THE ND 500 FAMILY

The ND-500 family concept

When it comes to designing computer systems, we at Norsk Data believe we have our priorities right – first the user, then the software, then the hardware. The result of this philosophy is the ND-500 family of 32-bit mini-computers.

Each system in the family is a flexible, general purpose data processing system giving you the facilities and power of a mainframe, together with the simplicity and economy of a mini.

The ND-520 is the smallest of the three systems and is contained within a single cabinet. The ND-540 has features which increase performance by about 90% relative to its smaller brother. The top of the line, the ND-560, is probably the most powerful and flexible super-mini system available today.

Regardless of the system you choose to solve today's needs, you may easily build up on your initial investment to meet tomorrow's demands. Without returning your hardware, rewriting your software or the expense of retraining your staff.

First the user...

There is no such thing as the typical user, the average user. Each user is an individual with individual needs and desires, individual tasks which he must perform with the help of the computer. So the first requirement is for a flexible, adaptable system. It must not have a rigid construction that places limitations on new applications, new thinking, new circumstances.

And no computer has one single user. It must serve a number of individual users, many people who use it in different ways for different purposes at the same time. We call this a multi-user, multi-task system. It must be able to handle time-sharing, real-time, batch and communications tasks concurrently. And it must do so efficiently so that it can take care of high-priority interrupts from on-line applications without keeping other users waiting.

The modern computer user wants to be directly involved in solving his own data processing problems, to work with the computer himself. He does not want to be isolated from the machine by an organisation of computer specialists--analysts, programmers, operators and administrators. He wants a system that is fully interactive and user-friendly. One that he can learn to use quickly and easily, one that is tolerant of small mistakes, and will not erase his data because he pressed the wrong key or allow his programs to be corrupted by someone else's error.

He expects the system to provide a wide range of high-level programming languages so he can choose the one best suited to his task. He expects these languages to conform to international standards, so he does not have to learn COBOL or FORTRAN all over again. The system must also provide software covering a broad spectrum of standard routines and applications. And he expects it to be easy to write programs so he can give his whole attention to the actual problem to be solved, without having to worry about limitations in the computer. This means, for example, that the computer's address space must be large enough for him to construct his programs naturally.

These are some of the requirements of the day-to-day users of the computer. But what about the people who have to pay for the system? They have other requirements, other criteria by which to judge. Firstly they want a system which will really do all the jobs it is intended to do. However they must also take a long-term view and ensure that the system will not only perform today, but also tomorrow and for many years to come. And they want to do so without having to buy an over-dimensioned system to allow room for growth. The problem is that nobody can predict the future accurately, so what is needed is a system whose design allows a gradual expansion as today's needs grow and change into tomorrow's—whatever they may be. It should be possible to add modules, both hardware and software, to the original system. And we mean add, not exchange one piece of hardware for another. The user should not have to learn a new job control language or recompile all his programs; just keep what he has, add to it when required, and go on working as before.

Often the largest part of the total investment is not the computer itself. It is the training of the users, the time spent writing, testing and documenting programs, and the definition and implementation of all the routines surrounding the new system. It is this total cost that should be minimized, which means that service, training and support are also of great importance to the user. He wants effective advice on new applications, and assistance in getting his programs into service as quickly as possible. He also wants close contacts with other users to benefit from their experience and with his supplier so he can influence future developments.

We kept these many factors in mind when we designed our new computer systems. Of course nobody can create a perfect system, but we believe we have come much closer to achieving this objective than any of our competitors.

...then the software...

Norsk Data was the first computer company in the world to provide its customers with an advanced interactive operating system on a mini-computer, thus freeing users from the restrictions and inconveniences of batch processing. Now we are innovators again, this time in a completely new field of total systems design. We have pioneered the technique of specifying software based on input from the users, and then using the software to determine the design of the hardware. In this way the future users of the system are genuinely able to influence its design—a rare opportunity.

We found that computer users demand software that is secure and reliable, user-friendly, flexible, efficient, and easy to maintain. We also found that most users believe in the continued growth of distributed data processing, and require a system which will work equally well in distributed and centralized configurations. So these became the basic design objectives for the operating system and all other software for the ND-500 family.

Powerful operating system

SINTRAN is an interactive, terminal-oriented operating system which allows many programs written in a range of languages to be executed concurrently. Depending on the resources available, it is possible to run a number of real-time processes, several batch streams, up to 64 time-sharing users and data communications, all at the same time. These facilities make the system particularly suitable for applications involving database management, time-sharing and transaction processing, heavy computation, data communications, data acquisition and process control.

SINTRAN has a simple, easy-to-learn command language. And once you have become familiar with it you can stay with it as your system expands, since SINTRAN will handle all configurations up to and including multi-processor systems and distributed networks.

REAL-TIME PROCESSING

Up to 255 different priority levels can be assigned to the various programs, ensuring that time-critical events are always serviced promptly. Context switching is very fast and operating system overheads have been kept to a minimum. Real-time programs may be scheduled by external event, operator command, program call, or time of day, thus allowing the programmer full flexibility.

TIME SHARING

Facilities and resources are allocated to all time-sharing users such that each user feels he has the whole system to himself. SINTRAN time-sharing can be used for on-line program development, information retrieval, computer-aided instruction, and other similar applications in which the user needs to access the system and get a response directly. On-line program development offers many benefits to every user. The individual programmer can input, edit, compile and test his programs without disturbing other users. This method considerably reduces the time and cost of software development.

LOCAL AND REMOTE BATCH

Time-sharing users may also submit jobs from their terminals for batch processing. SINTRAN's batch environment will handle both local and remote batch streams.

FILE MANAGEMENT

SINTRAN's File Management System allows users to address files and peripherals by locally-chosen names, both from terminals and under program control. This makes application programs device independent, an important advantage. The system also ensures file security, provides facilities for retrieving and copying files, and manages file output to print by means of a spooling system.

Simple programming, efficient compilation

You can choose to write your programs in FORTRAN, BASIC, PASCAL, SIMULA, COBOL or RPG.

ND FORTRAN is based on the ANSI -77 standard, and includes many modern features. The compiler produces compact object code designed to make optimum use of the instruction set of the ND-500 processor.

ND COBOL conforms to the ANSI -74 standard. Since the run-time system is completely re-entrant, COBOL programs can be used in real-time applications.

PASCAL was developed primarily for teaching people to program, and is easy to understand, learn and use.

SIMULA is an extended ALGOL-like language which has achieved widespread acceptance in universities and research centres, mainly for scientific programming and operational research.

BASIC is probably the most popular language for teaching, and ND BASIC meets the Dartmouth College standard.

ND RPG is fully compatible with that of the IBM System 3, making program conversion easy. RPG is a simple language, suitable for various administrative applications. These languages are complemented by newer scientific and real-time languages such as CORAL 66. They are largely compatible with the equivalent versions on the major mainframe systems. They all include efficient, easy-to-use debugging aids and programs can be compiled, tested and debugged on-line without risk to other running programs or the operating system. The Program Editor allows the user to edit text files in any programming language interactively from his terminal.

Efficient data communications

ND-NET allows any number of ND computers to be linked together to form a hierarchical, ring or star network. Under ND-NET any computer in a network can communicate with any other computer. Transmission can be half or full duplex and can take place at up to 9600 baud via the public telephone network. Speeds of up to 980 Kbaud can be achieved between physically close systems.

ND-NET allows a program running in one computer to transfer data directly to a program running in another computer; it allows a terminal connected to one computer to log on to another computer and use all its facilities; and it allows remote file access.

Many packages are available which enable ND computer systems to communicate with mainframes of various makes by emulating standard remote job entry and remote data entry terminals. These include the IBM 2780/3780, 3270 and HASP Workstation; Honeywell GRTS 115 and VIP 7750; CDC 200; and Univac NTR and DCT 2000. One user can communicate with several different machines at the same time.

The ND X.25 PACKET AND LINK LEVEL software simplifies the connection of any ND computer system to X.25 based networks such as PSS, TRANSPAC, DATAPAC and DATEX-P. The V.24 interface can be used with dial-up or leased lines. The X.21 facility may be used to access circuit-switched networks such as the Nordic Public Data Network.

Comprehensive data management

DATABASE MANAGEMENT

SIBAS, the ND database management system, was designed in accordance with the CODASYL DBMS recommendations, and provides the user with facilities normally found only on large mainframe systems.

SIBAS can handle multi-user concurrent processing, and allows application programs to be written in a number of high-level languages. It provides multiple access paths to the records, enabling different programs to use the same stored data in different ways. SIBAS is able to reflect data structures as seen by the user and thus reduces data redundance to a minimum. Its system of privacy locks prevents unauthorized access to the database.

An almost unlimited addressing range provides new possibilities for the SIBAS user. For example, a complete database could be incorporated into a single program. And a SIBAS database can be distributed over a number of computers in a network.

QUERY LANGUAGE

ND ACCESS is an interactive high-level language for database query and update. It is based on the renowned Query-by-Example technique. As such it is simple to use for non-edp trained users, and also for executing complex tasks.

TRANSACTION PROCESSING

ND TPS works under SINTRAN to provide a complete package for transaction processing. It handles all terminal input and output, communication with other computers, message queueing and routing, SIBAS database access control, transaction control, and operational control. The interface between TPS and the user's application programs is formed by transaction service routines, which allow the use of check-pointing. This ensures that transaction processing can always be restarted from a recent point in time.

FILE HANDLING

ND ISAM consists of a number of routines for sequential, indexed sequential and random processing of fixed record-length SINTRAN files. Each file can have up to 6 keys and duplicate keys are permitted.

ND SORT/MERGE allows files held on disk or tape to be sorted or merged. A number of different keys are possible.

INFORMATION PROCESSING

ND FOCUS enables each user to define his own screen formats interactively. He then uses these formats to input data to and output data from his programs, regardless of the language in which they are written.

NOTIS—the ND Text and Information System—is a powerful package for interactive text and information processing. Currently, NOTIS consists of word processing software, to carry out text entry, editing and formatting, and a module for information storage and retrieval—a very powerful tool for searching for documents according to their content. Modules are currently under development for report generation, information distribution and personal management.
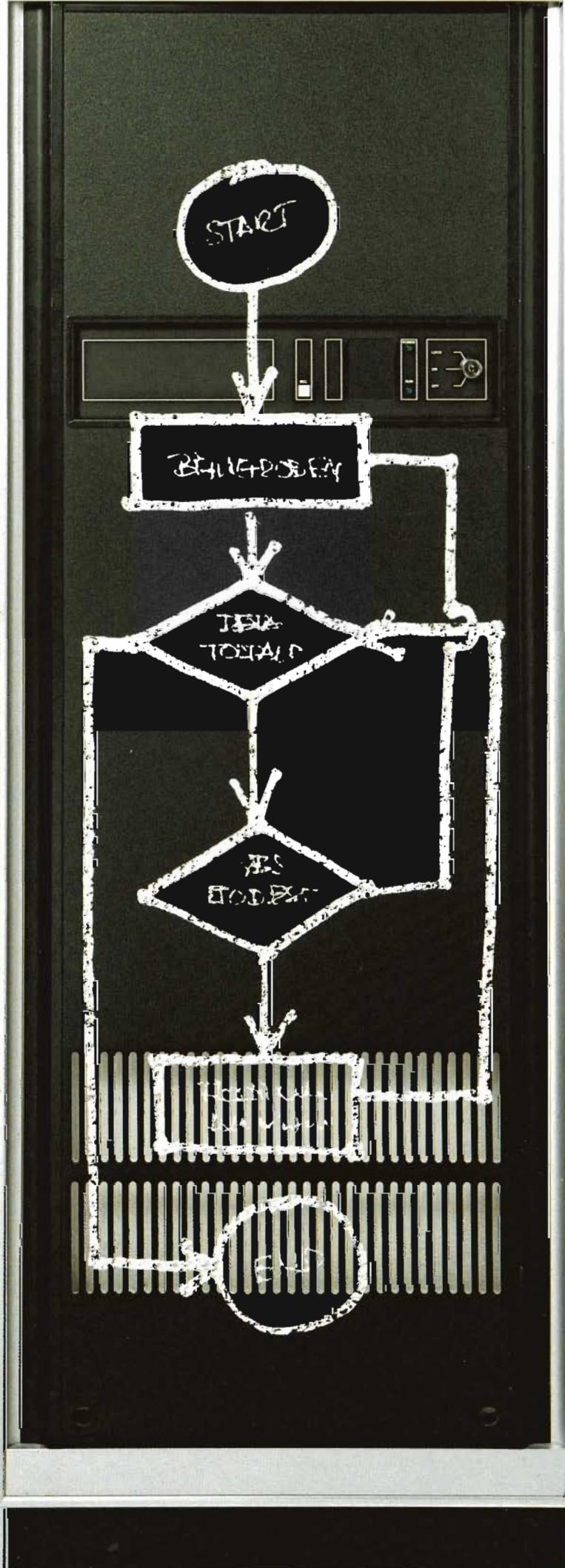
... and finally the hardware

In specifying the software, in particular the operating system, we had also specified a theoretical computer. We then converted this theoretical computer into real hardware, using the newest technology and latest system design concepts. The result is the ND-500 family of systems consisting of two or more processors, shared main memory, and a range of peripherals. The various hardware elements are logically and functionally integrated by the SINTRAN operating system. The ND-500 family consists of three systems: the ND-520, ND-540 and ND-560.

Multi-processor systems

Each system consists of two processors, one an ND-500, the other an ND-100. The ND-100 was the first high-performance 16-bit computer to be mounted on a single printed-circuit board and, together with memory and peripherals, it constitutes a powerful mini-computer in its own right.

The ND-500 processor, the heart of each system, is a very fast 32-bit machine. It is byte-oriented, with hardware instructions for operations on both 32 and 16-bit floating point numbers.

This combination of processors forms an extremely powerful and effective data processing system. If you need even more processing power, additional processors can be integrated into the system.

Optimal use of hardware

The users expect the system to optimize the use of its resources. So we have designed the operating system to ensure that each program is run in the processor which is most appropriate for it. The capacity of the ND-500 processor is not squandered on tasks which are anyway limited by input or output. So the system reserves the real power of the ND-500 for the processor- bound jobs: just those jobs it is designed to perform most effectively. These are primarily the compilation and execution of high-level language programs, where the full capacity of the processor can be used. The ND-100 has adequate capacity to handle all input/output, communication, data entry, editing, and parts of SINTRAN itself. In addition the ND-100 acts as a maintenance processor for the ND-500 and runs all test programs required to confirm the function of the system, either alone or under the operating system.

The ND-500 processor

Norsk Data built their first 32-bit computer as long ago as 1972, and the ND-500 is the third in the line. It thus represents many years' accumulated experience in 32-bit systems design. Our objective in designing the ND-500 was to create a processor which would compile and execute in the best possible way programs written in high-level languages, and on which essential parts of the operating system could be implemented simply and efficiently. In other words, a processor which makes program development as efficient as possible. After all, it's the software that costs most nowadays.

Efficient instruction set

The ND-500 processor has a rich instruction set, carefully selected to optimize compiler code generation. The range of addressing modes and data types is comprehensive and includes the logical indexing of array elements. These factors, combined with the high speed TTL logic used to implement them, result in extremely fast execution of programs written in high-level languages.

The instructions were chosen by a team of compiler and operating system experts, not by hardware engineers. This has produced a processor that does much of the compiler's work itself, thus allowing simpler and more reliable compilers to be used. Several high-level functions, such as FORTRAN DO-loops and CALL statements, COBOL STRING handling and decimal arithmetic, are each performed by a single ND-500 instruction.

Instructions are of variable length, so that the most used instructions require the minimum space in memory. The operands can vary from a single bit up to long strings, and 14 basic addressing modes are provided. Permitted data types are bit, byte, half-word, double-word and packed decimal. Indexing is logical, not absolute. The processor calculates the address of the operand by considering both the index value and the data type of the operand. For example, if an array of words is being addressed, then the index value is multiplied by 4 to obtain the relative byte displacement. If the array consists of half-words then the index value would be multiplied by 2. These design features result in compact code, efficient memory utilization, reliable compilers and simplified programming. Compact code and efficient memory utilization mean that you need fewer memory accesses to execute a given program, which therefore runs more quickly. Reliable compilers and simplified programming reduce the time and cost required for software development.

Fast execution

It is not enough to have efficient instructions; they must be executed quickly too. In the ND-500 the most commonly used instructions are performed in one 200-nanosecond machine cycle. Instructions are pre-fetched in a three-stage process. While the processor is executing one instruction, it is also fetching the operands for the next and decoding a third. This overlapping of instructions increases the throughput of the processor considerably.

Floating point instructions are carried out by special hardware. Arithmetic operations are performed on parallel arrays, not bit by bit. This gives very short execution times: double precision (64-bit) addition and subtraction take only 400 nanoseconds, multiplication 500 and division 2900 nanoseconds.

A system of hardware traps is used by both the operating system and by the programmer. Different types of trap can be used for tracing, debugging and evaluating programs.

ND-520

The smallest member of the ND-500 family is contained in a single cabinet which may house up to 2 1/4 Mbytes of memory. The basic ND-520 system includes 3/4 Mbyte of memory; it may be easily field-upgraded to an ND-540 system.

ND-540

The ND-540 is also contained in a single cabinet, with from 3/4 to 2 1/4 Mbytes of memory. A 32 Kbytes high speed cache memory system increases c.p.u. performance by about 90% relative to the ND-520.

ND-560

The top-of-the-line model, the ND-560 includes a basic memory of 3/4 Mbytes–this may be increased to 7 1/4 Mbytes! The ND-560 has 32 Kbytes of cache memory and is housed in two cabinets.
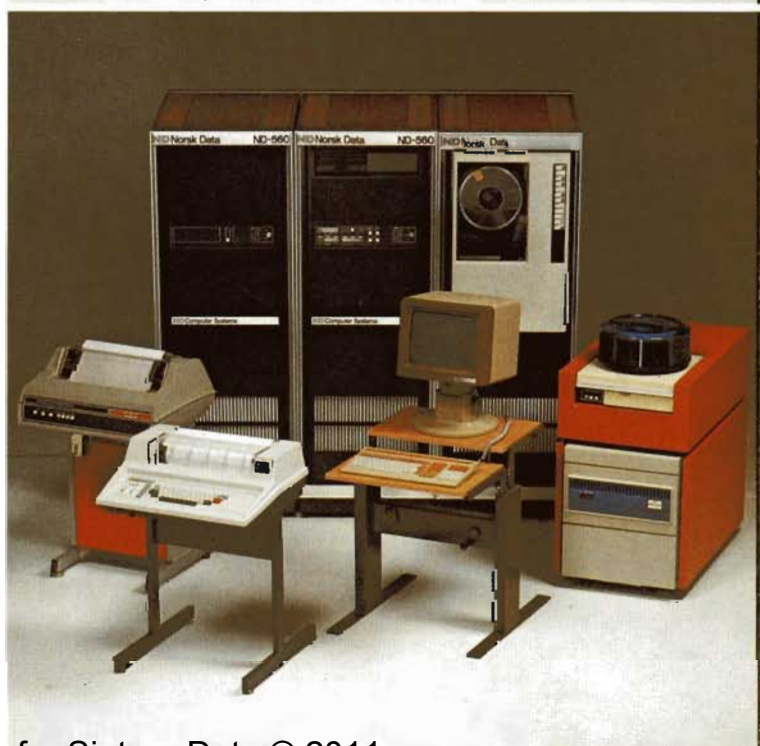
The memory system

The logical address space of the ND-500 family systems is practically unlimited—more than 4 Gigabytes for program (instructions) and the same for data. The memory management system is implemented twice, once for instructions and once for data, and handles the conversion from logical to physical addresses. An elaborate protection system is designed into the memory management system to ensure that a program may only access instructions and data which it has been given explicit permission to access. This system helps trap program errors earlier, resulting in more secure software.

Both the ND-540 and the ND-560 systems each include a 32 Kbytes cache memory system. The ND-560's cache system may be expanded up to 128 Kbytes. The cache is used by the processor to reduce the amount of time required to fetch instructions and data from main memory. There are two identical caches, one for instructions and one for data, so these may be fetched in parallel. The cache is always 4K elements deep and 4, 8 or 16 bytes wide. The cache block size is identical to the width of the channel from the main memory to the cache.

The cache can be divided into one 4K, two 2K or four 1K partitions. Each partition may be assigned to individual programs which eliminates the need to reload the cache from main memory when context switching.

The high-speed semi-conductor main memory of the ND-500 is multi-ported and is shared by the ND-500 processor, the ND-100 processor and Direct Memory Access (DMA) devices such as disk and tape systems and fast communication links. Interleaving is used to speed memory access. The physical size of the main memory varies with the system, but can range from 512 Kbytes up to as much as 32 Mbytes. In addition to the shared main memory each processor may have its own private memory, which is not accessible to other processors in the system. Each basic ND-520, ND-540 and ND-560 contains 256 Kbytes of memory which is private to the ND-100 processor.

Expansion

The ND-500 family was designed with expandability as a major feature. Both I/O and memory expansion systems are readily available—for every machine in the family. Each I/O expansion system provides an extra 18 I/O slots. Memory expansion systems can be used to increase memory capacity up to 32 Mbytes.

The ND-560's performance can be enhanced by increasing its cache memory system to 64 or 128 Kbytes.

Peripherals

The ND-500 family is supported by a full range of peripherals. Mass storage devices include floppy disks, fixed and removable disk systems and very high speed magnetic tape units. The maximum disk storage capacity is 2300 Mbytes. Paper tape and punched card equipment is available plus several character, line and band printers, and display and graphical terminals. There are also process interfaces and a range of communications interfaces.

ND-560 **ND** Norsk Data ND-560 **ND** Norsk Data

ND Computer Systems

Ergonomic terminals

These days it is not sufficient to have a good system—it is also essential that it is accepted by all the people who will be using it. Quite rightly, the health and comfort of the users is considered to be an important part of the proper functioning of the system.

Since almost all interaction between the computer and its users takes place via display terminals, Norsk Data have taken care to ensure that the terminals we supply are both functionally and ergonomically correct for their intended purpose.

The position and angle of the terminal can be freely adjusted to suit each individual user. The screen can be swivelled through 30° in either direction and tilted between 10° forward and 15° backward. This is enough to cut out interference from windows and overhead lighting. In addition the terminal can be raised and lowered through 90 mm to permit different operators to adjust its height for their comfort. This range of adjustments should allow every user to adopt a natural and convenient posture when working with the terminal. And since there is no cooling fan, the terminal is silent in operation.

The 15" screen is treated to minimize reflection and the display colour is chosen to reduce eye strain. The screen shows a flicker-free display of up to 25 lines of 80 characters. Each character is formed in a 9×14 point matrix, giving high resolution. Both upper and lower case are provided, with a full character set for each local language. Blink, underline and inverse display are all included as standard features.

The keyboard is of modern design, with a very low profile. This enables the terminal to be used comfortably on a standard office desk. Special function keys speed and simplify the input of commands to the system. And the cabling is concealed under a snap-on cover so the terminal work-station has a generally attractive appearance. The keyboard is of course separate from the display, allowing you to place it in the most convenient position for each job. We believe we have done everything possible to make our terminals simple, pleasant and comfortable for you to work with.
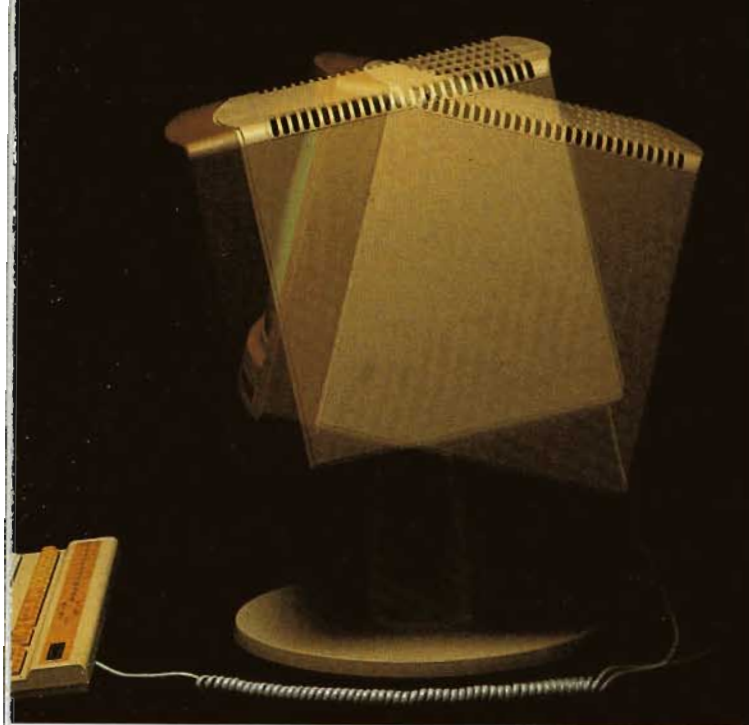
Plus service and support

So that you get the maximum benefit from your ND-500 system, Norsk Data offers you a comprehensive international support programme.

You may call on our customer support services if you need advice or assistance in the use of our hardware and software in your application. Highly qualified consultants can help you with system specification, design and implementation.

The education and training of your personnel is a vital part of our programme. Comprehensive courses in programming and system operation are held regularly. Great emphasis is placed on practical training, and ample computer time is made available to all students. On-site courses specially tailored to fit your individual requirements can also be provided.

And to ensure the maximum possible availability of your ND-500 system a service contract may be signed. This will give the full benefit of our field service organisation which has experienced engineers, stocks of spare parts, and advanced test equipment at many strategic locations.

NOCUS is the ND computer users' society and is an active organisation, to which all owners of ND systems are invited to belong. You will be able to exchange experiences with other users, both at its regular meetings and via participation in its many sub groups.

The ND Five Hundred Series.
Family planning in data processing.

Norsk Data

Systems that put people first