Suitability ratings

To obtain the suitability ratings the clients were interviewed and were asked to rate the suitability of each of the three different communication media for each of the ten service activities on a scale from 1 = totally unsuitable to 10 = ideally suitable, as if they were marking it for a school report. These scores were then divided by 10 to obtain normalised suitability scores on the same scale as the weightings and used for calculating the utility scores.

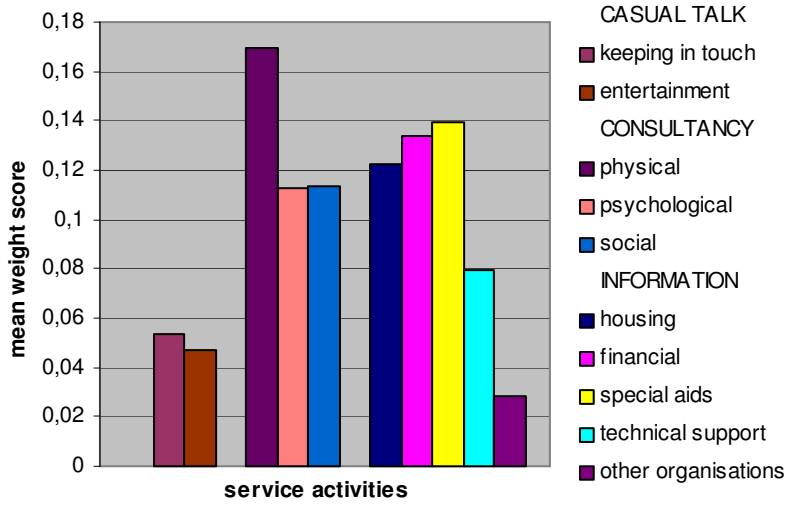
5.3 Data analysis and results

5.3.1 Weightings _ IST@Home

The mean weights of the service activities that served as selection criteria are presented in Figure 23. The main features of these data are that:

- consultancy about physical health was the single most important service activity, but consultancy about psychological and social problems was also important;
- other important activities is the provision of information about housing, finances and special aids;
- 'casual talk ' was relatively unimportant.

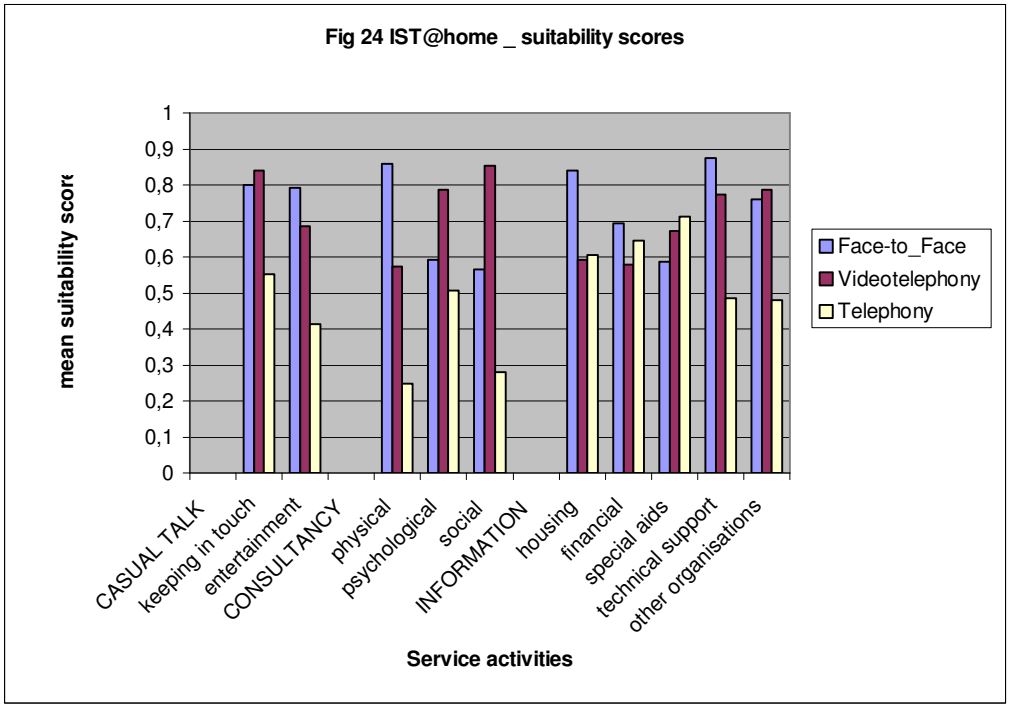
Fig 23 IST@Home _ weightings



5.3.2 Suitability scores _ IST@Home

The suitability scores are presented in Figure 24. The most noticeable features of these data are that:

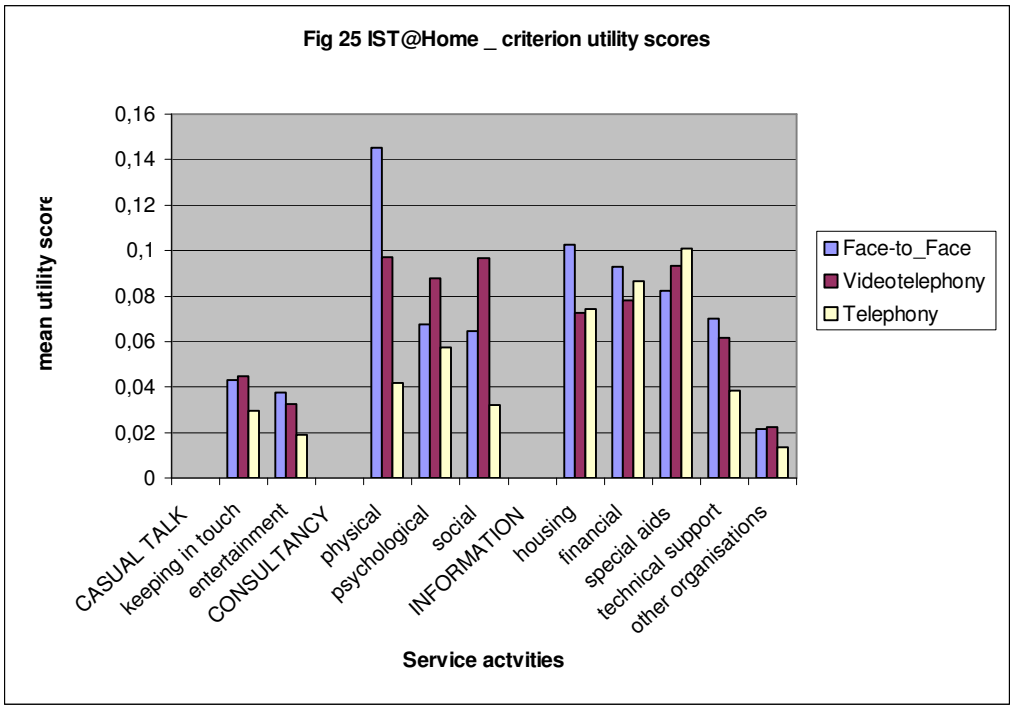
- for 'casual talk' and all three consultancy activities the videophone is more suitable than the ordinary telephone;
- for consultancy about psychological and social matters the videophone is also better than face-to-face communication; probably because the videophone makes it possible to see and talk to the service staff immediately whereas where as for face-to-face communication the client has to wait for a home visit;
- for consultancy about physical health and providing information about housing matters videotelephony was less suitable than face-to-face communication during home visits; probably because during a home visit the client can be physically examined and show the service staff around the house.



5.3.3 Criterion utility scores _ IST@Home

The criterion utility scores are presented in Figure 25. The main conclusions from these data are that:

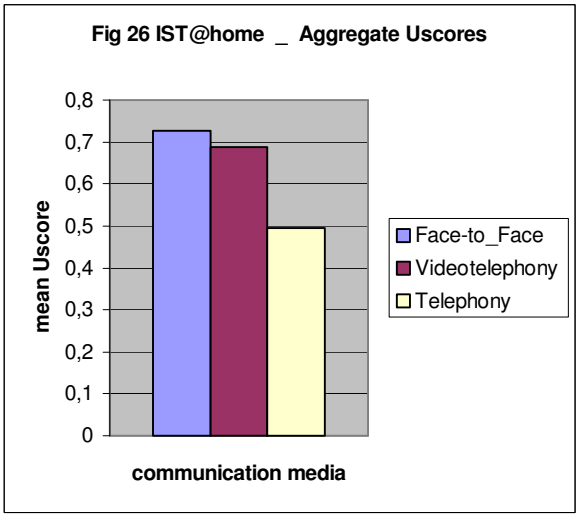
- the main activities where videoconferencing was more useful than telephony were the three consultancy activities
- for psychological and social consultancy the videophone can very well replace the home visits
- for consultancy on physical health home and providing information about housing matters, (some) home visits are still necessary.



5.3.4 Aggregate utility scores _ IST@Home

The aggregate utility scores in Figure 26 show that:

- face-to-face was only slightly more useful than videotelephony
- videotelephony was clearly more useful than ordinary telephony.



6 Applying MAUT to select communication media for disabled people

6.1 Aim and objectives

This chapter describes a second case study carried out by IvD in collaboration with Kwecoo, a small-scale housing project in Landgraaf (the Netherlands) for adults with multiple sensory, motor, and/or mental disabilities. It was set up by parents of the clients to provide sheltered housing in a new, wheelchair accessible apartment building with an up to date information infrastructure. The emphasis of the care is on helping the clients to develop their communication with each other, but also in the community, the sheltered workplace and during recreational activities.

For Eye2Eye, Kwecoo offered an opportunity to pilot MAUT with a varied population that is likely to need customised telecommunication solutions to fulfil their special needs. Specific objectives were to address the typical MAUT questions, i.e.:

- which communication activities are most important to these individuals,
- which communication media would be most useful to them.

6.2 Participants

The participants were eleven of the Kwecoo clients, 8 men and 3 women, aged between 22 and 49 years. The one common characteristic of the Kwecoo clients is that they need support in order to be able to communicate. The communication problem can stand alone, or be part of a more general disabling condition, like hearing loss to the point of deafness or poor vision to the point of blindness. Motor ability ranges from normal to clumsiness to severe cerebral palsy, mental abilities range from profound mental retardation to average intelligence. Social abilities are very limited in some with a diagnosis of autism spectrum disorder, and relatively good in others. This diversity in (dis)abilities is reflected in the communication modalities that are accessible to the clients: in either reception or production: speech, visual communication modes like signing (sign language, sign systems), finger spelling or graphic symbols, including text, or tactile (tangible) symbols.

Approval to participate was obtained from their parents during one of the regular meetings of parents of Kwecoo clients.

6.3 Data collection method

As previously explained, to apply MAUT and compute utility scores it is necessary to specify:

- the set of alternatives to be evaluated;
- the set of selection criteria on which these alternatives are to be evaluated
- a method to determine the relative importance or weight of these selection criteria
- appropriate measures for value scoring the set of alternatives.

Specifying the alternative communication media
On the basis of what was known about the clients' abilities and special requirements, the following telecommunication media were selected for consideration as potentially useful:

- Telephone
- Video-telephone implemented through settop box on TV (provided by IST@Home).
- Computer or PDA (Personal Digital Assistant) with internet access and different input and output modes; i.e.:
  Input:
  -(adapted) keyboard,
  - drawing tablet,
  - (adapted) joystick,
  - symbol board,
  - speech input
  Output:
  - text,
  - text to speech,
  - graphic symbols,
  - graphic symbols to speech.

These media were demonstrated to the clients and their parents on a specially organised day, during which they all obtained hands-on experience of video-telephony, computer use with a variety of input and output modes and a dedicated PDA with digitised speech output. Ordinary (mobile) phones were not demonstrated as those were known to all clients, though most of them could not use them without assistance. Two sessions were given, one in the morning and one in the afternoon to ensure that everyone could have ample time for a good try-out. Most clients who attended the demonstration were fascinated by the devices and were able to access the various devices after a relatively short introduction. One profoundly deaf client, diagnosed as with autistic spectrum disorder, was observed to suddenly grasp the idea of communicating visually by videophone.

Specifying the selection criteria
Just as in the SINTEF field study and the IST@Home case study, we assumed that the criteria for selecting the communication media should reflect the suitability of these media for carrying out communication tasks or activities. On the basis of already existing intake-interview reports and a full day's registration of all activities of each client, the following communication activities were specified as selection criteria:

- contacting family
- making appointments (e.g. with friends, family)
- public information (e.g. looking time tables for the train)
- commercial information (e.g. offers from local stores)
- commercial services (e.g. making a shopping list)
- news/ interest groups
- (tele)counselling
- (tele)education

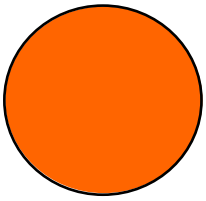
Weighting the selection criteria
Weighting the selection criteria was done through interviews. Because the communication difficulties were mostly about the clients, this required special procedures and adaptations.

Three of the clients were blind and only one of them has good hearing and speech. These clients could be interviewed orally, but the other two are unable to indicate their opinion reliably to an outsider, so their parents were the only ones interviewed. It is known that parents or carers do not always hold the same opinion as their children or clients (Welle Donker et al, 1991; Didden et al, in press), but in cases such as these it is the best approximation possible.

For most of the clients without a serious vision problem, spoken language is in itself not sufficient to obtain reliable information; but with the aid of visual communication support they can express their own opinion. It was therefore decided to use pictograms or illustrations, in addition to speech or signing or finger spelling in the interviews with all clients who are not blind; clients who depend on signing or finger spelling for their communication were accompanied by a familiar sign language interpreter. In addition, we also interviewed most of the parents or carers of those clients that were able to give their own opinion.

The communication activities were visualised through the use of cards with pictograms, such as the illustration for 'communicating with family' pictured here:

This allowed intuitive rank ordering of activities by simply positioning the most important nearest to the client, and the least important farthest away. Subsequently, the weighting was done with a separate set of four round cards indicating relative importance of the communication activity on a four-point scale: not important (blue background with black zero in centre), somewhat important (white background with black and white thumbs-up in centre), important (red background with two coloured thumbs-up symbols), very important (orange background with three thumbs-up symbols), e.g.:

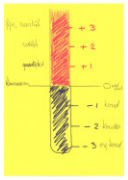


For the purpose of computing utility scores, these 4-point weightings were then normalised by converting them to a scale from 0 to 1.0.

Suitability ratings of the communication media

The possible communication media were also visualised through the use of illustrations. Each possible medium was depicted by a picture pasted onto a yellow A5 sized card, with an arrow in the left bottom corner e.g.:

Subsequently, the suitability of the medium for a communication activity was indicated by pointing the arrow of the medium card to a point ranging from –3 (dark blue) to +3 (red) on a "thermometer" on another yellow card, i.e.:



This translates into a seven-point scale, which for the computation of utility scores was converted to a normalised scale from 0 to 1.0.

6.4 Data analysis and results

Because of the varied nature of participants, needing customised telecommunication solutions to fulfil their special needs, their is little point in reporting the group averages. Also, providing a full data description for each individual seems unnecessarily detailed. The main questions addressed in this study were which:

- communication activities are most important to these individuals,
- communication media would be most useful to them.
-

To answer these questions, Table V presents a summary of each client and the data obtained for each client and/or their relatives or carers the:

- three most important communication activities in rank order
- three most suitable communication media in rank order.

In interpreting these data, it should be noted that to use the communication media they would often rely on the assistance or mediation of their carers. For instance, a deaf client may communicate by ordinary telephone through the mediation of a carer, or a carer may help the client to access a website.

Table V: Most important activities and most suitable media for Kwecoo clients.

Clients' profiles	Persons interviewed	Most important activities	Most suitable media
Isaac (31) - seriously hearing-impaired - one eye is blind - below average IQ - simple reading, writing & typing	client	1. contacting family 2. public information 3. (tele) education	1. face-to-face 2. pc (email) 3. videophone
	mother	1. contacting family 2. news/interest groups 3. making appointments	1. face-to-face 2. videophone 3. telephone
Theo (49) - deaf - below average IQ - no oral or signing skills - communicates with pictograms	client	1. contacting family 2. making appointments 3. (tele) education	1. face-to-face 2. videophone 3. pc (email)
Leo (22) - hearing-impaired - visually impaired (tunnel vision) - normal IQ and language skills - poor social skills/ vulnerable	client	1. contacting family 2. making appointments 3. public information	1. face-to-face 2. pc/pda/phone combi 3. telephone
	parent	1. contacting family 2. making appointments 3. public information	1. face-to-face 2. pc/pda/phone combi 3. pc (email)
Josephina (43) - hearing-impaired - visually impaired (tunnel vision) - Down syndrome - limited speech and language skills - motor-impaired	client	1. contacting family 2. making appointments 3. commercial info	1. face-to-face 2. pc (text to speech) 3. telephone
	sister	1. contacting family 2. making appointments 3. (tele)counselling	1. face-to-face 2. pc/pda/phone combi 3. videophone
Paddy (24) - deaf / no speech - sufficient language perception - limited reading, writing & typing - poor social skills	client	1. contacting family 2. making appointments 3. public information	1. face-to-face 2. videophone 3. pc (email/www)
	carer	1. contacting family 2. making appointments 3. public information	1. face-to-face 2. pc/pda/phone combi 3. videophone

Table V (cont): Most important activities and most suitable media for Kwecoo clients

Clients' profiles	Persons interviewed	Most important activities	Most suitable media
Dirk (25) - blind - mentally retarded - sufficient speech and language skills - no reading, writing or typing	mother	1. contacting family 2. interactive games 3. news/ interest groups	1. face-to-face 2. pc (text to speech) 3. telephone
Maria (34) - sufficient hearing & vision - limited speech and language skills - Down syndrome - no reading, writing or typing - warm, social personality	carer	1. contacting family 2. making appointments 3. commercial services	1. face-to-face 2. videophone 3. pc (text-to-speech)
	sister	1. making appointments 2. contacting family 3. news/ interest groups	1. face-to-face 2. pc (text-to-speech) 3. (mobile) telephone
Eddy (43) - blind - hard of hearing - normal IQ and language skills - good social skills	client	1. contacting family 2. making appointments 3. public information	1. face-to-face 2. telephone 3. mobile phone
Erica (22) - severely motor-impaired - severely mentally retarded - visually impaired (tunnel vision) - little speech (about 20 words) - some language comprehension	client	1. contacting family 2. making appointments 3. commercial services	1. face-to-face 2. pc (text-to-speech) 3. telephone
	parent	1. contacting family 2. making appointments 3. commercial services	1. face-to-face 2. videophone 3. pc (text-to-speech)
Peter (32) - deaf - visually impaired in one eye - some motor-impairment - below average IQ - no speech, reading or writing	mother	1. contacting family 2. making appointments 3. (tele)counselling	1. face-to-face 2. pda (with symbols for emergency) 3. pc (symbol chat)
Anna (24) - blind - adequate hearing - severely mentally retarded - limited language comprehension - no speech	mother	1. contacting family 2. making appointments 3. (tele)counselling.	1. face-to-face 2. videophone 3. telephone

Given the communicative and cognitive limitations of these clients as well as their limited experience with most of the communication media in this study, conclusions from these data are provisional. Nevertheless, it seems clear that contacting the family is the most important communication activity and that face-to-face is the most suitable way to communicate. Telecommunication should therefore be regarded as complementary and not as subsidiary.

There also appears to be a relation between most suitable media and a client's (dis)ability; but this relation is also not as obvious as one may expect. For instance, Anna the last client in the table is blind; yet her mother's ratings indicate that the videophone is more useful than the telephone. This can only be understood if we consider that Anna is severely retarded and cannot speak; this makes it very important for the mother to be able to see Anna's reactions and expression while speaking to her. Analysing the data in this way can be a basis for an initial selection of the most promising (tele)communication media for specific clients. This in turn can then be followed by a pilot in which the clients can use the selected media on a more regular basis.

7 Design specification of the Cost-Benefit Analysis Tool

The Eye-2-Eye cost-benefit analysis method aims to asses the (potential) utility or value of the telecommunication media for end-users. The target audiences for this method are organisations that have an interest in optimising telecommunication media for end-users. These are:

- Telecommunication network operators and service providers (e.g. Telenor)
- Telecom equipment manufacturers (e.g. Tandberg)
- Service content providers (e.g. IvD, City of Kortrijk) who use telecommunication to deliver their services such as information, entertainment or support services for their clients/customers.
-

Early in the project it was determined that for a telecom operator (e.g. Telenor) and for an equipment manufacturer (e.g. Tandberg), the cost-benefit analysis method would be implemented as a software tool to be useful for the people within those type of companies using the method. Within a network operator these may be people with the following roles:

- Strategic planner
- Network planner
- Service developer
- System integrator
- Sales person.

For a service content provider the need for software implementation was not initially assumed, but it was decided to determine whether a software tool was necessary on the basis of the results of the case studies carried out by IvD in collaboration with IST@Home and Kwecoo. These studies are fully reported in chapters 5 and 6. They show that a software implementation is not necessary for the collection, analysis or reportiing of the cost-benefit data. Because a service provider would most likely collect the data through interviews or questionnaires a software implementation is not really required. This led us to the conclusion that for a service content provider a software implementation is not necessary for the cost-benefit analysis method to be useful. Nevertheless, the strategic planners within a service content provider may benefit from a software implemenation to enable them to simulate the cost-benefit consequences of alternative service scenarios; but their requirements would probably be similar to those of the strategic planners within a telecom operator or manufacturer. Therefore, it was decided that the specifications for the software implementation could be based on the requirements collected in the case studies carried out by Telenor and Tandberg for that specific purpose.

7.1 General approach to requirements collection

Requirements were identified through interviews, workshops and case studies over the duration of the 3-year project and based on the implementation and assessment of intermediate tools by which to present an increasingly concrete representation of a tool to intended users. As the first interviews were conducted before a cost-benefit modelling approach and implementation had been developed, they provided less constrained requirements about possibilities for cost-benefit in general; whereas later work was more focused on the type of cost-benefit approach and tools

chosen as appropriate for the project. Therefore, both 'bottom-up' and 'top-down' approaches to specification were performed.

The case studies included interviews, workshops and reviews of written materials such as company presentations of products and services. 52 in-depth semi-structured interviews and four group interviews (of 4-10 persons) have been conducted with persons having strategic, tactical or operational responsibilities in their organisation (Table VI).

External workshops were held to present and discuss the MAUT approach to cost-benefit analysis. Shortly after selection of the MAUT approach a workshop was held with representatives of British Telecom and Sony working on the EC IST project VIRTUE (June 2001). VIRTUE aims to develop semi-immersive 3D videoconferencing. When data was available from the Eye-2-Eye laboratory experiments a presentation of the approach and early results was also given at the ICOB'03 workshop (Immersive Communication and Broadcast Systems, http://bs.hhi.de/ICOB-Workshop/index.htm).

Table VI: Categorisation of participants for the individual and group interviews

Role/Position	Level[3]	Organisation
Service prescription for personal equipment	Strategic/tactical	Network operator
Investor for SMEs (for system integrators)	Strategic	Network operator
Director of research	Strategic	Network operator
Sales manager of communication services	Strategic/tactical	Network operator
Product co-ordinator for video/audio conferencing	Strategic/tactical	Network operator
President of research	Strategic	Network operator
Coordinator of public videoconference service	Tactical/operational	Network operator
Project leader, 4G mobile systems	Strategic/tactical	Network operator
System integrator	Tactical/operational	Network operator
Project leader, IP telephony	Strategic/tactical	Network operator
Executive Vice President	Strategic/tactical	Equipment manufacturer
Head of development	Strategic/tactical	Equipment manufacturer
Sales representative	Tactical	Equipment manufacturer
Salesmen (group interviews)	Tactical/operational	Service provider
Market analysist (group interviews)	Tactical	Service provider
Management (group interviews)	Strategic	Service provider
Operators	Operational	Service provider
Customer support people	Operational	Service provider
System developers/integrators	Tactical/operational	Service provider
System maintainers	Tactical/operational	Service provider

The main requirements identified in early interviews focused on content and application requirements for the Cost-Benefit Analysis Tool. These general requirements are summarised in the next section.

7.2 Cost-benefit tool requirements

General requirements for cost-benefit identified in early interviews are summarised in Table VI. In addition to informing certain requirements for the actual implementations of a cost-benefit analysis tool, these general requirements were used to inform:

- design of the Eye-2-Eye user tests
- the technical set-up and manipulations of the user tests.

[3] Levels conceptualised as Strategic, Tactical, and Operational.

The requirements that were identified as applicable to the Eye-2-Eye objectives are summarised in Table VII.

Table VIII lists additional requirements that were identified but beyond the scope of Eye-2-Eye.

Table VII. Cost-benefit analysis requirements identified in early interviews

Content and application requirement	Explanation
Data required for general purpose situations	The majority of products and services are developed for non-specific communication situations
Knowledge required about which communication situations have the strongest requirements for quality	A specific request from the Target Audiences
Thresholds for QoS parameters	For identification of which communication situations have the strongest requirements for quality
Data required for business end-users which can include their private life (not private domain end-users)	The business end-users are the market when these new services are introduced
Knowledge required on end-user preferences and behaviour	To identify new products and new markets
New communication situations should be derivable from the data	A specific request from the Target Audiences
New markets for videoconferencing should be derivable from the data	A specific request from the Target Audiences
Data should be based on communication efficiency with the communication service	To upgrade the knowledge of marketing people (including salesmen and product experts) about user behaviour
Data should be based on user satisfaction with the communication service	To upgrade the knowledge of marketing people (including salesmen and product experts) about user behaviour
Data should be based on high-quality services for both fixed and mobile networks.	A specific request from the Target Audiences
Data should enable ranking between different communication services	To better understand and the customers preferences
Tool should assist Target Audiences to 'convince', 'understand' and 'be convinced'	As a sales support tool
Data should identify return of investment	As convincing data in a sales situation
Data should be based on individual users and groups of users	For personal and meeting room applications and services

Table VIII. Cost-benefit analysis requirements not addressed in this project

Content and application requirement	Explanation
Data should be quantifiable and financial	Decision makers argue most of all with quantitative financial costs and benefits but and can mix it by adding qualitative data
Contribution to a better understanding of job satisfaction?	A specific request from the Target Audiences
How can the absence because of sickness be reduced?	A specific request from the Target Audiences

7.3 The Cost-Benefit Analysis Tool design requirements

Initial assessments of tool requirements for a MAUT approach to cost-benefit analysis were performed using a commercially available program that supports this technique applied to decision analysis (www.SIMUL8.com/products/visa.htm). This existing tool was instantiated with a selection of data from early project laboratory experiments to enable early hands-on experience and assessment against the existing requirements summarised in Table IX and by some of the project partners.

An example view of the Cost-Benefit Analysis Tool with Eye-2-Eye data is shown in Figure 3.

The results are summarised as requirements for the Cost-Benefit Analysis Tool. Although some requirements were met by the existing decision-support tool, many requirements were not met.

All of these requirements shall be addressed the Eye-2-Eye cost-benefit tool (Deliverable D5.3).

Table IX. Cost-benefit tool implementation requirements

Eye-2_Eye Cost-Benefit Tool requirements	Requirements 'met' or 'not met' by VISA decision support tool
User Guide & Manual	Met
Visual & interactive interface	Met
Ability to modify in terms of changing ('what if') and adding alternatives and criteria (eg, new criteria to an existing model)	Met
Options for tailoring/viewing	Met
Intuitive manipulation and presentation of 'cause & effect'	Not met
Ability to easily check for correctly inputted data	Not met
Promote trust in the tool by providing access to the tool's calculations (eg, to see how scores are calculated)	Not met
Prevention of user from too easily changing data, with obvious 're-set' or 'return to origin'	Not met
Do not require active modification/working with the tool unless chosen by the user	Not met
Enable more 'passive' information retrieval	Not met
Ability to easily compare multiple data files (eg, to compare communication tasks)	Not met
Access to raw data (for ease of updating, etc)	Not met
Ability to run on Apple Macintosh as well as Microsoft Windows PCs	Not met
Avoid need to learn entirely a new tool (ie, maximise confidence and transfer of learning with existing common products such Microsoft Office).	Not met
Instructions for input of data	Not met
Instructions for collecting new data	Not met
Ability to provide remarks for data (eg, textual descriptions/conclusions from D5.2).	Not met

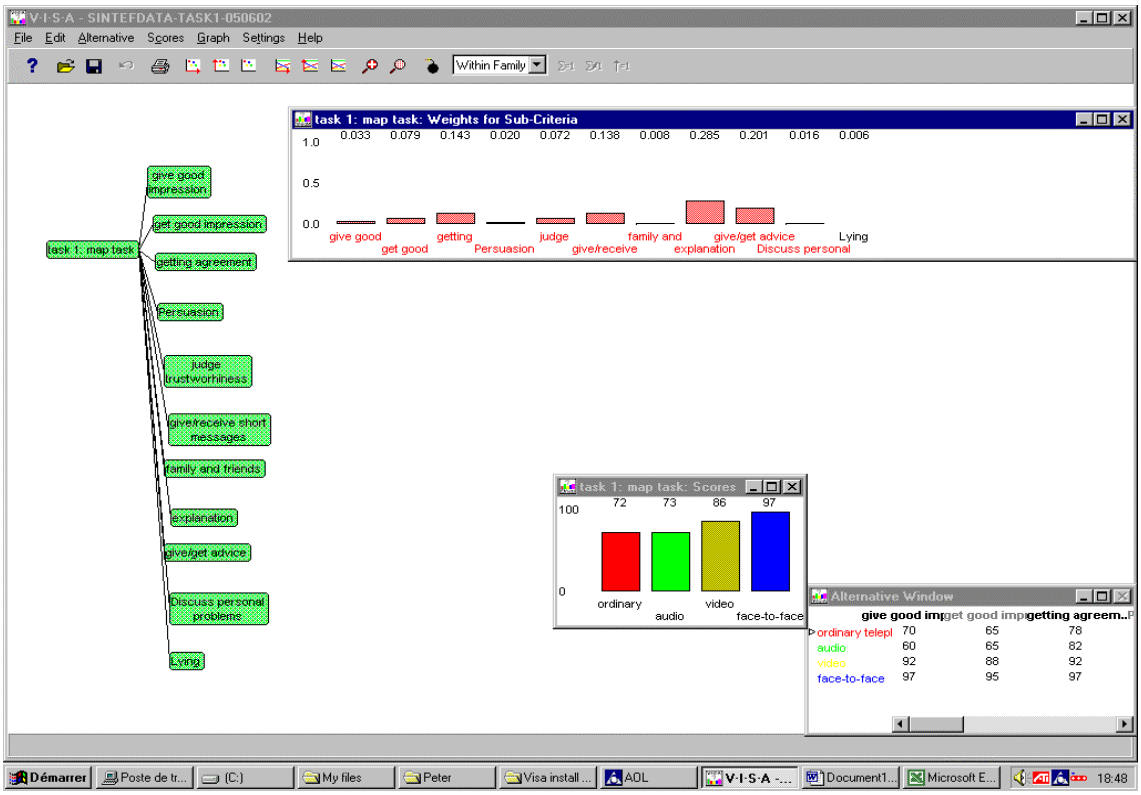


Figure 3. User interface of 'Year 2' interim test implementation (based on the commercial VISA decision-support tool)

7.4 Specification of the Cost-Benefit Analysis Tool

Table X lists the final set of requirements identified for the final version of the Cost-Benefit Analysis Tool and the specification meeting each requirement.

This specification is based on the selection of MS Excel (Microsoft ® Excel) for implementing the tool. The main reasons for selection are:

- MS Excel is a well known tool to most PC- and Macintosh users and therefore imposes a low initial learning cost
- All inputted data can be examined whenever needed
  - Users have the possibility to view/access the computation mechanisms (which should lead to better understanding and higher trust in the calculations).

A description of the design of the resulting tool follows in the following section.

Table X. Mapping of tool specifications to requirements

Tool Requirement	Tool Specification
Avoid need to learn entirely a new tool (ie, maximise confidence and transfer of learning with existing common products such Microsoft Office).	Use mature generic computational software (MS Excel)
User Guide & Manual	Use mature generic computational software (MS Excel) that has an existing user guide and manual to which a specific 'ReadMe' file can be added
Ability to modify in terms of changing ('what if') and adding alternatives and criteria (eg, new criteria to an existing model)	Have access to all data for the purpose of changing them and roll back to initial values
Intuitive manipulation and presentation of 'cause & effect'	A change in data should 'immediately' respond in that change that is implied on the rest of the data
Instructions for input of data	To be provided in specific ReadMe file
Instructions for collecting new data	To be provided in specific ReadMe file
Ability to easily check for correctly inputted data	All data should have their cells visible when data are inputted
Do not require active modification/working with the tool unless chosen by the user	A read-only or protection mechanism should be available
Enable more 'passive' information retrieval	Having a presentation that has a value for users that only will retrieve information
Access to all data	No data should be permanently hidden for the reason that that user will not have interest in it
Ability to provide remarks for data (eg, textual descriptions/conclusions from D5.2).	Use of 'Comment' facility within MS Excel and also direct 'copy and paste' within Excel cells of text, data and graphics from other MS files (e.g., MS Word and PowerPoint)
Promote trust in the tool by providing access to the tool's calculations (eg, to see how scores are calculated)	Every calculations should be available and every calculated value should be able to derive the calculation of
Ability to easily compare multiple data files (eg, to compare communication tasks)	Have a reference mechanism between certain blocks in the same file and between files
Graphical output	Use of chart types when applicable
Options for tailoring/viewing	Possibility to change chart type based on user's preference
Ability to run on Apple Macintosh as well as Microsoft Windows PCs	Some of the Target Audiences may have an Apple Macintosh

7.5 Design of the cost-benefit analysis tool

The final cost-benefit analysis tool shall be implemented in MS Excel to comply with what were found as strengths for the VISA decision-support tool whilst also addressing the requirements not met by VISA:

- Existing Guide & Manual – that is supplemented with a ReadMe-file of how the data are organised (Eye-2-Eye Deliverable D5.3)
- As visual as VISA with Excel graphs
- A interactive as VISA, but with better control of what is changed
- Modifiable in terms of changing ('what if') and adding (new criteria to an existing model)
- Many options for tailoring/viewing
- Helps/forces determination of criteria (as hierarchy trees)

- Very stable and high reliability of the MS Excel
- Can be modified /extended for specific Eye-2-Eye requirements
- The 'cause & effect' of the presentation and manipulation is more intuitive
- All interesting data is viewable at one time in order to compare tasks
- Full access to raw data (for ease of updating, etc)
- Available for Macintosh users.

7.5.1 Key design features.

The tool shall exploit features of Excel work sheets to treat either one specific task (Figure 4) or comparisons between tasks (Figure 5).

The following illustrations are based on a prototype version of the tool ('Year 3' interim version) and show provisional data for three pilot experimental tasks. In a final version of the tool, task names shall be given more intuitive labels, such as 'Joint problem solving task' or 'business communication'.

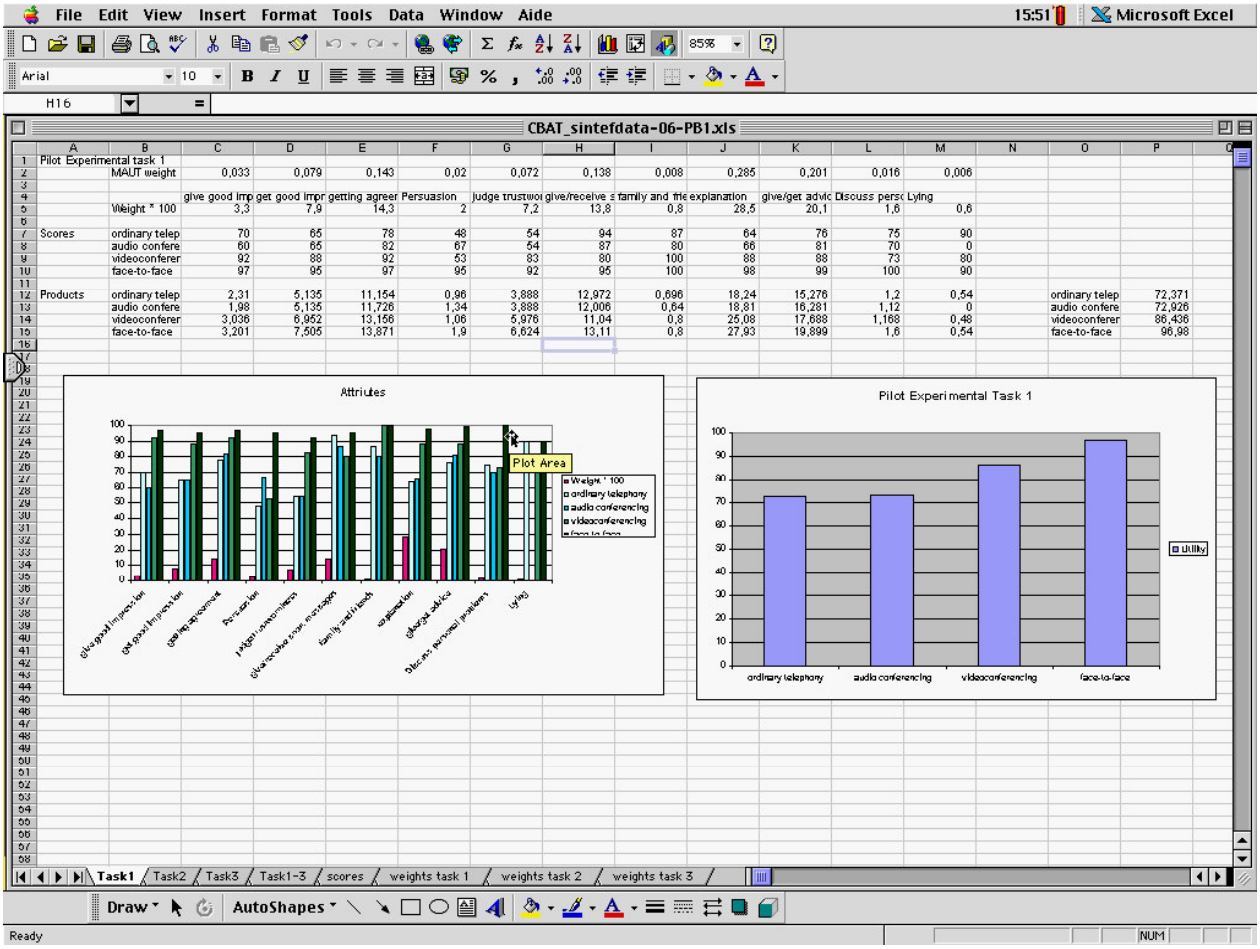


Figure 4. Utility score shown for 1 task ('Year 3' interim implementation)

As shown in Figure 4, both the attribute scores and the attribute weights that calculate the utility scores shall be provided.

- The **attributes** shall have their own column (from Column C to M). Row 2 provides the MAUT **weights** that are normalised to the sum of 1,00).
- The attribute **scores** are shown in Row 7 to 10, each row containing data about one of the communication services (e.g., Row 7 has the score for "ordinary telephony" and Column C has the data for the attribute "give good impression").

(1) The weights in Row 2 are multiplied with the corresponding attribute score for each service (the same weight is used for all services) and the product is found in Row 12 to 15.

- In Column O and P the **Utility score** for each service is calculated on the sum of the products for that service.

The graph to the left in Figure 4 ("Attributes") shows the input data based on data from B4 to M10.

The graph to the right ("Pilot Experimental Task 1") is the result graph and shows the utility score for one task (e.g., this might be 'problem solving') and is based on data from O12 to P15.

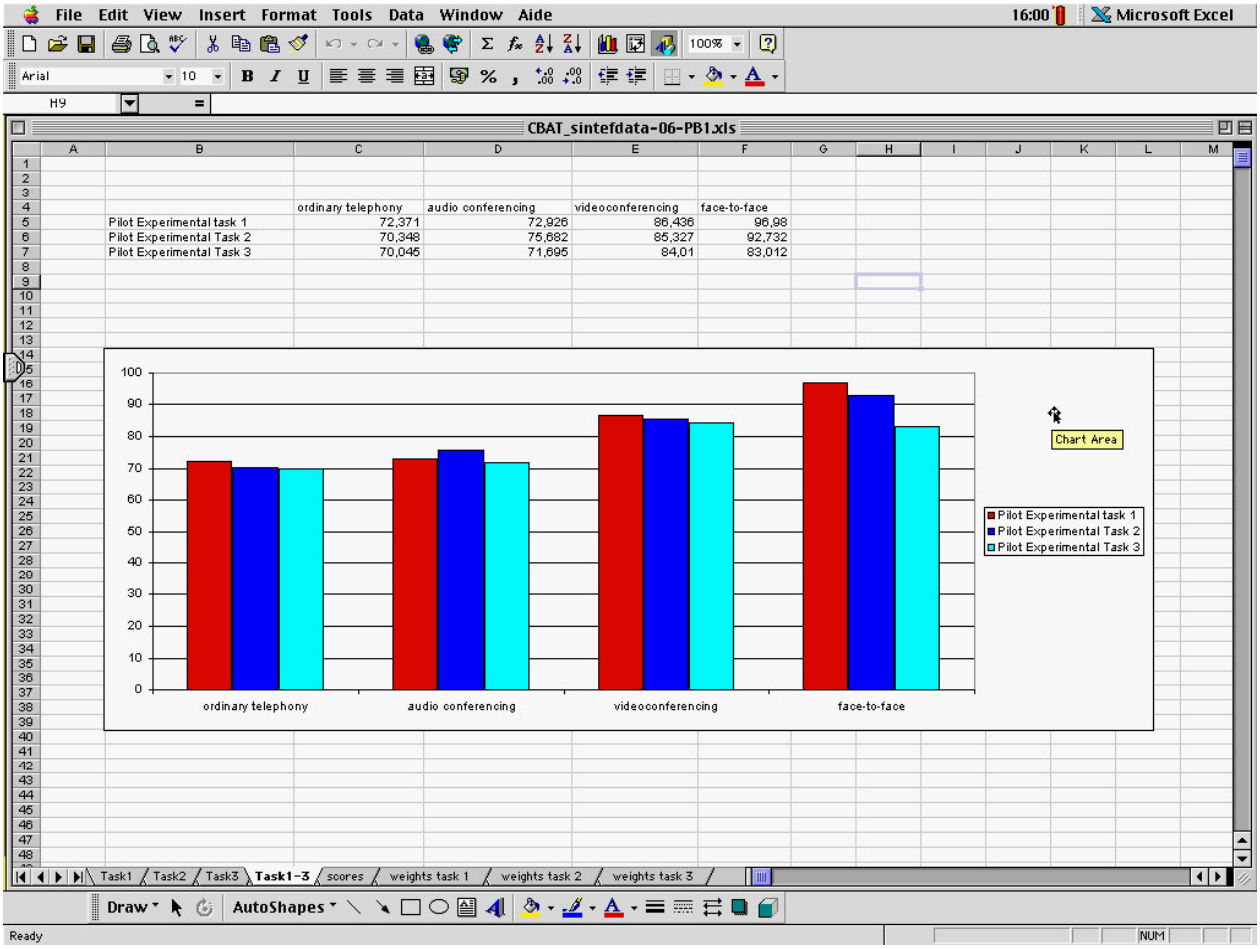


Figure 5. Comparison of utility score between 3 tasks ('Year 3' interim implementation)

In Figure 5 the graph provides a comparison between 3 tasks:
- Pilot Experimental Task 1
- Pilot Experimental Task 2
- Pilot Experimental Task 3.

In the case of the data reported in the current document, these task labels might be 'Joint problem solving task', 'simple negotiation task', etc., in the case of experimental tasks.

The attribute data are extracted from 3 work sheets, one for each of the 3 tasks in this particular illustration. For a "Pilot Experimental Task 1" C5 to F5 are extracted from the calculated sum of the products that is better shown in Figure 4.

7.6 Summary

The cost-benefit analysis tool development passed through three main iterations:

- Assessment of existing decision support tool based on MAUT ('Year 2' implementation)
- Assessment of prototype MAUT-based implementation in Microsoft Excel ('Year 3' implementation)

- Final MAUT-based implementation in Microsoft ® Excel (separate future Deliverable D5.3).

Key features of this tool are:

- Well known tool to most PC- and Macintosh users and therefore low initial cost of learning
- Access to all data for examination
- Accessibility to all the calculation mechanisms to promote a better understanding and higher trust in the analysis
- Ability to modify to conduct 'what if' analyses.

8 General conclusions and next steps

The studies reported in this deliverable show that the Eye-2-Eye application of MAUT can lead to meaningful results that, at least on the face of it, are a valid basis for recommending which telecommunication services are best suited for particular end-users and communication activities.

Two significant strengths of the method are:

1. It quantifies not only how suitable or usable a service is for carrying out a particular communication activity, but also how important that activity is to the end-users. In this sense it can bring together the aims of human factors specialists who usually focus on the former, and market researchers who usually focus on the latter.

2. The method is relatively simple to apply and the data collection method may be pragmatically chosen. Questionnaires and interviews are very suitable, but the researcher may also use already existing data, as we did for instance in the IST@Home case study.

The studies in this report can also be used as examples of when to apply the Eye-2-Eye cost-benefit method. The laboratory studies and the Kwecoo case study are examples of how the method could be used to assess the *potential* usefulness of new communication media for particular user groups or communication activities. The field study and the IST@Home study are examples of how the method could be used to evaluate the *actual* usefulness of a communication medium after the users already had considerable experience with the medium.

Further work in this area believed to be worth pursuing are developments in knowledge of consumer behaviour, such as heuristic consumer decision processes, and whether there are other non-linear processes that can predict better the decision than the linear MAUT technique.

The next steps for the Eye-2-Eye cost-benefit analysis method will focus mainly on application and dissemination:

- Eye-2-Eye partners will use the method within their own organisations and provide support for other interested organisations
- This report and the software tool will be publicly available on the Eye-2-Eye website
- The partner organisations and other interested partners will continue to exchange information on their experience with method and the tool
- The current report will be submitted to ETSI HF for consideration as an ETSI Guidelines report.
- Two journal publications and one conference paper are in preparation.

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10 Glossary of main Eye-2-Eye terminology and concepts

Acceptable price: The price that end-users are willing to pay for a particular communication service or for improved quality of service. The price of telephony (equipment as well as service) should be used as a benchmark when asking (potential) end-users of acceptable price; and the latter should be expressed as a percentage of the price of telephony, e.g. 50% (half the price of telephony), 300% (three times the price of telephony), etc.
Benefits: Benefits to the end-users from using a particular communication service (e.g. savings of travel time and costs, achievement of task goals, ease of use, easy accessibility to the called party, increased communication quality and effectiveness, etc.).
Communication activity: What the end-users (want to) do with a communication service (e.g. social chatting, buying or selling shares, conducting a job interview, etc.).
Communication media: Types of information with which humans communicate. Examples are text, audio, moving image (video, moving graphics) and still image.
Communication service: A service that is provided via a telecommunication network. Examples are ordinary telephony, email, videoconferencing, avatar-telephony, audio-conferencing.
Communication situation: The combination of task, motive, content and user (group) characteristics.
Communicative behaviour: End-user behaviour while using a communication service, including turn taking, interruptions, verbal and non-verbal back-channels and gaze.
Conference: used as follows within the scope of Eye-2-Eye: (a) From a technical orientation a point-to-point connection (i.e., there were no studies of multi-point connection); From a service orientation it is always person (or group)-to-person (or group) communication.
Costs: Costs that the end-user has to pay for using a particular communication service. These include not only financial costs but also subjective costs; e.g. the user may see loss of privacy as one of the costs to pay for having a videophone.
Duplex: A mode of operation by which information can be transmitted in both directions simultaneously between two points.
Dyadic: (Distance) communication between two people
Effectiveness (ISO 9241 definition): The accuracy and completeness with which specified users can achieve specified goals in particular environments.
Efficiency (ISO 9241 definition): The resources expended in relation to the accuracy and completeness of goals achieved.
End-users: The people who use a communication service for person-to-person communication.
End-users: The people who use the communication service*(s)*.
Fitness-for-Purpose: The correct balance between technological performance and human performance, such that the interaction is both sufficient and beneficial for person-person communication and consistent with human expectations from face-to-face communication.
Group: (Distance) communication between three or more people.
Half-duplex: A mode of operation where, at a given instance, only one of the two correspondent information streams is transmitted.
Interpersonal perception. The extent to which the perception of the other person's attributes (how likeable, intelligent, friendly etc.) is positive or negative.

Media effects: The effect a particular communication medium has on an end-users task outcome, communicative behaviour, attitudes and beliefs.
Media preferences: The subjective assessment by users or user groups of when a given communication medium is preferred over another.
Multi-point: Distance communication between three or more locations (also termed **Multi-party**)
Point-to-Point: Distance communication between two locations
Quality of service: Those aspects of the service which are assumed to affect the degree of satisfaction of the user of the service (e.g. the number of frames per second in videoconferencing, the auditory bandwidth in audio conferencing).
Satisfaction (ISO 9241 definition): The comfort and acceptability of the work system to its users and other people affected by its use.
Target audience: The people or organisations who are going to use the fitness-for-purpose guidelines, the cost-benefit analysis tool and/or the fitness-for-purpose evaluation toolkit.
Task elements: Features of *tasks* that can be expected to vary (e.g., extrinsic-intrinsic origin, symmetrical-asymmetrical balance, originator-recipient role, ego involvement level, information dependency, sociability level)
Task goal: The aim or object towards which the communication is directed. It is what end-users want to do with the *communication technology* (e.g. social chatting, buying or selling shares, conducting a job interview, etc.).
Task outcome: The extent to which task performance dependent on the medium
Task: What users of *communicative technology* actually do in order to accomplish some *task goal*. In experiments tasks may be described to the participants or they are embedded in scenarios as a part of a *situation*.
Usability (ISO 9241 definition): The *effectiveness*, *efficiency*, and *satisfaction* with which specified users achieve specified goals in particular environments.
User groups: End-users who with respect to their usage of communication service may be grouped together (e.g. business executives, university students, grandparents, deaf people, etc.).
Willingness to pay: An end-users willingness to pay in financial terms for a given communication service in a given situation.

11 List of Main Project Abbreviations[4]

ACTS	Advanced Communications Technologies & Services
AI	Artificial Intelligence
AMR	Adaptive Multi-Rate
ANOVA	Analysis of Variance
AO	Audio only
API	Application Programming Interface
CIF	Common Intermediate Format – a video format defined by ITU-T
CBA	Cost-Benefit Analysis
CBAT	Cost-Benefit Analysis Tool
CODEC	Coder/Decoder
COST	Co-operation for R&D in Science and Technology
CSCW	Computer supported collaborative work(ing)
CVE	Collaborative Virtual Environment
EC	European Commission
EDF	European Disability Forum
ERCIM	European Research Consortium for Informatics and Mathematics
ETSI ETR	ETSI Technical Report
ETSI	European Telecommunications Standards Institute
EUD	European Union of the Deaf
FtF	Face-to-Face (real-time human communication in the physical rather than digital world)
fps	(video)frames per second
FfP	Fitness-for-Purpose
GSS	Group Support System
GUI	Graphical User Interface
H261	Standard for audio-visual coding
HDTV	High definition television
HCI	Human Computer Interaction
I2I	Eye-2-Eye (abbreviation)
ICIF	Interlaced CIF (having the same number of pixels per line as CIF but twice the number of lines (i.e., 352 pixels per line and 576 lines)
ICT	Information (and) Communication Technology
IETF	Internet Engineering Task Force
IMPP	Instant Messaging/Presence Protocol
IMTC	International Multimedia Telecommunication Consortium
IP	Internet Protocol
IPR	Industrial Property Rights, Intellectual Property Rights
IRC	Internet Relay Chat
ISDN	Integrated Services Digital Network
ISO	International Standards Organisation

[4] This is a general list for the Eye-2-Eye project as a whole and is not restricted specifically to this document.

IST	Information Society Technologies
ITU	International Telecommunication Union
Eye-2-Eye	Eye-2-Eye, an abbreviation of the project's short name.
Kbps	Kilo Bits per Second
kHz	Kilo Hertz
LAN	Local Area Network
LEO	Low Earth Orbite – a new generation of satellite systems for mobile communication (both low and high bandwidth)
MAN	Metropalitan Area Network
MAUT	Multi-Attribute Analysis Technique
Mbps	Mega Bits per Second
MCP	Medium Choice Pattern
MOS	Mean Opinion Score
MPEG	Motion Picture Experts Group
MPLS	MultiProtocol Label Switching
MRT	Media Richness Theory
ms	Milli-seconds
MSP	Media Selection Panel
MUD	Multi-User Dungeon
NTSC	National Television Standard Committee
PAL	Phase Alternating Line – a TV standard used in most European countries (except France)
PC	Personal computer
PSTN	Public Switched Telephone Network
QCIF	Quarter CIF
QoS	Quality of Service
R&D	Research and Development
RACE	R & D in Advanced Communications in Europe (R&D Programme, 1985-1995)
RSVP	Resource ReSerVation Protocol
RTD	Research, Technological Development and Demonstration
RTP	Real-time Protocol
SDL	Specifation and Description Language
SIF	Source Input Format – a video format defined for MPEG 1
SMS	Short Message Service
SVHS	Super VHS – improved performance compared with VHS
SQL	Structural Query Language
TAP	Telematics Applications Programme
TCP	Transmission Control Protocol
TELR	Talker Echo Loudness Rating
TH	Talking Head
TIPHON	Telecommunications and Internet Protocol Harmonisation Over Networks. An ETSI project which started in Spring 1997 with members from Europe (including Israel), North America and Australia and co-operating with a Japanese regional standardisation organisation.
UDP	User Datagram Protocol
VHS	Video Homes System – a format for Home Video Cassette Recorders
VMC	Video mediated communication

VoIP	Voice over IP
VPN	Virtual Private Network
WAN	Wide Area Network
WAP	Wireless Application Protocol
WtP	Willingness to Pay