CHAPTER 4. TOOTHPICS AND IDENTIFY

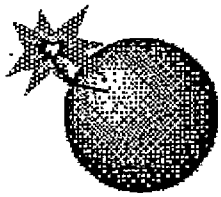
4.1. Detroit and Sioux City Flight Accidents

DETROIT, 1987

The idea to use computerized dental identification and the Macintosh was introduced in connection of Northwest Flight # 255 Accident in Detroit, September 1987. The Finnish DVI-Team had already started more than a year before to look for a suitable basic program for this type of micro. In the February, 1988, MacWorld magazine we saw the following article (a few excerpts here):

Typing

A Mistake Prone Effort



"ToothPics was developed by Class One Limited in Tempe, Arizona, to provide dentists with an easy way to enter their patients' information and run their practices. ToothPics pioneered the on-screen dental chart in which a dental assistant uses the mouse to select teeth and procedures Older systems required that all entries be typed, a mistake-prone and time-consuming process.--- the program that allowed charting information to be transferred as a text file. Standard database programs could then be used to match existing dental records with human remains.---

When a major airline crash occurred in Detroit, Dr. Allan Warnick, chief forensic odontologist of Wayne County, Michigan, asked Dr. Smith and his colleague Dr. Larry Pierce to set up and run forensic computers at the crash site. Apple immediately airlifted in two Mac IIs. The Mac IIs and several locally donated Macs were networked in the Forensic hangar. The Macintosh lived up to its reputation for ease of use: volunteers were trained and charting dental records within an hour of arriving.---With the aid of ToothPics' charts and a list of most probable matches (generated on 4th Dimension by database expert Forrest Lorz of Maryland), the forensics specialists began to identify the victims.

3 Weeks or 6 Days

One FBI expert, upon seeing the devastation of the crash, had estimated that it could take **three weeks** before all the remains could be returned to the families. But in this case, the forensic team completed the crash site identifications within **six days** of the accident- 129 of the 156 victims were identified by dental records.

The results of the case proved the system to be easy to use and effective. We do not know today an easier way of entering dental information. User friendliness meant, that no special computer operators or other additional personnel were required. No one had a degree in engineering or computer science. No one had taken a 4 days course for learning the basics and secret codes to get in to the programs. There was no remembering directories, subdirectories etc., to be able to navigate in the files, no learning tens of codes and additional codes Just pointing and clicking with the mouse was enough in the data entry.

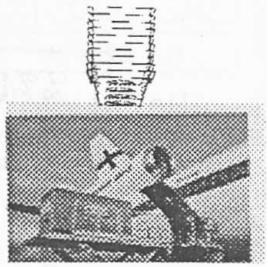
The output looked like the one in Appendix # 7, copied from a letter from NCB Washington to NCB Helsinki. The statement is signed by D.D S. **Allan Warnick** , Chief Odontologist, and M D. **Werner Spitz** , Chief Medical Examiner, both from Wayne County, Michigan, USA.

Dr. Warnick and the Michigan Dental Association have got special recognition in creating the State of New York Forensic Dental Identification Team Manual This work of about 40 pages, like the one by Colonel **William M. Morlang**, United States Air Force, Medical Service, Human Systems Center, DC, Mass Disaster Management, 45 pages plus 40 pages of Appendices (Forensic Dentistry Kit, Equipment & Supplies, Facilities etc.), are basic reading for all interested in forensic dentistry.

The Mac and a suite of software tools called MatchPics played a critical role in speeding the identification of the 111 victims of the July 19, 1989, crash of United Airlines Flight # 253. A clip of MacWeek 12 September 1989" *Mac On Scene At Crash*" is attached here as Appendix # 7a

4.2 The Finnish DVI-Team

To give the reader a snapshot of the equipment of our Team we have appended a couple of photographs and a small brochure. In Appendix # 3 we can see the Finnish DVI-Team arriving to a flight disaster scene in November 1988. Note in front of the Super Puma helo the compact, transportable micros and a stack of **DVI-Coffins.** These light and robust transportation containers are just one example of our domestic DVI- innovations for worldwide use, as are the specially designed **DVI-Stakes** , which can be easily installed without a hammer or other tools, see earlier mentioned *Appendices # 3 a, 3 and 3c.*



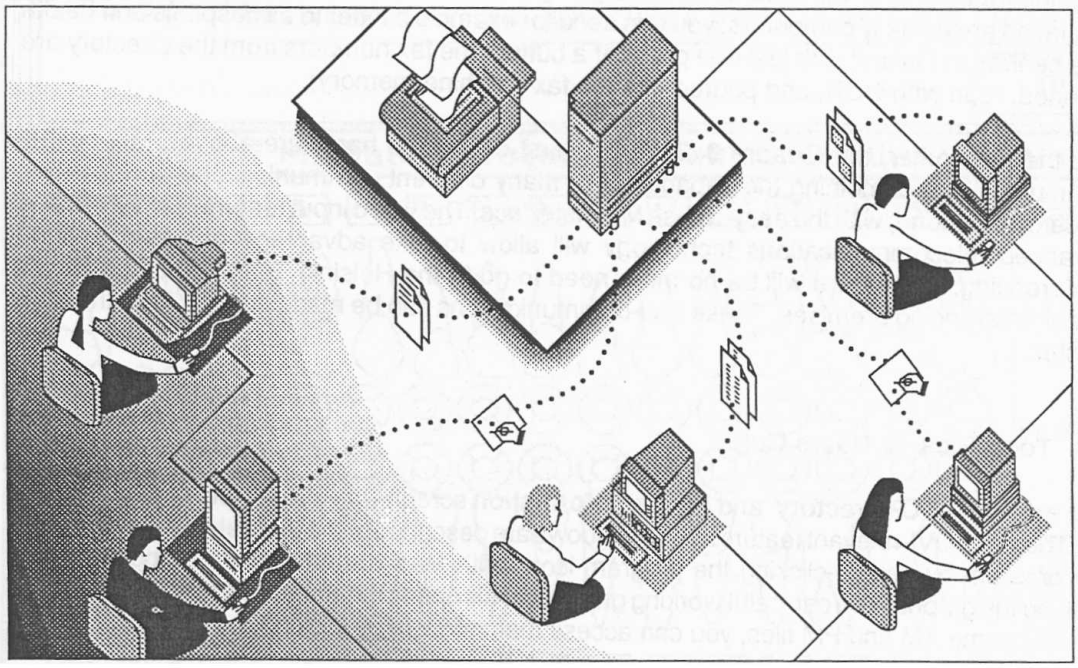
The DVI-Center

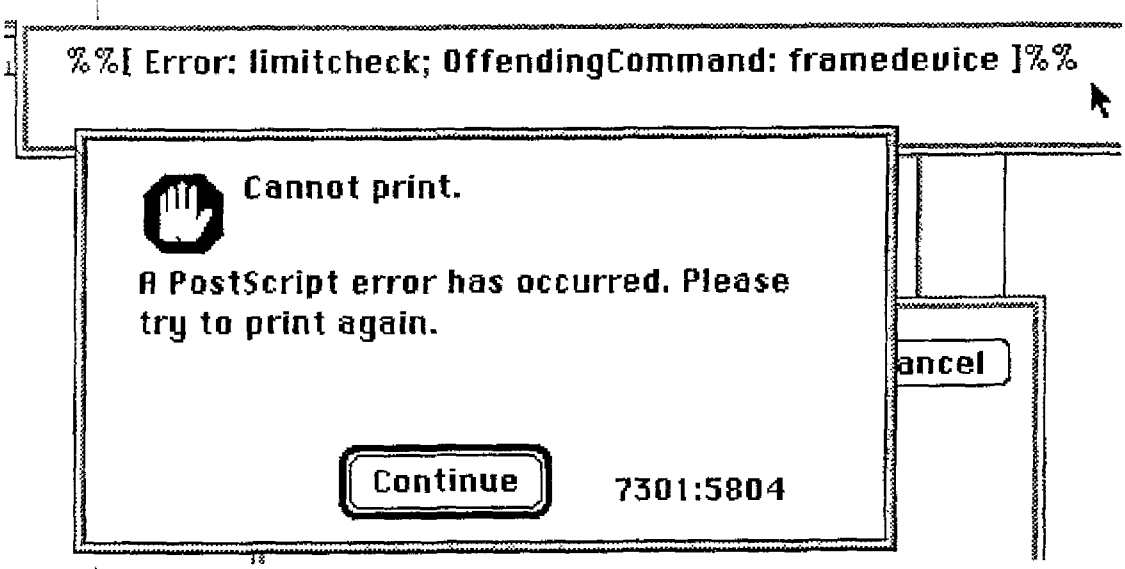
The *Appendix # 8* photograph is taken in the Finnish **DVI-Center**, ForMedInstitute/Helsinki. The Team members in their work in February 1989. Second man from the right is Mr. **Olavi Heikinheimo**, whom we might introduce here, like Oscar Amoëdo before for the whole world, as the "Father of the Finnish Forensic Odontology"

Macs and PC's, LAN

The Floorplan for the computers and peripherals of the Finnish de facto DVI-Team is very similar of that in Detroit crash (Appendix # 9). You just put in your mind more modern hardware into the picture. There are still about ten old Macs (Plus, SE, II, IIfx and Portable), a Local Area Network (PhoneNet), Removable Cartridge Back Up (Mass Drive , 45 MB Cartridges, the new ones have double or more capacity, this hardware is extremely important for **Information Secu-rity**) and Laser Printers (Apple, HP). A couple of PC's (Nokia 4 and 5 TT) are hooked in the same net allowing access to police and other register databases. Their files can be fed straight into the Macs.

The new ones are equipped with Superdrives (running PC-programs, if you like). The newest hardware consists of Quadras (700, 800), the most modern **(840 AV)** to be shipped to us in September 1993. What we still are missing, are the high end Powerbooks. We have had to borrow them, like here in Düsseldorf, August 1993, from Apple Finland.





Communications are made by telephones and telefaxes. There will be 20 extensions for the DVI-use only in the near future (mere bureaucracy has prevented the installation so far, the cordless ones do not solve the whole problem). The telefaxes will be leased from the Helsinki Telephone Company, because this way we can get the latest and most efficient models in a very short time. Two of the facsimiles are aimed for the domestic, two for international traffic, one machine for incoming, the other one for outgoing information. The important thing is that the new faxes are actually computers: you can send for example a letter to all hospitals and health care centres in Finland with just one press of a button (the fax numbers from the directory are scanned, read with OCR, and poured into the fax-machine memory).

And the newcomer, the **Quadra 840 AV** (the first one of the hardware above), has built in communications combining the capabilities of many different communications devices (fax, modem, telephone) with the easy-to-use Mac-interface. The video input feature, paired with the advanced telecommunications technology will allow to take advantage of desktop video conferencing. Then there will be no more need to go to the Helsinki Telephone Company's videoconferencing premises. These DVI-communications can be made straight from the DVI-Center.

4.3. ToothPics ® Users Guide

The graphic **ICPO-Directory** and **Patient Information** screen was already presented on page 20. The other DVI-relevant features in the windows are described in the text below here. We open the program by double-clicking the program icon. With Mac you often work by pointing and clicking the graphs. You can call it working graphics. This opens the Patient Directory. If you have already some AM and PM files, you can access them straight by clicking the Alphabetic Index Buttons. If not, click the *New Patient*. Then ToothPics presents page one of the Patient Personal Data dialog boxes so that the name and other information for the AM and PM data files can be entered. We have already filled our suspected victim, Michael James "Crocodile" Dundee. There is no need to fill in the other information found in *Appendix # 10*, which stands for an example of Formsprogram use. The three first screens are placed on the next page.

Finnish National Central Bureau of ICPO Directory

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

New Patient | Delete Patient | Open Patient Folder | Send Patient to...

○ Waiting List ◉ By Person ☐ View Details

"Our Office".

Last First Middle Nick

Please enter information for a new patient...

9.8 1993 19:19 Lastname Dundee

First Michael Mid James Nik Crocodile

Address

City State

ZipCode

Born Month /Day /Year

Area Telephone

Height Weight

Home

Business

Emergency

◉ Male ○ Female

◉ Single ○ Married

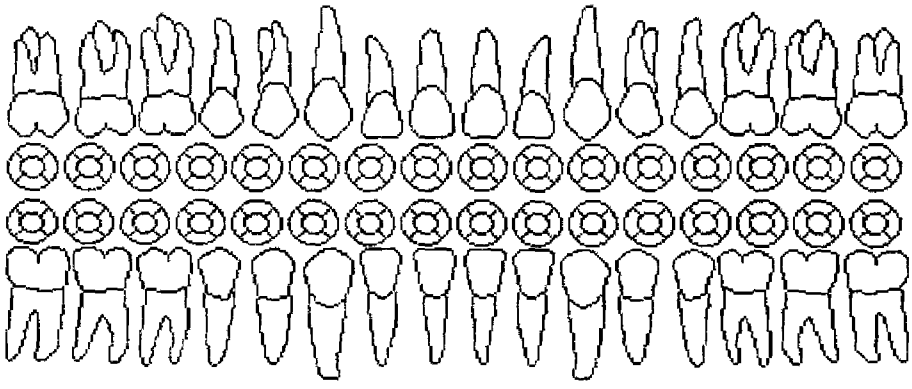
SS #

Message Between now and your next visit brush and floss regularly!

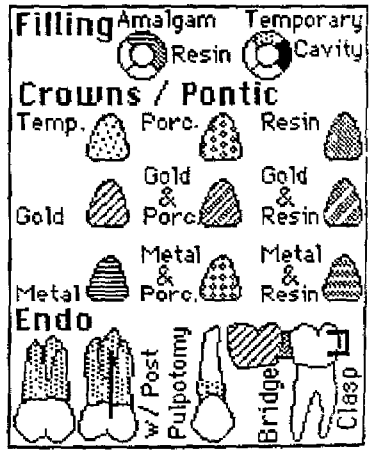
OK Cancel

Michael "Crocodile" James Dundee's Charting

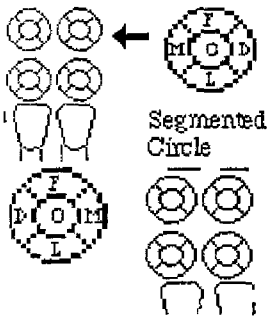
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16



32 31 30 29 28 27 26 25 24 23 22 21 20 19 18 17

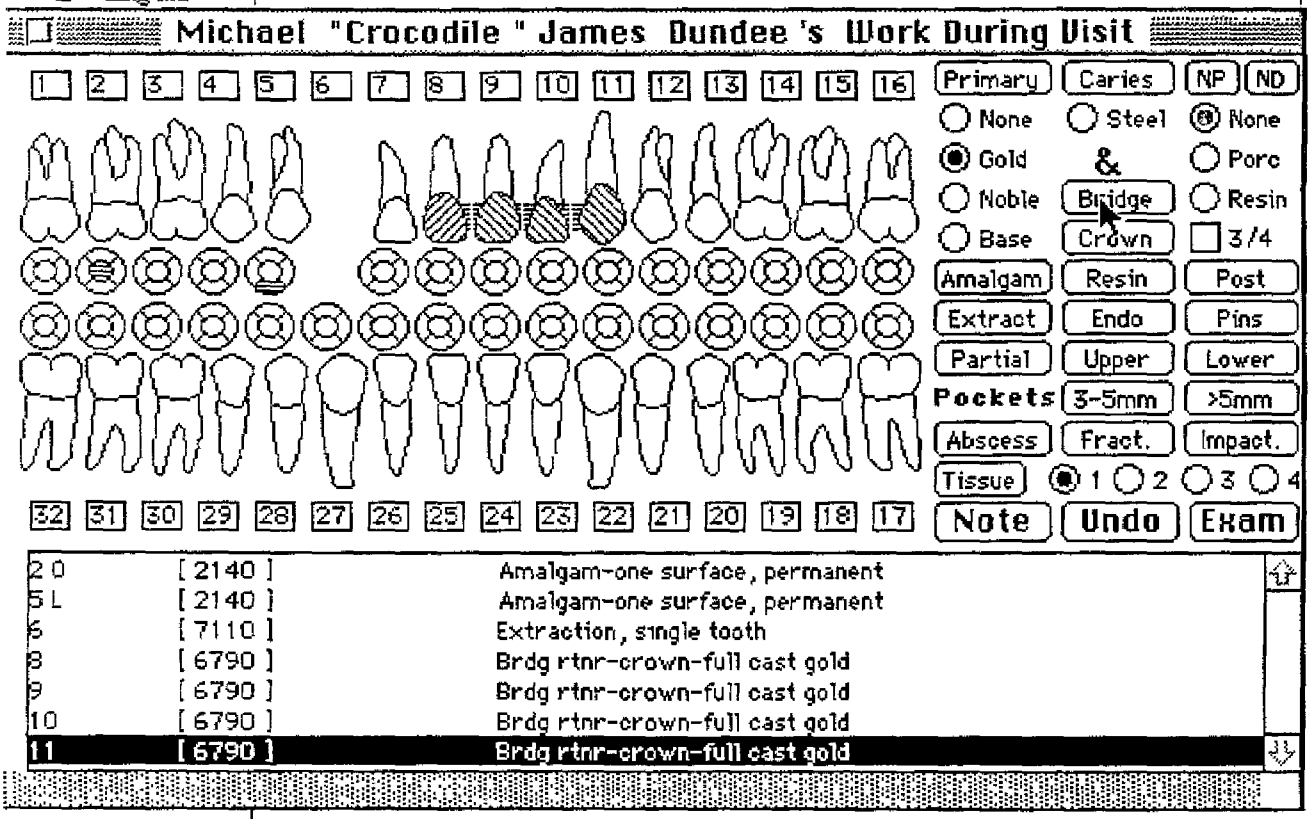


4.3.1. Tooth Selection and Elementary Charting Procedures



O = occlusal
M = mesial
D = distal
F = facial
L = lingual

Teeth are represented by a number box, a tooth outline, and by a segmented circle representing the five surfaces of the tooth. A mouse click on any segment of the circle selects that surface for the procedure. Multiple surfaces of one tooth can be selected by clicking the first surface, letting the selection be verified by a pattern inversion, then clicking on the second surface. A click in the lower right corner of the surface icon will select all surfaces of that tooth. If the wrong tooth or surface has been selected, a click on the Undo button makes the un-selection. ToothPics® shines with a very rapid input. The average Entry Rate including all quality controls is 5-10 per hour. A superuser, like Captain Hannu Mäkelä, makes 30. The real problem is the time needed to get and verify (by phone and fax) the mysterious underwriting, left/right errors etc., in the dentists' patient records and other documents and materials. Take some time here. We have put for our crocodile hunter one amalgam and one resin, the canine tooth is missing (presumably due a duel with an alligator in the Florida Everglades). Finally, and because of the world famous movies, the poor safari guide from Walkabout Creek, is now a first class passenger with a broad smile of full cast gold.

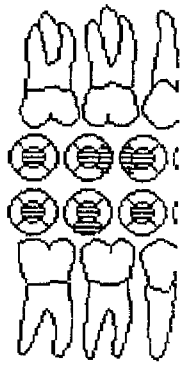


4.3.2. Dental Charting, Graphics and Text Simultaneously

Faxing the Visual Chart,

Even A Policeman Can Analyze It!!!

Dental Charting is visual. Thus every policeman in the world, even the prototype with a big head and big fists, can understand it. Trying to test them with the over 30 "secret" coding systems would be insane. There is absolutely no need to try to develop old or new nomenclatures of any kind. We repeat this, because most forensic people not so accustomed with modern computer technology seem to think only about a "Nordic", "European", "North American", etc. dental nomenclatures. Copying the chart to other documents for domestic and international fax traffic is easy. The even for a layman fully understandable information will be immediately on the other side of the globe. This is a huge advantage in the Interpol framework. We are not sending just some strange looking characters to be interpreted with the help of forensic scientists only. We sent a fax like the picture above to the Interpol Santiago some years ago, they forwarded it to the Valparaiso Police, and in no time at all an unknown body found drowned in the harbour was identified - Without a Nomenclature!



Dental Charting is suitable also for recording single unidentified bodies or missing persons as well as risk personnel (flight crews, DVI-teams etc.). Building up databases for these groups for rapid information retrieval is cheap and easy. A good rule would be that the policeman investigating the Missing Person case in question should send a copy of the dental journal to the National Police Authority in 30 days after the disappearance. A forensic dentist then could interpret the writing and chart the status into the police computer. All other physical characteristics could be fed in to the database just by using the Interpol AM Forms. A standard database or perhaps more efficiently a free text retrieval program could be used for searches.

4.3. 3. Setting Up

ToothPics® is a registered trademark of Class One Limited, Tempe, Arizona, USA. The installation is described it its own Manual (see Installing ToothPics on a Hard Disk). If you want to use more than one database (for example, AM- and PM-data in a separate one), our advise is to make a folder of their own for both of them and to copy there the ToothPics Disk 2 containing the patient library files.

NOTE! Copy only the Patients Folder, there is no need to use the others in connection of the forensic application. Here is an example how the different parts of the program can be separated in their own folders We use here different databases in Tooth-Pics® for AM- and PM-data.

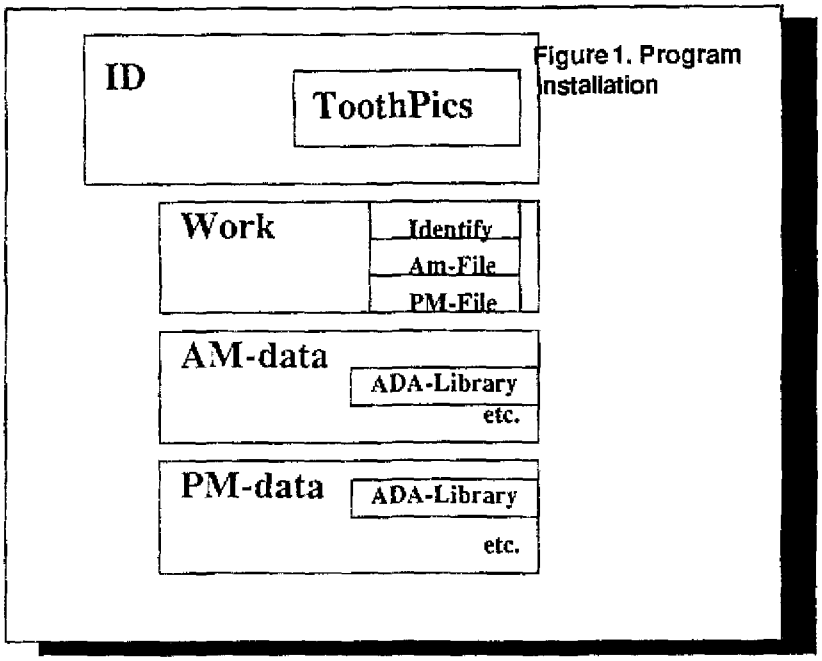


Figure 1. Program installation

The installation of the package in a Macintosh computer means installing both the data entry module ToothPics® and the comparison program Identify©.

For hardware even a seven years old Mac Plus (which you can now get with less than 300 USD) with 20 Mb Hard Disk is sufficient. The whole line of newer hardware up to the 4 000 $ Quadra 840 AV is also available. For example, a jumbojet crash with 400 victims would need for AM and PM files about 3 Mb. To run this in the RAM of an old Plus (expanded to 4 Mb) you will need a program called RamDisk + (35 $) We explain the idea of RAM-use in more detail somewhat later in the context of program running

USD 300 - 4000

Installing Identify© is done by copying the program into a folder. A separate work folder is recommended, but the program can also be in the same folder as ToothPics®. One important detail: remember to put the *TP-Config-file* to the System Folder. And do not have more than one TP-Config-file on your hard disk at the same time. Otherwise there will be a prompt for a system error

Identify 2 0


Turbo 1.1

If the resulting documents of the comparison program shall be opened straight on the screen by double-clicking the document icon, there shall also be the **Turbo-Pascal ™-Compiler** installed on the hard disk. Although, it is possible to read and print the output lists with standard word processors and without the compiler. For example, you start (Word, WordPerfect, MacWrite, etc.) and choose "Open..." from the "File"-menu. Then you can get the comparison list on the screen.

Remember, if you have used previously PC's only, the CR-codes are to be interpreted in Mac as end marks for the paragraphs, not for lines as in MS-DOS.

4.3.4. Structure

Programs Combined

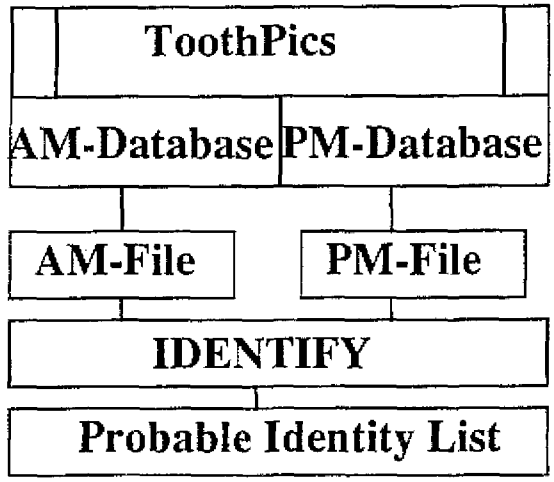
ToothPics® and Identify© is combined of two parts and programs. We shall here remember that the whole Computer Aided System of the Finnish DVI-Team consists of more than twenty programs. We have included into the micro environment the big mainframe systems' (PIRS and Crisis) major benefits: both Visual Charting and Free Text Retrieval. ToothPics® is the data entry module and user interface, Identify© does the comparison work. It should be warned already here about the common misconception, that this kind of computer program would identify anyone. No, this is the privilege of the forensic experts and the Investigator-In-Charge. The computer does only the preliminary steps by finding the best candidates and thus saving them for the unnecessary waste of time. - The same principle applies as well for the extremely complicated algorithms and sophisticated programs (most expensive, too) of automated fingerprint identification. AFIS gives us the best guesses only by automating the long process.

Two Block Transfer

The necessary transfer of information between the two components is done in two blocks called Ante Mortem (AM) and Post Mortem (PM) files. The data in ToothPics® is respectively called Ante Mortem (AM) and Post Mortem (PM) database.

The comparison program Identify© writes its own results into a file. It is also possible to start to print them right away.

Fig. 2, Program Structure



4.3.5. Logic and Calculation Schemes

3 Simple Results: *Mismatch Possible Match*

Logically forensic comparisons have the following three simple and clear results: **1.** Elimination ("Mismatch"), **2.** "Uncertain" (Possible), **3.** Identification (Match). The output with comparison programs, both in the field of dental identification as well as in automated fingerprinting, will be **a printout listing match of candidates in order of probability.**

The forensic dental comparison program Identify© has two different modes. It either tries to find a AM-dentition most likely corresponding a certain PM-dentition (Identical Search) or tries to deduct, if certain PM-dentition could have evolved from a certain AM-dentition (Possible Match).

Identical Search

The Identical Search compares every surface on every single teeth in AM- and PM-files. This search criteria is therefore fulfilled only in case of exactly identical dentition. The general dental conditions (virgin/missing/crown) must be the same as well as the fillings must fit exactly.

Just in case a dentition fulfilling this strict criteria is not found the most probable candidates are picked up according to the following calculation scheme:

In every comparison (general dental conditions, five surfaces) the total score is added with 10 if this detail is identical in AM- and PM-files. If not, the score is subtracted with 100. Those AM-files with the highest scores correspond best the searched PM-files.

Possible Match Search

The Possible Match Search tries to find out, if a given PM-file can be evolved from a certain AM-file. The starting point here is the assumption that the AM-data is not up-to-date and there are unmarked changes - as tends to be a rule in real life. In this case each individual tooth is checked for unmarked changes only. Whether the fillings are on the same locations or whether they are of the same material is completely irrelevant here.

Selection Criteria

The Selection Criteria are as follows:

◊ If the tooth concerned is missing in the PM-file all possible alternatives are allowed in the corresponding AM-file location.

◊ If the tooth concerned is missing in the AM-file it cannot be virgin in the PM-file either.

◊ If the corresponding tooth is virgin in the PM-file it must be virgin in the AM-file also.

◊ If there is a crown in the PM-file the corresponding tooth cannot be missing in the AM-file.

◊ If there are no fillings in the tooth concerned in the PM-file neither can it be restored in the AM-file.

If there are many flawless dentition in the AM-files and in the PM-files many teeth are missing or are restored this criteria gives naturally many possible candidates (a perfect dentition can become restored and teeth may loosen, but **not the other way around**).

Like in the case of the Identical Search the score here is calculated just in case no dentition fulfilling the criteria is found. The score in each aforesaid comparison location is *added* with 10 when the criteria is valid, but *subtracted* by 100 if it is invalid. This kind of calculation is benefiting small deviations in the right course.

+ 10
-100

If we want to minimize the amount of possible candidates, but maintain the possibility that the AM-data is not up-to-date, we can add to the Possible Match Search the condition that the restorations in the teeth are on the same surfaces and are made of the same material. Naturally then, the risk for erroneous interpretations grows. The aforesaid sum is calculated in this case the same way as before, but the score is *added* by 5 on each surface (M,O,D,L,F) when the criteria is fulfilled, otherwise it is *subtracted* by 50.

+ 5
- 50

Decide the Search Mode *in casu*

Different search criteria generally give somewhat differing results, although they generally find the right and corresponding pair. As a rule of thumb it is suggested to do both the Identical Search and at least one of the other Possible Matches. The suitability of different methods is naturally depending on the nature of the material to be processed. The decision has to be made *in casu*. If there are reasonable grounds to believe faults (for example, a tooth is recorded to be missing in the AM- but not in the PM-file) it is better to use the Identical Search.

Temporary File

The processing time can be reduced by using the Temporary File. The contents of the AM-file is copied here into a form more accessible than the original one. The Temporary File takes about 10 kB/AM-record extra disk space, but it accelerates the process in the Identical Search mode by 2.5 and in the Possible Match searches by 1.5 times.