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Foreword

This ETSI Technical Report (ETR) was produced by the Human Factors (HF) Technical Committee of the European Telecommunications Standards Institute (ETSI).

ETRs are informative documents resulting from ETSI studies which are not appropriate for European Telecommunication Standard (ETS) or Interim European Telecommunication Standard (I-ETS) status. An ETR may be used to publish material which is either of an informative nature, relating to the use or the application of ETSs or I-ETSs, or which is immature and not yet suitable for formal adoption as an ETS or an I-ETS.

Introduction

In recent years, prepayment telephone cards bearing a small indentation on one edge have appeared in several European countries (e.g. Belgium, Denmark, Netherlands, Norway, Switzerland and United Kingdom). This indentation or tactile identifier, which can be felt with the fingers, has been provided explicitly to aid blind and visually impaired people to orientate the telephone card correctly before inserting it into the card reader of the telephone terminal.

Unfortunately, at least four different tactile identifier designs are currently in use in various countries (in the UK there are even two different tactile identifiers (BT and Mercury) in concurrent use) and the position of the tactile identifier varies. In Italy a Thin Flexible phone Card (TFC1) has been adopted. On this card the user needs to break off a corner before it can be inserted. Initially, this was introduced to prevent fraud, but it also provides a very conspicuous tactile identifier for orientating the card quickly and correctly.

With no fewer than four different tactile identifier designs in concurrent use, many people may be confused, especially blind and visually impaired people and older people who travel internationally. There is, therefore, a pressing need to standardize *one* tactile identifier design for all prepayment telephone cards and GSM cards and, preferably, for all other machine readable ID-1 cards (i.e. credit cards, debit cards and prepayment cards) which are also used to pay for telecommunication services.

Any tactile identifier which is recommended for international standardization should be selected on the basis of proper user trials. Such trials will help to determine which tactile identifier is most easily identified by different user groups, especially by blind and visually impaired people and older people.

In ITU-TS, Study Group (SG) 1, Question 18, work is currently in progress on Working Draft Recommendation E.136 [1] “Specification and use of a tactile identifier for use with telecommunication cards”. The design proposed by the ITU is identical with the design recommended in this ETR. In CEN/TC 224, work is in progress on a European standard for a tactile identifier on ID-1 cards and TFC1 cards, but this design (CEN/TC 224/WG6/N69) deviates somewhat from the design proposed by ETSI and ITU-TS.

The four tactile identifier designs currently in use on prepaid telephone cards in Europe, plus an earlier version of the CEN design and two designs proposed by representatives from the Norwegian organisations for blind and visually impaired people, were subjected to user trials by Norwegian Telecom Research. These user trials are presented in annex A. The results from these tests provide the basis for the present recommendation of a standard for a common tactile identifier on all machine readable ID-1 cards.

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1 Scope

The purpose of this ETR is:

- to demonstrate that a tactile identifier on telephone prepayment cards (and on all other machine readable ID-1 cards) is essential for blind and visually impaired people and for older people to orientate the cards quickly and correctly;

- to show that a tactile identifier on Machine Readable Cards (MRCs) is also beneficial for all non-impaired users;

- to argue the view that only *one* common tactile identifier should be standardized for all machine readable ID-1 cards (including prepayment telephone cards and GSM cards);

- to present a technically compatible recommendation for a single tactile identifier, based on user trials, for prepayment telephone cards and GSM cards – and, ultimately, for all machine readable ID-1 cards – for a future common international standard.

It is outside the scope of this ETR to deal with Thin Flexible (TFC1) Cards.

2 References

This ETR incorporates by dated and undated reference, provisions from other publications. These references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETR only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1] ITU-T Draft Recommendation E.136: "Specification and use of a tactile identifier for use with telecommunication cards".

[2] ISO 7811-1 (1985): “Identification cards – Recording technique – Part 1: Embossing”.

[3] ISO 7811-3 (1985): “Identification cards – Recording technique – Part 3: Location of embossed characters on ID-1 cards”.

[4] ISO 2894: “Identification cards”.

[5] ISO 7810 (1985): “Identification cards – Physical characteristics”.

[6] ISO 7816-1 (1987): “Identification cards – Integrated circuit(s) cards with contacts – Part 1: Physical characteristics”.

[7] ISO 7816-2 (1988): “Identification cards – Integrated circuit(s) cards with contacts – Part 2: Dimensions and location of contacts”.

[8] ISO 7811-2 (1985): “Identification cards – Recording technique – Part 2: Magnetic stripe”.

[9] ISO 7811-4 (1985): “Identification cards – Recording technique – Part 4: Location of read-only magnetic tracks – Tracks 1 and 2”.

[10] ISO 7811-5 (1985): “Identification cards – Recording technique – Part 5: Location of read-write magnetic track – Track 3”.

[11] ISO/IEC DIS 11694-2: “Identification cards – Optical memory cards – Linear recording methods - Part 2: Dimensions and location of the accessible optical area”.

[12] EN 27810 (1989): "Identification cards - Physical characteristics".

[13] EN 753: "Thin Flexible Cards (TFC-1)".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this ETR, the following definitions apply:

embossed card: An ID-1 card with embossed characters (cf. ISO 7811-1 [2] and ISO 7811-3 [3]).

embossing: Raised (embossed) letters and digits on ID-1 cards for visual reading for making paper (carbon) imprints or for machine reading (cf. ISO 7811-1 [2] and ISO 7811-3 [3]).

"front side" of card: The side of an ID-1 card bearing the contacts of an Integrated Circuit (IC) and opposite the side bearing a magnetic stripe.

ID-1 card: A personal identification card, 85,60 mm wide x 53,98 mm tall x 0,76 mm thick, with 3,18 mm radius corners, made from solid or laminated PVC (cf. ISO 2894 [4] and ISO 7810 [5]).

integrated circuit: A programmable electronic microchip with read/write memory and processing functions which are accessible via surface contacts (cf. ISO 7816-1 [6] and ISO 7816-2 [7]).

integrated circuit card: A machine readable ID-1 card bearing an electronic read-write integrated circuit (IC) memory microchip with surface contacts (cf. ISO 7816-1 [6] and ISO 7816-2 [7]).

Machine Readable Card (MRC): An ID-1 card bearing information in a format (mechanical (embossing), magnetic, inductive, electronic or optical) which can be read by a mechanical, magnetic, electronic or optical card reading device, respectively.

magnetic card: An ID-1 card with a read-only or read/write magnetic stripe (cf. ISO 7811-2 [8], ISO 7811-4 [9] and ISO 7811-5 [10]).

magnetic stripe: A stripe of magnetic material on ID-1 cards on which information can be recorded, stored and read (read/write or read-only) in analogue or digital form (cf. ISO 7811-2 [8], ISO 7811-4 [9] and ISO 7811-5 [10]).

optical card: An ID-1 card with a surface on which digital information can be recorded and read optically.

PIN-code: Personal Identification Number (PIN), a secret, multi-digit (usually four-digit), personal, security number to be entered by the user to authenticate and authorise the use of a machine readable ID-1 card.

prepayment telephone card: An ID-1 or TFC1 card with a specified number of prepaid telephone tariff units stored in machine readable form (magnetic stripe or Integrated Circuit). When the card is used in card-telephones, tariff units are deleted from the memory unit by unit until the card expires.

"rear side" of card: The side of an ID-1 card bearing the magnetic stripe and/or opposite the side bearing the surface contacts of an Integrated Circuit.

"smart card": An ID-1 card with an Integrated Circuit with memory and processing functions accessible through surface contacts (cf. ISO 7816-1 [6] and ISO 7816-2 [7]).

tactile identifier: Any physical marking, e.g. edge indentation, cut-out in card, hole, embossing, surface treatment or other device, which can be perceived and recognised by the sense of touch.

Thin Flexible Card (TFC1): A machine readable personal identification card of the same dimensions as an ID-1 card (85,60 mm wide x 53,98 mm high), but thinner and flexible, usually bearing information on a magnetic stripe.

3.2 Abbreviations

For the purposes of this ETR, the following abbreviations apply:

GSM	Global System of Mobile Telecommunication (cellular telephones)
ID-1	Identification Card 1 (85,60 mm x 53,98 mm x 0,76 mm)
MRC	Machine Readable Card
TFC1	Thin Flexible Card (85,60 mm x 53,98 mm)

4 Background

The ubiquitous machine readable "plastic card" is fast invading all areas of modern society; e.g. (pre)payment, banking, security, travel, admission, health, leisure activities and, not least, telecommunications. Transactions based on traditional technologies, using coins, tokens, keys, paper tickets, photographic paper ID-cards, etc., are fast being replaced by Machine Readable Card (MRC) technologies in all areas.

This creates problems for all users; namely, to orientate and turn the card the right way so that it can be inserted correctly in the card-reading device. One only needs to observe people using money dispensing automatic bank tellers, card telephones or ticket collecting machines to appreciate the extent of the problem. For people who are blind or severely visually impaired the task of correctly orientating Machine Readable Cards can be an insurmountable obstacle. There is thus now a need for an international standard for a tactile identifier to help all users, but especially blind and visually impaired users, to orientate Machine Readable Cards properly.

4.1 The machine readable telephone card

The progenitor to the modern Machine Readable Card was the simple, embossed, plastic ID-1 (Identification 1) card for making carbon imprints on paper receipts of the bearer's embossed name, account number and other information. The embossed 85,60 mm x 53,98 mm x 0,76 mm ID-1 card evolved directly from the movable printing plates used in the special machines for printing addresses on envelopes and labels (e.g. addressograph). This simple paper-based technology is still in wide use.

This embossed ID-1 card was later furnished with a recordable magnetic stripe on its "rear side" so that pre-recorded account numbers, codes and other identification information could be read automatically and, if necessary, be altered by magnetic card reading devices – the Machine Readable Card (MRC) had been born.

Later still, so called "smart cards", equipped with a very thin programmable and machine readable Integrated Circuit (IC), which can hold information that can be changed or updated at each new transaction, have been introduced. "Smart cards" provide a better and safer technology for machine readable memory as an alternative or supplement to magnetic stripe cards. These cards were taken up by banks and telephone operators for automatic transactions when paying for services. We may soon have optically readable cards which can store one megabyte, or more, of information on an ISO standard size (85,60 mm x 53,98 mm) machine readable ID-1 card (cf. draft standard ISO/IEC DIS 11694-2 [11].

Magnetic stripes and Integrated Circuits can easily handle changing information. This allows a fixed number of telephone tariff units to be pre-stored on a magnetic stripe or Integrated Circuit card, which can then be sold to the users, ensuring the telephone operator its remittance. When the card is used units are deleted one by one during the call, leaving a new balance on the card after the call, until all units are used and the card is depleted and cannot be used any more – the prepayment telephone card became a reality.

Some telephones are also designed to read credit or debit bank ID-1 cards (e.g. VISA, Diners Club, Eurocard, American Express, etc.), making it possible for users to have the amount deducted directly from their bank account or be billed by the credit company. Such cards usually need to be inserted into a different card reader slot than the prepayment telephone cards, or they need to be dragged through a "swipe-card"-reader. These ID-cards, normally, also need to be verified by keying in a secret, four-digit Personal Identification Number (PIN-code).

4.2 User problems with Machine Readable Cards

Different card-readers require different card orientations when inserting the card, and since most card readers will not accept or read the card if it is not correctly oriented when inserted, this will easily create problems for the users. The user problems associated with orientating and aligning Machine Readable Cards correctly for insertion into the card reader seem to be nearly universal. With card readers which accept cards "narrow end in", there are four possible orientations for inserting a card, only one of which is correct. Users may easily get confused when they insert the card and it is not accepted by the card reader. Retrieving the card and turning it before reinserting it will not always produce the desired results.

Some prepayment telephone-card readers accept cards "broad side in", but here also there are four possible ways of inserting the card, only one of which is correct. Much would have been gained in user friendliness if card readers were designed to read cards whichever way they are inserted; like modern bar-code readers which will read bar-codes reliably in any orientation and direction.

Matters are further complicated for users by the various positions adopted for the insertion slot of the card reader on different terminals: it may be placed horizontally at the top, middle or bottom; or vertically to the left, in the middle or to the right; and the front of the terminal may have any angle, from vertical to horizontal. Most users have definite views on which card orientation is most "natural" for each insertion slot position; i.e. if the "front side" of the card should face up or down, left or right. These views often differ from the solutions offered by the terminal designers.

A picture of the card, usually showing the "rear side" and depicting the magnetic stripe to the left or to the right, is usually provided on the terminal. This may just as often confuse rather than help users who are required to inspect both the picture and the card very closely to determine which orientation the card should be turned before being inserted. Often there will be many other pictures either on or around the terminal showing the "front side" of all the various cards which that particular terminal will accept to confuse the user further.

Printed instructions, with pictures showing which way the magnetic stripe needs to face, are not always easy to interpret and are often at odds with what many users feel to be the "natural" way to insert the card; e.g. many card readers require that the magnetic stripe faces up which may seem "unnatural" to many users since the side opposite the magnetic stripe usually bears the company logo and is considered by many to be the "front side".

Informal discussions carried out with many users indicate that most people perceive the magnetic stripe to be on the "rear side" of the card and that the "front side" of the card (bearing the text and company logo) should face up when inserting the card. Designers of card reading terminals often have tight technical constraints on where to place the card reading mechanism, which may often lead to cards having to be inserted in unexpected orientations.

5 A tactile identifier for Machine Readable Cards

A simple and cheap solution to help users orientate Machine Readable Cards, and to make such cards readily usable to blind and visually impaired users, is to furnish all machine readable ID-1 cards with a physical, tactile identifier, e.g. a notch, cut-out or indention in the edge of the card, which can easily be felt by the user to aid in orientating the card correctly, without the need to look at it.

This solution has, for some time, been provided by several telecommunication administrations in Europe, but lack of standardization has resulted in at least four different tactile identifier designs now being in concurrent use; in the UK there are even two (BT and Mercury) different designs in parallel use. These tactile identifiers all have different shapes and are at different positions on the cards. This is bound to confuse most users who travel from one country to another and it leaves the area open to new *ad hoc* designs. It is, therefore, important to stop the proliferation of new tactile identifier designs.

5.1 Position of the tactile identifier

There is some controversy over the best position of a tactile identifier on Machine Readable Cards, but before determining the best position a clear understanding of the users" perception of the card is needed. Users and designers of terminals may differ in their views as to which is the "front side" and "rear side" of the card. As mentioned above, most users seem to perceive the side of the card bearing the picture, the company logo and main information about the card and the contacts of the Integrated Circuit (if fitted) as

the "front side" of the card and the side bearing the magnetic stripe and the signature field as the "rear side" of the card. This goes back to the embossed card, where the side bearing the embossing was seen as the "front side". When embossed cards received a magnetic stripe, this was placed on the opposite or "rear side" of the card which, in the users' mental model, became the "rear side" of the card.

Most users seem to regard the "landscape" (i.e. the long sides are horizontal and the short sides are vertical) orientation of the card as "normal" and most cards have pictures, text and logos placed on the card according to this view. Some "smart cards" with Integrated Circuits have "portrait" orientation (i.e. the short sides are horizontal and the long sides are vertical) with the surface contacts of the Integrated Circuit at the upper end of the "front side" and the logo and text placed parallel to the short sides.

It is important for designers to consider the users' mental models of the card when deciding the position of a tactile identifier. Unfortunately, this was not always the case when the position of the existing tactile identifiers were adopted. Many card reading terminals require that the user turns the card "upside down" (rear side up) when inserting it, which conflicts with the users' "natural" or spontaneous inclination on card orientation.

Three tactile identifiers which have been in use (from BT, Mercury and Norway) are positioned on the right short end of the card, as was the CEN/TC 224 N293 draft. In the user tests these tactile identifiers did rather badly; the CEN-proposal actually coming last. The tactile identifier used in Denmark is positioned near the right hand lower corner on the bottom long edge of the card (see figure 1). This identifier position achieved the best outcome in the user tests and seems to best fit most users' mental model of the card. This is, therefore, the recommended position for a tactile identifier in this ETR.

From the user trials we know that blind people normally search the edges of the card before searching the surface for a tactile identifier. Together with the reasons given above, this leaves the edge of the card as the best area to place a tactile identifier in the form of a notch or an edge indentation.

5.2 Tactile/visual conspicuity of the tactile identifier

With two exceptions (the design used in Denmark and the special cards used in Italy), the tactile identifiers in current use are rather small and inconspicuous and are, therefore, not very well suited for the users who really need them. This was brought out in the user testing of all the current tactile identifier designs performed by Norwegian Telecom Research in 1993 (for further details, see annex A).

To be of any real help to the intended users, a tactile identifier on Machine Readable Cards needs to be highly salient; i.e. it needs to be very conspicuous, easy to feel, easy to see and it must be easy to locate. This means that any tactile identifier needs to be large enough to be readily detectable, but not so large that it interferes with the normal use of the card. The best way to test the salience of different tactile identifier designs is to test them in practical user trials. Such trials, carried out by Norwegian Telecom Research, form the basis for the present recommendation.

The form of a tactile identifier should preferably be a rounded notch or edge indentation, i.e. a cut-out segment in the edge of the card (see figure 1). Trials have shown that a depth of about 2 mm is sufficient for most users. It is important that the notch has no sharp corners that may injure the user or can catch in the clothing or in the feeding mechanism of card readers.

5.3 Existing standards for a tactile identifier

It is mandatory that any recommendation for a tactile identifier on Machine Readable Cards complies with existing international standards. Currently, there exists no international standard for a tactile identifier on Machine Readable Cards, but there is one national standard (DIN 9781, "Identifikationskarten aus Kunststoff oder kunststofflaminiertem Werkstoff"). There are two general standards for Machine Readable Cards, ISO 7810 [5] and a European Norm, EN 27810 [12].

ISO 7810 [5] and EN 27810 [12] define the general physical measures and attributes of machine readable ID-1 cards, among other things, the radius of the cards' corners. The German national standard conflicts with these standards because it defines a larger radius (9 mm ± 0,1 mm) for one corner of the card, but this tactile identifier is currently not in use. There is also a norm for TFC1s and machine readable paper tickets (EN 753 [13] "Thin Flexible cards") which covers e.g. the Italian prepayment telephone cards.

From COST 219 comes a suggestion for a tactile identifier for blind and visually impaired people in combination with one or more smaller notches to code the number of units on prepayment telephone

cards. Although ETSI fully agrees with the intention of the suggestion, it has not been tested and the number of units varies so much between cards that the suggestion should be regarded as *ad hoc*.

5.4 Technical constraints of the tactile identifier

Any tactile identifier for Machine Readable Cards needs to be compatible with existing card technologies and with technologies anticipated in the near future, both storage technologies, such as embossing, magnetic stripes, Integrated Circuits, optical memory, etc., and with mechanical card handling technologies, such as card feeding mechanisms, swipe-card readers, carbon-copy rollers, card dispensers, etc.

In practical terms, this excludes holes in the card or embossing on the card as a tactile identifier as they will corrupt optically readable cards, which utilise nearly the whole surface of the card (ca. 81 mm x 46 mm) for optical storage. Holes and embossing may also conflict with magnetic stripes and Integrated Circuits.

The same technical constraints which prevent placing any tactile identifier on the surface of the card also excludes placing a tactile identifier on the short ends of the card, as this may conflict with the magnetic stripe or corrupt the optically readable surface which extends to within 1 mm of the short ends of the card. Neither can corners be used as tactile identifiers since they are defined by the ISO 7810 [5].

We are thus left with the long edges of the card for placing a tactile identifier. Again for technical reasons, the tactile identifier should be placed on the near long edge of the card, i.e. on the lower long edge of the card when the "front side" of the horizontal card is viewed straight on (see figure 1) and not on the far or "top edge" of the card. This is to prevent the tactile identifier interfering with "swipe card" readers where the "top" edge of the card is pulled (or "swiped") through the card reader slot.

6 Requirements of a common tactile identifier

Which are the most important properties that a standard tactile identifier on Machine Readable Cards should have? From the preceding discussion, it is now possible to set up a list of the most desirable requirements for the design of a standard common tactile identifier for all types of machine readable ID-1 cards.

The requirements listed below are of nearly equal importance and are, therefore, not prioritised. The common standard tactile identifier needs to have:

- **High tactile conspicuity**. The tactile identifier needs to be easy to feel and to be recognised tactually by all users, but especially by the intended user groups; i.e. blind and visually-impaired people, older people, etc.

- **High visual conspicuity**. The tactile identifier needs to be easy to see and to be recognised by non-visually-impaired users.

- **Asymmetrical position**. The tactile identifier needs to have an asymmetrical position so that the orientation of the card is unambiguously defined.

- **User Testing**. The tactile identifier to be recommended for standardization should be selected on the basis of actual user testing to verify that the design meets the requirements of the intended user groups.

- **Technical compatibility**. The tactile identifier should not interfere with the proper working of existing card reading technologies; embossing, magnetic stripes, smart chips, optical storage areas, security holograms, etc.

- **Mechanical compatibility.** The tactile identifier should be positioned on the card so that it will not interfere with the proper working of the mechanical card handling technologies; card feeding mechanisms, swipe card readers, carbon-copy rollers, card dispensing vending machines, etc.

- **Compliance with existing standards.** The standard for one common tactile identifier for Machine Readable Cards needs to comply with all existing standards for such cards, e.g. ISO 7810 [5].

- **Standardization**. There should be only one common standard design for a tactile identifier for all types of Machine Readable Cards to avoid confusing the users.

- **Avoid new designs**. If possible, the recommended tactile identifier should use an existing design to avoid any proliferation of new designs. Only if it is not possible to use any existing design should a new tactile identifier be created.

7 Recommendation

On the basis of user trials with seven different tactile identifier designs (see annex A for further details) and allowing for the basic technical constraints imposed by different card reading technologies, as elaborated in the preceding discussion, a recommendation for a future single standard for a common tactile identifier for machine readable ID-1 cards can now be made.

Thus, the so-called "Danish" tactile identifier design for machine readable ID-1 cards (see figure 1), which achieved the best results in the user-trials and which also complies with all the technical requirements listed above, is hereby recommended by ETSI for adoption as the future standard for a common tactile identifier design on prepaid telephone cards and for all other machine readable ID-1 cards.

7.1 Description of the tactile identifier

This recommendation applies to all prepaid telephone (ID-1) cards, which measure 85,60 mm x 53,98 mm, 0,76 mm thick, with 3,18 mm radius corners, according to ISO standards 7811-1 [2], 7811-2 [8], 7811-3 [3], 7811-4 [9], 7811-5 [10], 7816-1 [6] and 7816-2 [7].

The geometry and location of the tactile identifier on prepaid telephone cards are shown in figure 1. The tactile identifier is an edge indentation in the form of a 2 mm deep cut-out segment with a radius of 12 mm in the right hand side of the bottom, long edge of the card (when the "front side" of the card is viewed (landscape format) with the IC contacts to the left). The centre of the cut-out segment is located at the intersection of a line parallel to and 15 mm inside the right hand short end of the card, which is opposite the end with the integrated circuit contacts (see figure 1, top), and a line 10 mm outside and parallel to the bottom long edge of the card, which is furthest from the magnetic stripe (see figure 1, bottom).

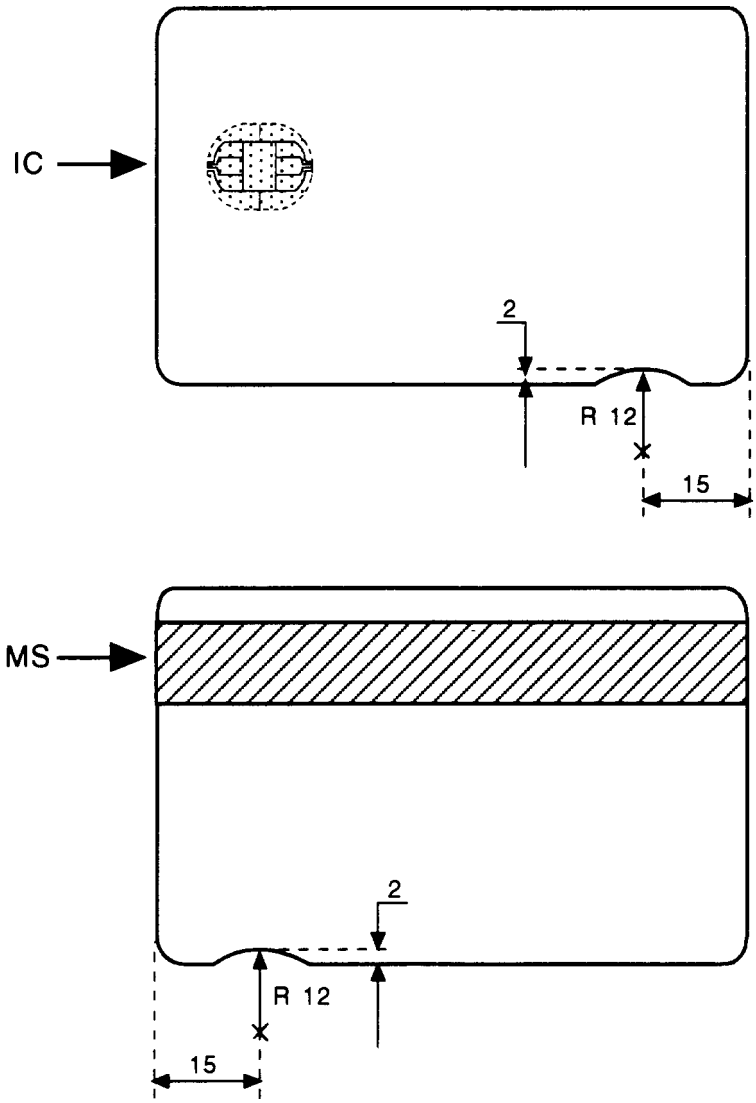

Figure 1

The figure shows the position and the geometry of the tactile identifier for telephone prepayment (ID-1) cards in two views: the upper part shows the "front side" of the card with the tactile identifier at the right on the long bottom edge; the lower part shows the "rear side" of the card with the tactile identifier at the left on the long bottom edge. All measures are in millimetres (mm). IC = Integrated Circuit, MS = Magnetic Stripe.

Annex A: User testing of tactile identifiers on machine readable ID-1 cards

A.1 Summary

This ETR concerns the use of tactile identifiers for assisting in the orientation of machine readable ID-1 cards, especially for blind and visually impaired people. No material on tactile identifiers for Machine Readable Cards is available in the literature. Two tests were carried out: Test One to determine if a tactile identifier actually assists in card orientation, and Test Two to determine which of seven tactile identifiers is best (for details see figure A.1). The results from Test One (N = 75), measured in terms of time used, errors made and user preferences, show that a tactile identifier *substantially* aids users in orientating cards, and is *essential* for blind and visually impaired people. The results from Test Two (N = 92) show that the more prominent or conspicuous a tactile identifier is the better it is. The seven tactile identifiers used in the tests received the following usability ranking: 1 Italian phonecard; 2 Danish phonecard; 3 hole in card; 4 Norwegian phonecard; 5 embossed Braille arrow; 6 CEN draft; 7 BT phonecard. The two last were no better than unmarked cards. A sub-group of blind (N = 17) and visually impaired (N = 33) subjects were singled out for separate analysis. These show the same general trend as the full group, only stronger. All results are significant ($p < 0,01$). However, for technical reasons only the *Danish* tactile identifier can be recommended – the other six identifiers cannot be used.

A.2 Introduction

Machine Readable Cards, ID-1 cards and Thin Flexible Cards (TFC1 cards), are increasingly found in many societal functions, such as financial services, access control, public transport, for medical information, for personal identification and, not least, for telecommunications. As these cards are becoming more widespread, it is vital that they can be used easily and correctly by all card-holders. A prerequisite for using ID-1 cards is that they are correctly oriented when inserted into the card-reading device. Cardholders who cannot or have difficulties in orientating their cards correctly may thus be excluded from using important or vital societal services – i.e. they will be discriminated against.

The purpose of a tactile identifier is to make orientation of cards easier for all users, especially for blind and visually impaired people who cannot rely on visual cues alone. Under some conditions (e.g. poor lighting) people with normal vision may experience problems with card orientation. In situations where safety is important (e.g. paying a toll when driving) vision should *not* be used for orientating the card.

Several standardization bodies are showing an active interest in standardizing a tactile identifier for ID-1 and TFC1 cards. It is important that these bodies avoid developing different standards and that they develop only *one* common standard. When proposing a tactile identifier for ID-1 cards for an international standard, the following issues should be taken into account:

- there already exist at least four different tactile identifiers for phonecards and changing already existing tactile identifiers may confuse users of current marked cards;

- the location of a tactile identifier needs to take into account current technologies so that it will not interfere with embossing, magnetic stripes, Integrated Circuits or optical storage;

- different card reading devices require cards to be inserted differently, and a tactile identifier needs to clearly inform the user about the orientation of the card;

- the aim of this ETR is to provide empirical data to assist in developing a standard for a tactile identifier for machine readable ID-1 cards. Thin Flexible Cards (TFC1) are not covered by these trials, but the same principles obviously also apply to these cards.

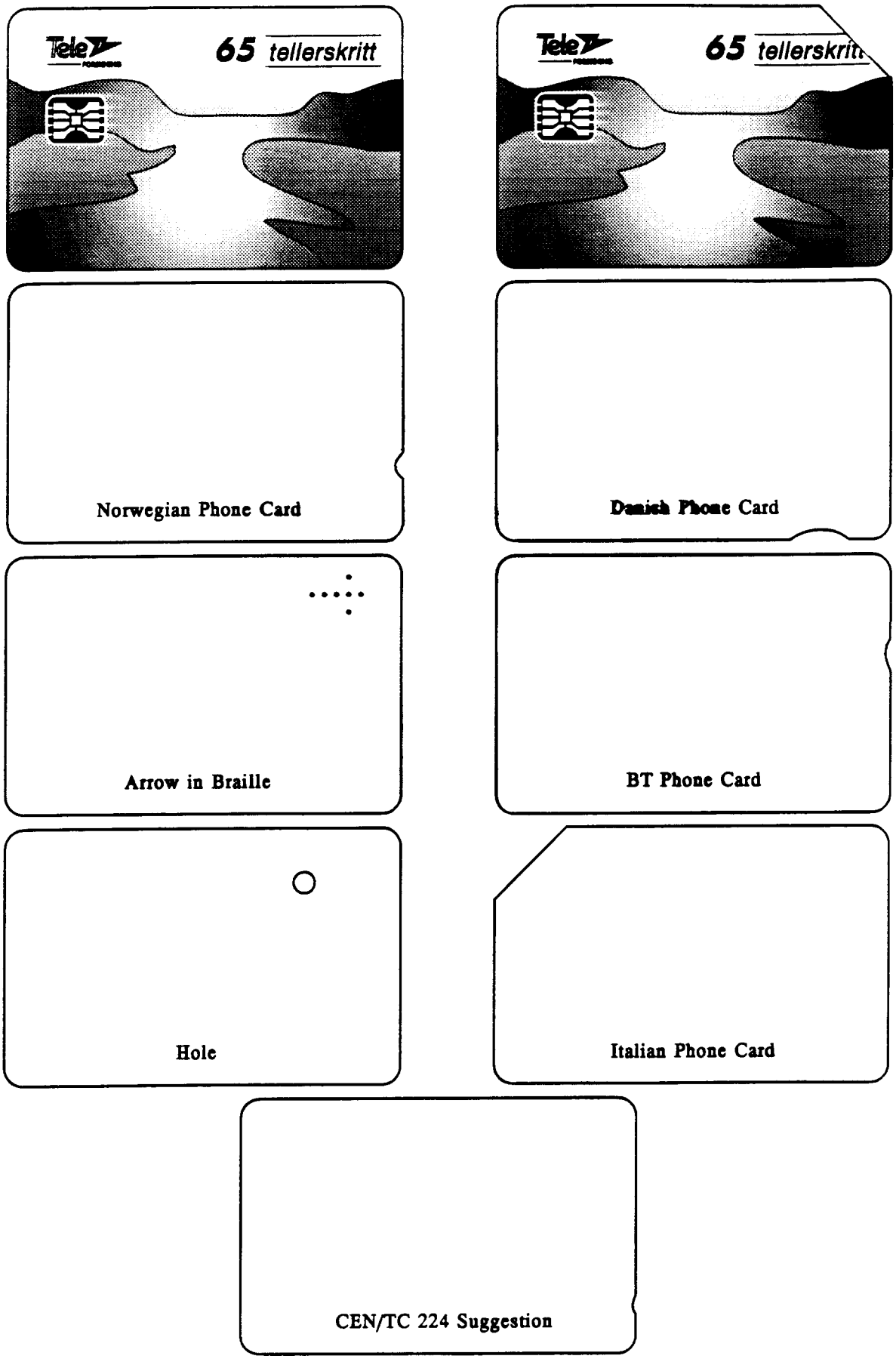

Figure A.1: The two tactile identifiers used in Test One (top) and the seven designs used in Test Two (bottom)

A.3 Method and results

To test these two main goals, two user tests, hereafter referred to as Test One and Test Two, were devised. In these tests the subjects had to orientate ID-1 cards, both with and without a tactile identifier. Test One was designed to determine whether a tactile identifier actually aids in orientating the cards. Test Two was designed to determine which of seven different tactile identifiers best aids users in orientating cards.

A.3.1 Test One

In this test, the subjects (N = 75) were presented with two stacks of 20 ordinary, graphically marked, ID-1 cards (see upper two cards in figure A.1). In addition to the graphic markings, the cards in the experimental stack had a tactile identifier in the form of a cut off corner (upper right card in figure A.1) while the cards in the control stack were plain. The cards in both stacks were randomly oriented.

The subjects' task was to restack the cards so that they were all oriented the same way. The task was to be completed as quickly as possible. When restacking the cards which did not have a tactile identifier (the control stack), the subjects were instructed to place the "picture side" up with the text on each card oriented in the same way. When restacking the tactilely marked cards (experimental stack), the subjects were instructed to place the tactile identifiers on top of each other.

The time to perform the task, the number of errors made and the subjects' card preference were recorded. To show their preference, subjects were asked to rank the cards 1 for best and 2 for worst. Mean time used, median time used, total number of errors made and the mean preference ranking for each card category were computed and are shown in table A.1 (see subclause A.4.1).

A.3.2 Test Two

In this test, the subjects (N = 92) were presented with seven stacks of 20 completely white cards. All the cards in each stack had a different tactile identifier (for details on the seven tactile identifiers used, see figure A.1). The cards in each stack were randomly oriented.

The subjects' task was to restack the cards in each stack to the same orientation. The task was to be completed as quickly as possible. When restacking the cards, the subjects were instructed to place the tactile identifiers on top of each other.

The time to perform the task, the number of errors made and the subjects' card preferences were recorded. To show their preference, subjects were asked to rank the cards from best (1) to worst (7). Mean time used, median time used, total number of errors made and the mean preference ranking for each tactile identifier were computed and are shown in table 1 (see subclause A.4.1).

To reduce any learning effects, Test One and Test Two were presented randomly and, within tests, the order of presentation of the card stacks was randomised.

A.3.3 Subjects

A total of 92 subjects participated in the tests. They included people who were: blind (N = 17); partially sighted (N = 33); elderly, mentally retarded and people with no apparent disability, among them some 16 – 17 year old students. Some of the subjects had and some had not used ID-1 cards before, but none of the subjects had previously used tactilely marked cards. Participation was voluntary and the subjects were not paid.

A.3.4 Tactile identifiers used in the tests

Seven different tactile identifiers were used in Test Two (for further details, see figure A.1). One of the tactile identifiers (the Italian card with the cut off corner) was also used in Test One). The seven tactile identifiers used included the four existing tactile identifiers (BT, Danish, Italian and Norwegian), two tactile identifiers devised after suggestions from experts at Norwegian institutions for blind and visually impaired people (hole in card and embossed Braille arrow) and the seventh was according to the CEN TC 224 draft. Twenty white cards with each type of tactile identifier were made for these trials.

A.4 Discussion of the results

A.4.1 Test One

The results from Test One are shown in table A.1 (upper part). The number of errors made ($T = 5{,}785$ $p < 0{,}01$), the time used to complete the task ($T = 6{,}603$ $p < 0{,}01$) and the mean subject preference (1,061) clearly show that a tactile identifier *significantly* aids users in card orientation.

It should be noted that 15 of the 17 "blind" subjects who participated could not complete part of Test One (i.e. stacking the visually marked, tactilely unmarked cards) since, obviously, they could not see the visual markings on the cards and their data are not included in the results ("blind" here also includes severely visually impaired people). However, they could all orientate the tactilely marked cards. Thus, for blind users, a tactile identifier is a necessity (for further data on blind and visually impaired users, see clause 4).

Table A.1: The results for all subjects from Test One (N = 75, top) and from Test Two (N = 92, bottom)

Test One

	Time (seconds) Mean	Median	Error Total number	Preference Mean
Unmarked cards	61	55	133	1,894
Tactilely marked cards	43	35	8	1,061

N = 75

Test Two

	Time (seconds) Mean	Median	Error Total number	Preference Mean
CEN TC 224	64,8	55	56	5,8
Italian 'phonecard	44	35	16	1,8
BT 'phonecard	66	51	149	5,7
Danish 'phonecard	47	40	8	2,6
Hole in card	47	40	6	3,5
Braille arrow	55	45	12	4,3
Norwegian 'phonecard	49	40	49	3,9

N = 92

A.4.2 Test Two

The results from Test Two (see table A.1, lower) show clear differences between the seven tactile identifiers investigated. However, there are some technical constraints which prohibit the use of several tactile identifiers. Although some tactile identifiers were better than others in Test Two, they cannot all be recommended for standardization because of these technical constraints. Below is a card-by-card analysis of the results with recommendations for standardization.

A.4.2.1 Italian card

The Italian phonecard was the most preferred card and required the least amount of time for orientation; note that the time required to orientate this card in Test One and Test Two are nearly identical, thus confirming the inter-test reliability. In terms of number of errors, this card only came fourth best, however it should be noted that a single subject was responsible for 11 of the 16 errors made and that the differences in the number of errors between the four best tactile identifiers is small compared to the number of errors in the worst case.

However, for technical reasons this tactile identifier cannot be proposed for an international standard for ID-1 cards because it takes away too large a part of the card, corrupting the magnetic stripe area and the optical storage area (although this marker is in current use on Thin Flexible Cards). It should also be noted that a standard (ISO 7810 [5]), defining all four corners of ID-1 cards, already exists.

- *Overall, the **Italian phonecard** was judged to have come best in Test Two. However, for technical reasons this tactile identifier cannot be recommended.*

A.4.2.2 Danish card

The Danish phonecard came second equal best in terms of time used, second best in terms of errors made and second best in terms of user preferences.

- *Overall, the **Danish phonecard** was judged to have come second best in Test Two. This tactile identifier is thus our first recommendation.*

A.4.2.3 Card with a hole

Cards with a hole came second equal best in terms of time used, best in terms of errors made and third best in terms of user preferences. However, for technical reasons this tactile identifier cannot be used since this hole will corrupt the magnetic stripe or the optical storage surface.

- *Overall, the **card with a hole** was judged to have come third best in Test Two. For technical reasons this tactile identifier cannot be recommended.*

A.4.2.4 Norwegian card

The Norwegian phonecard came third in terms of time used, fifth in terms of errors made and fourth in terms of user preferences. The indentation in the short end is so deep that it may corrupt the optical storage surface.

- *Overall, the **Norwegian phonecard** was judged to have come fourth best in Test Two. For technical reasons this tactile identifier cannot be recommended.*

A.4.2.5 Card with embossed arrow

Cards with an arrow in raised Braille dots came fifth in terms of time used, third in terms of errors made and fifth in terms of user preferences. However, for technical reasons this tactile identifier cannot be used since the raised dots of the embossed arrow will corrupt the magnetic stripe area and the optical storage surface.

- *Overall, **card with arrow in raised Braille dots** was judged to have come fifth best in Test Two. For technical reasons this tactile identifier cannot be recommended.*

A.4.2.6 CEN TC 224 card

Cards marked according to the proposed CEN TC 224 draft recommendation came sixth in terms of time used, sixth in terms of errors made and last in terms of user preference. This card was not better than tactilely unmarked cards in Test One. For technical reasons, however, this tactile identifier cannot be used, since even a small (0,7 mm) indentation in the short end of the card may corrupt the optical storage area.

- *Overall, the **CEN TC 224 card** was judged to have come sixth best in Test Two. For usability and for technical reasons this tactile identifier cannot be recommended.*

A.4.2.7 BT card

The BT phonecard came last both in terms of time used and errors made and sixth in terms of user preference. This card was not better than tactilely unmarked cards in Test One. For technical reasons this tactile identifier cannot be used, since even a small (0,7 mm) indent in the end of the card may corrupt the optical storage area.

- *Overall, the **BT phonecard** was judged to have come last in Test Two. For usability and for technical reasons this tactile identifier cannot be recommended.*

A.4.3 Some further comments

The results obtained with the proposed CEN TC 224 card and the BT phonecard are similar to, or worse than, the results obtained with the tactilely *unmarked* cards in Test One! Thus, no real benefit is gained by using these two tactile identifiers, except for completely blind people who depend on any form of tactile identifier.

A.4.3.1 Technical constraints with embossing as tactile identifier

Embossed tactile identifiers on ID-1 cards cannot be recommended for a common standard tactile identifier for the following reasons:

- not all cards on the market are embossed or can use embossing;
- any new identifier may be confused with existing embossing;
- the transition from paper to electronic environment means that embossing will be phased out;
- embossing may facilitate fraud.

An interesting finding was that when blind people feel the cards with the tip of their index fingers they usually feel along the edges before feeling the surfaces of the card. Thus, finding a tactile identifier (e.g. embossing) on the surface of the card takes longer than finding a tactile identifier (e.g. indentation) on the edge of the card.

A.4.3.2 Technical constraints with a hole as tactile identifier

The use of a hole as a tactile identifier on ID-1 cards cannot be recommended for the following two reasons:

- search patterns of blind people (see comment on embossing);
- corruption of the memory surface (especially on optical memory cards).

A.4.3.3 Technical constraints with magnetic stripe cards

Placing a notch or indentation on the short ends of magnetic stripe cards may interfere with this stripe. For this reason the short ends of the card should not be used for tactile identifiers.

A.4.3.4 Technical constraints with optical memory cards

A notch or edge indentation on the short ends of a card may corrupt the optical memory surface and cause problems for the proper functioning of optical memory cards. This is because the optical memory area extends to within about 1 mm of the edge of the card at the short ends (ISO/IEC DIS 11694-2 [11]). The optical area's proximity to a 0,7 mm deep notch increases the risk for environmental damage to the optical memory. However, the distance from the optical memory area to the edges on the long edges of the card is approximately 4 mm. A 1,5 to –1,8 mm deep notch on the long side of the card is safe and should be fully acceptable.

A.5 Discussion of visually impaired users

The results obtained with the 17 blind and the 33 visually impaired subjects who participated in Test One and Test Two have been singled out for separate analysis and the results are shown in table A.2. These results and the conclusions drawn from them are, on the whole, the same as the results and the conclusions for the whole group, only much stronger.

A.5.1 Test One

The results from Test One, as shown by the number of errors made, the time used to complete the tasks and by the subjective preferences, clearly show that a tactile identifier *significantly* will assist blind and visually impaired people in orientating Machine Readable Cards (see table A.2, upper).

Of the 17 blind subjects who participated 15 could not complete Test One (i.e. stack the visually marked, but tactilely unmarked cards) as they could not use visual cues; note that some "blind" people have residual vision.

Table A.2: The results for blind and visually disabled subjects, Test One (N = 33, top), Test Two (N = 50, bottom)

Test One

	Time (seconds) Mean	Median	Error Total number	Preference Mean
Unmarked cards	72	70	64	1,950
Tactilely marked cards	49	37	5	1,049

N = 33

Test Two

	Time (seconds) Mean	Median	Error Total number	Preference Mean
CEN TC 224	77	65	27	6
Italian 'phonecard	54	43	14	1,5
BT 'phonecard	77	62	85	6
Danish 'phonecard	57	52	2	3
Hole in card	56	46	4	3,75
Braille arrow	61	55	0	4
Norwegian 'phonecard	57	55	30	4

N = 50

A.5.2 Test Two

The results from the 17 blind and the 33 visually impaired subjects in Test Two show the same clear trend as the full group and the final recommendations come out nearly the same for both groups (see table A.2, lower). The differences in the number of errors between the four best tactile identifiers is small compared to the number of errors for the worst cases.

A.5.2.1 Italian card

The Italian phonecard came best in terms of time used, fourth in terms of number of errors made, but best in terms of user preferences.

- *For blind people, the **Italian phonecard** was judged to have come best in Test Two. For technical reasons, however, this tactile identifier cannot be used.*

A.5.2.2 Danish card

The Danish phonecard came third equal best in terms of time used, second best in terms of errors made and second best in terms of user preferences.

- *For blind people, the **Danish phonecard** was judged to have come second best in Test Two. This tactile identifier is also our first recommendation for this group.*

A.5.2.3 Card with a hole

Cards with a hole came second best in terms of time used, third best in terms of errors made and third best in terms of user preferences.

- *For blind people, the **card with a hole** was judged to have come third best in Test Two. For technical reasons, however, this tactile identifier cannot be used.*

A.5.2.4 Card with embossed arrow

Cards with an embossed arrow in raised Braille dots came fourth in terms of time used, first in terms of errors made and fourth in terms of user preferences.

- *For blind people, **cards with an arrow in raised Braille dots** was judged to have come fourth in Test Two. For technical reasons, however, this tactile identifier cannot be used.*

A.5.2.5 Norwegian card

The Norwegian phonecard came third equal best in terms of time used, sixth in terms of errors made and fifth in terms of user preferences.

- *For blind people, the **Norwegian phonecard** was judged to have come fifth in Test Two. For technical reasons, however, this tactile identifier cannot be recommended.*

A.5.2.6 CEN TC 224 card

The proposed CEN TC 224 draft recommendation came equal last in terms of time used, fifth in terms of errors made and equal last in terms of user preferences.

- *For blind people, the **CEN TC 224 card** was judged to have come sixth best in Test Two. For technical reasons, however, this tactile identifier cannot be recommended.*

A.5.2.7 BT card

The BT phonecard came equal last in terms of time used, last in terms of errors made and equal last in terms of user preferences.

- *For blind people, the **BT phonecard** was judged to have come last in Test Two. For technical reasons, however, this tactile identifier cannot be recommended.*

A.6 Conclusions

The results from both tests show that a tactile identifier on ID-1 cards *significantly* aids card orientation for *all* users and is preferred to not having a tactile identifier. A tactile identifier on ID-1 cards is *essential* for blind and visually impaired people to be able to orientate the cards correctly. As a result of these user trials, the seven tactile identifiers tested have received the following usability ranking:

1) the Italian phonecard;

2) the Danish phonecard;

3) the hole in the card;

4) the Norwegian phonecard;

5) the embossed Braille arrow;

6) the CEN TC 224 draft;

7) the BT phonecard.

For technical reasons, however, only the Danish phonecard can be used. The other six tactile identifiers are incompatible with various card-reading technologies; i.e. the magnetic stripe area, the optical storage surface and the proper functioning of Integrated Circuit contacts.

The two last tactile identifiers (the CEN and BT cards) are, apart from their technical unsuitability, no better than unmarked cards. The proposed CEN TC 224 draft recommendation for a tactile identifier for ID-1 cards is thus unsuitable for all but the completely blind or most severely visually impaired people and should not be adopted as an international standard for a common tactile identifier. The BT phonecard, which is in current use in several countries (e.g. Belgium, Netherlands, Switzerland and United Kingdom) is not really better than the unmarked cards and should be replaced by a better tactile identifier.

The results from Test Two clearly show that the more prominent or salient a tactile identifier is the better it is. The results from the full group and from the sub-group of blind and visually impaired subjects are virtually the same, and our recommendation is exactly the same for both groups. For usability and technical reasons, only one tactile identifier, the *Danish phonecard*, can be recommended for an international standard.

Annex B: Bibliography

1) DIN 9781 - 1: “Identifikationskarten aus Kunststoff oder kunststofflaminiertem Werkstoff. Anforderungen an die Identifikationskarte 1 (ID–1)”.

2) CEN TC 224/WG6/N.69, Part 2: "Definition of the tactile identifier on ID-1 / TFC-1 cards".

History

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