# COMPUTER GRAPHICS, A POWERFUL INFORMATION TOOL

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Information transfer from/to human beeings is a central part of a computer system. We will here show how Computer Graphics can make man machine communication extreemely much more efficient. A case study of a Norwegian mining company, A/S Sydvaranger, will illustrate this fact. This company uses Computer Graphics for information transfer between people at all levels.

The graphic system in use for the above mentioned application is G P G S - F (General Purpose Graphic System in Fortran) which is the standard graphic system for Norwegian users.

This standardization has been pushed through by NORSIGD, The Norwegian Cooperation in Computer Graphics, formed by Norwegian users.

GPGS-F which here will be briefly described (A more detailed description in (1) ) is implemented for 12 different computer types with device drivers for 17 different graphic devices. There are approximately 70 installations of the sysyem today throughout the world, 10 of theese are HP 3000 installations.

# BRIEF DATA ON AKTIESELSKABET SYDVARANGERs PRODUCTION

**THE BASIS** for the company's existence are the very substantial iron ore deposits situated on the Kirkenes-peninsula combined with excellent deep sea harbour facilities in Kirkenes, only 5 miles from the main orebody at Bjørnevatn.

**AKTIESELSKABET SYDVARANGER** was founded in 1906. The company today has 2300 shareholders. The Norwegian government owns 51% of the shares.

**THE PLANT** is today designed and built for a total production capacity of 2.5 million metric tons iron pellets (minimum 65% Fe).

**THE MINING** in Bjørnevatn is carried out as an open cast operation. The open pit is considered large by Norwegian standards. The present production plans operate with a stripping ratio of 2,5:1, i.e. 15 million tons of waste have to be removed to enable recovery of our annual production of approx. 6 million tons of magnetic ore which contains about 30% iron.

**DRILLING** is mainly carried out by means of Bycyrus Erie 60 R rotary drills producing holes of 12 1/4 inch diameter.

**BLAST CHARGING** is done with ANFEX (Ammonium nitrate-fuel explosives) and TNT-slurry. Each hole is charged with approximately 1 ton of explosives. Total blast size varies between 75.000 tons and 750.000 tons of material broken, and the equivalent amount of explosives used varies between 30 and 300 tons.

**LOADING OF MATERIAL** is carried out with track mounted P & H electric shovels with 7 m3 bucket capacity and one Marion 191 and one P & H 2100 shovel, each with 11 'm (15 'yds) bucket. In addition to this several wheel loaders are used, the largest of which is a 10 'yds Caterpillar 992 and Dart 600 12 'yds.

**ORE AND WASTE TRANSPORT** is taken care of by a fleet of 100 and 150 tons Lectra Haul and Haulpack trucks.

**PRIMARY CRUSHING** is done in Bjørnevatn by means of (two) 54" Nordberg gyratory crushers (54" wide intake opening) which is normally set at 5½" closed side, giving ore crushed down to approx. minus 5".

**ORE COBBING** is carried out on conveying it over large magnetic drums separating most of the waste (15% - 20 %) from the ore before it is discharged into the ore storage silo.

**THIS CRUSHED ORE** is transported by our own railway in 60 tons capacity cars and dumped in large ore bins at our secondary crushing plant. Each train has 20 cars and thus carries approx. 1200 tons.

**OUR TWO STAGE SECONDARY CRUSHING PLANT** uses 7"Symonds cone crushers and reduces the ore in size to approx. minus 1 inch.

**PRIMARY GRINDING** of this material is carried out in a two stage ball mill process where water is added as a carrying agent. After this grinding approx. 30% of the material is separated out as waste over series of magnetic drums. This product or concentrate, is ground further to make it suitable for pelletizing.
This concentrate contains approx. 68% Fe.

**PELLETIZING**, a process which transformes the concentrate into the shape of small ½" diameter balls is carried out by adding approx. 1% of a binding agent called bentonite (basically a special, dry, finely ground clay). This mixture is rolled in large inclined drums which produce small balls (green pellets).
These are dried over a travelling grate, preheated and sintered. The «pellets» will have a temperature in excess of 1000° C when leaving the grate. From here they enter a rotating oven or kiln where they are heated further to approx. 1350° C. The hot pellets are now discharging into a cooler section where they are cooled down to 20-30° C by a forced air draught.
This product is stored in a large 400.000 tons capacity silo blasted into the mountain.

**THE HARBOUR** in Kirkenes is a good natural harbour which has little problem with ice in winter, in spite of its location at 70° North. The harbour facilities has a capacity for loading ships up to 150.000 tons at a rate of approx. 4.000 t/h.

**AKTIESELSKABET SYDVARANGER** today has approx. 1250 employees in Sør-Varanger



1 COMPUTER GRAPHICS IN A MINING COMPANY

1.1 A/S Sydvaranger

"Raw data".

A/S Sydvaranger is a mining company situated i Kirkenes, a small town on the russian border far up north an far east in Norway.

The mine is an open pit one and contains low grade iron ore which are concentrated to the proper quality in a conventional crushing/milling/separating plant. Our final product is iron pellets which is small balls (about half an inch in diameter) containing 65% iron.

Further information about the company and the process is given on the next pages.

## 1.2 An EDP pioner in Norway

A/S Sydvaranger installed its first EDP equipment in 1963. At that time a computer was a scarcity even at the norwegian universities.

The first machine was an IBM punched-card-based 421.

Part of the companies staff-department-routines were implemented in the first place and soon afterwards a first version of a stock controlling and accounting system.

In 1966 a new and more powerful computer was installed (IBM 360/20) and the main part of the companies accouting system was "computerized".

An information system for the mining operations was also devel-loped.

In 1974 the 360/20 was scrapped and after a short interludium where different alternatives were tested, the company in 76 bought and installed a HP 3000.

Today A/S Sydvaranger heavily depends on the computer in the following areas:

- Production reporting
- Accouting
- Stock control
- Payment of wages

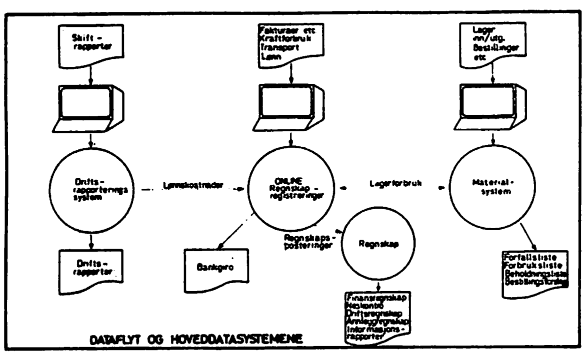



Fig. 2 Dataflyt og hoveddatasystem.

The companies data flow



Within a year a process control machine (Siemens R 30) will be installed to improve production quantum- and quality control in the pelletizing plant.

We are also testing out a mineral evaluation system (Mineval), which is a program based on first generation graphical methodes.

The total investment in EDP equipment so far amounts to approximately 5 mill. kroner. (1 mill. $)

The hardware configuration consists of approx 30 terminals of all kinds - six of them at the companies headquarters in Oslo.

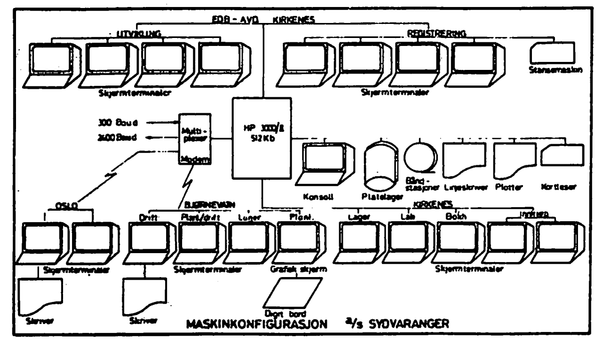



*Fig. 1. A/s Sydvarangers maskinkonfigurasjon*

The EDP-department today counts 11 persons, 7 of them are programmers.

Our main effort is to improve the information contained in the great variety of EDP-reports, and also get the computer and computer methods accepted everywhere in the company.

Considering the fact that EDP less than 20 years ago was a rarity, it is not surprising that use of the modern microprocessorpowered computers have created a lot of discussion, - both seen from the economic and social point of view.

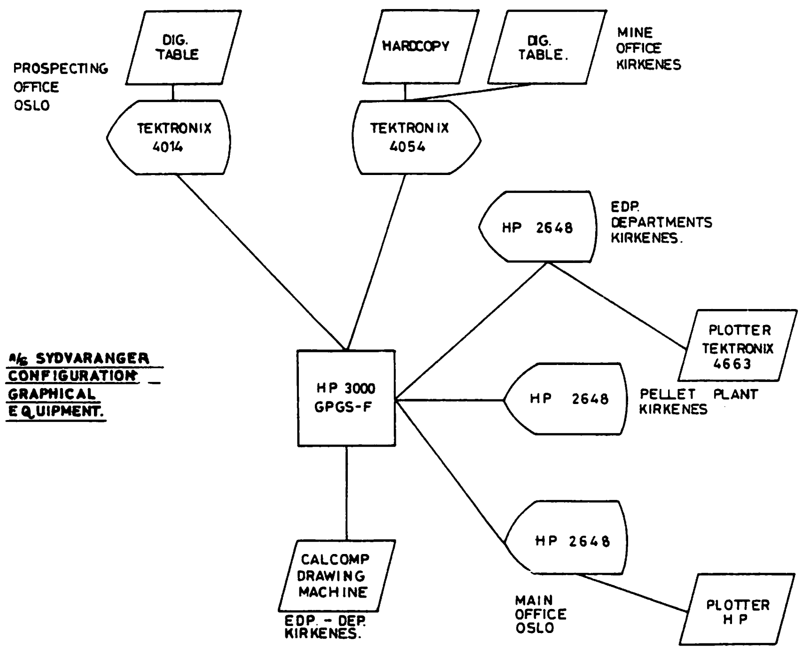
What is the outcome of the millions that have been invested in EDP-equipment the manager is asking. What will happen with my job is the workers question.

One of our projects to reassure both parts is to supplement the numerical reports with better understandable one's . Today this is possible not least due to computer graphies.

Drawing machines, plotters, graphical screens, digitizers etc. has moved the computer a big step towards the people.

## 1.3 Graphic Hardware

The hardware is a mixture of a number of units as shown below.




All units is online to the HP3000. Some of them are multi-plexed on medium capasity telephon lines.



## 1.4 Graphic Software

Hardware is mentioned - computer journals are full of visualization units of all kinds. Less is spoken about software. How do you program a 3 dimensional rotation picture; how do you program a histogram? Do you hav to write a special program for every graphical output unit?

So many questions. And so many traps to be caught in.

One way to get rid of most of the difficulties is to choose a standardized graphical software package.

The GPGS-F is such a system. Standardized by NORSIGD, a norwegian organization formed by people interested in graphics.

GPGS-F is fortunately implemented on the HP3000 system. The system basis is a set of fundamental routines drawing lines, circles, character strings, numerics etc..

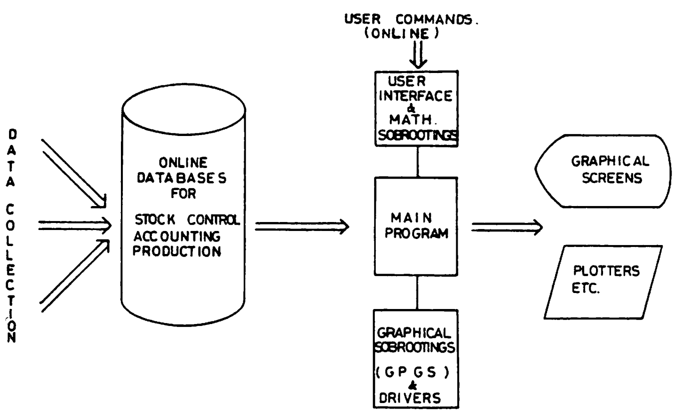
Besides the routines already mentioned the system contains a number of special drivers for the most popular and common graphical units.

The system is very well documented and easy to learn.

1.5 System philosophy

The graphical system is an online one. On the user's commands it are fetching data from the big databases containing up-to-date information about the stock, the production, the accounting etc.. The extracted data is then presented as diagrams..

The user's of the system are not computer specialists, they might not even be interested in computers. They are mine foremen, geologists, production planers, clerks, directors etc.. Therefore the user interface to the system is very important. The online dialog should be adapted to the user's language and way of thinking.




**ONLINE GRAPHICAL REPORTING SYSTEM A/S SYDVARANGER.**



This is obtained by giving the user a series of commands to choose between.

A valid command leads to a conversation like the following

- . command name identifying the user's main topic of interest
- . additional information f.ex. machine number
- . period of interest
- . output media

Not valid input at all levels are followed by a very friendly-sorry - and a recommended continuation.

The language is plain and simple norwegian, not a word is reminding the user of the bits and bytes, the full duplex, the recursive procedures, the interlaced memory - and whatsoever.

As a first aid the HELP command gives an overall information about the system.

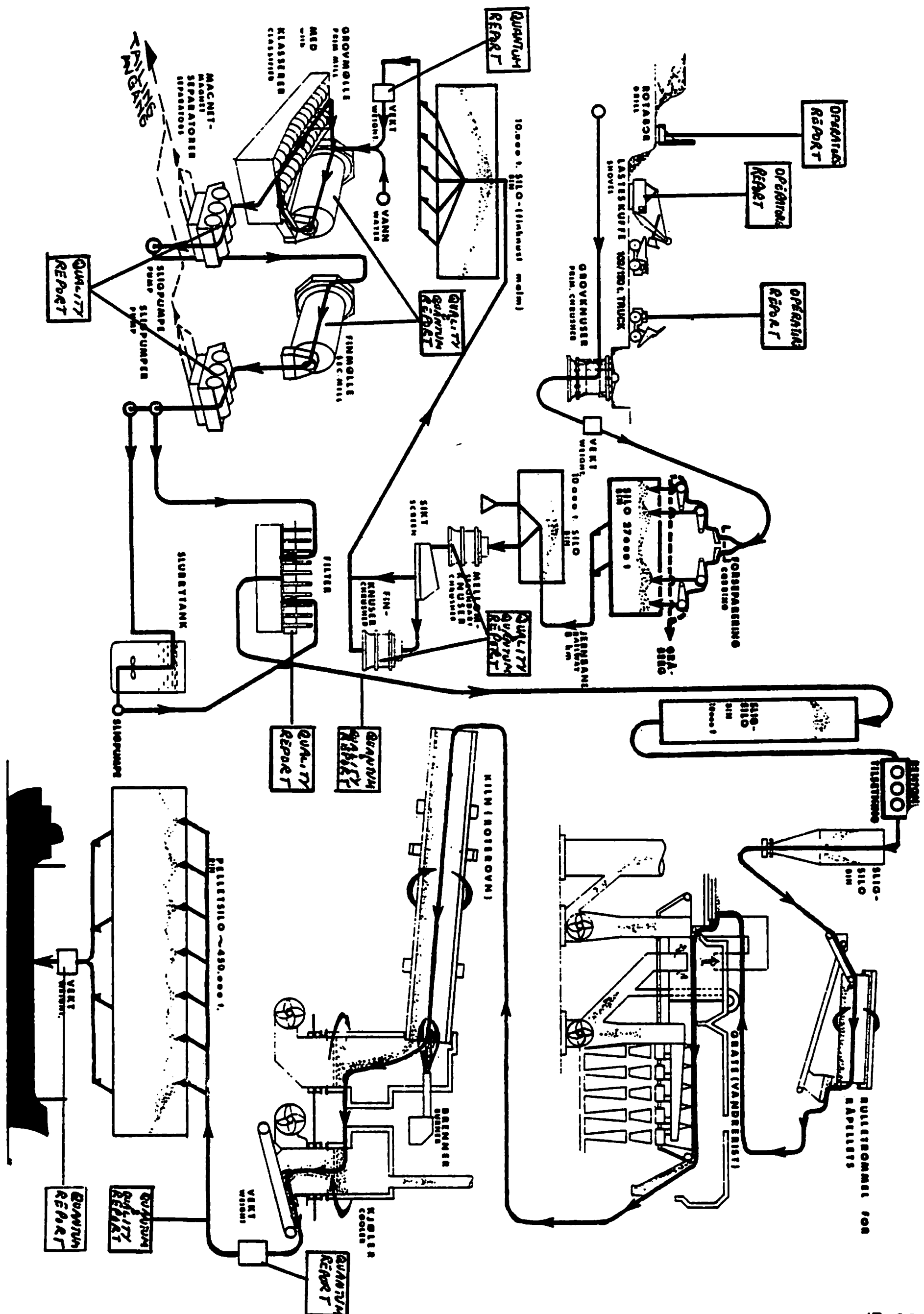
1.6 Data collection

The systems practical value fully depends upon the quality of the information put into the databanks. It has therefore been necessary to establish a data reporting program.

A great number of reports is collected and registered into the computer.

This is also done online by means of masking technics.

On the next page the data collection system for the production data is shown.





1.7 Examples

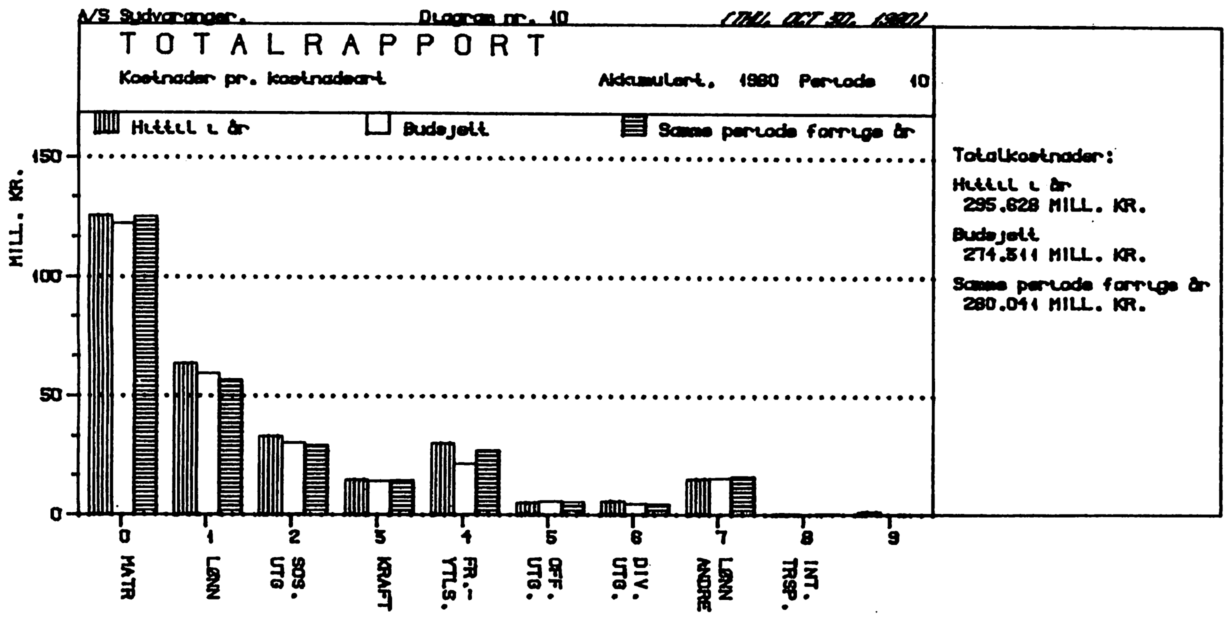
The example section is devided in three parts.

Part one contains examples from the economics reporting system (diagram 1 - 3).

Part two shows some mining reports (diagram 4 - 6).

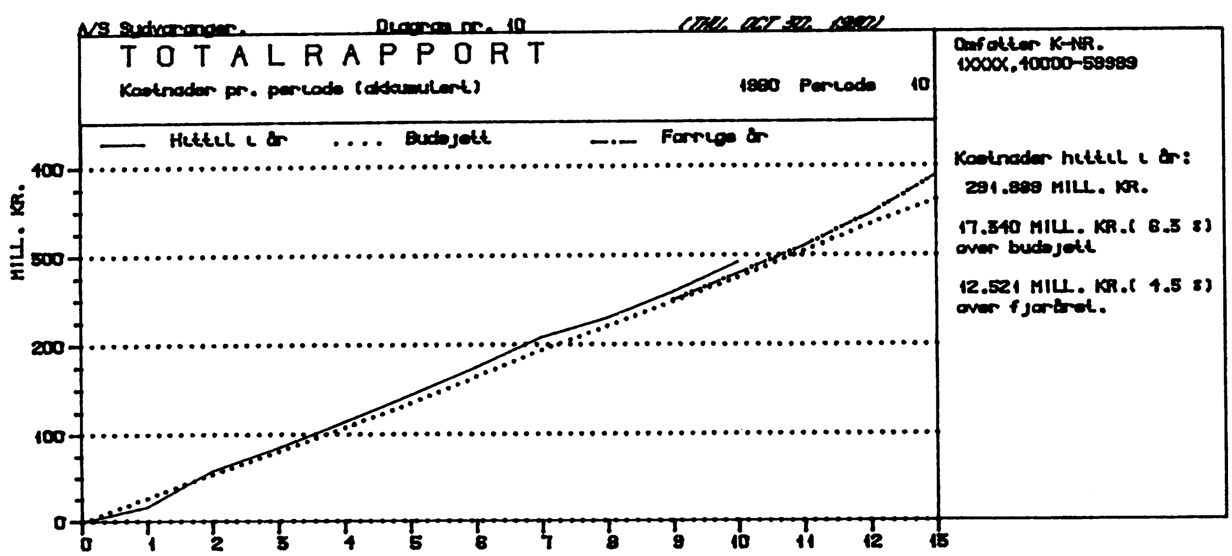
Part three shows how the pelletizing plant has been run (diagram 7 - 8).

J5 14



A/S Sydvaranger.
Diagram nr. 10
TOTALRAPPORT
Kostnader pr. kostnadsart
Akkumulert. 1980 Periode 10
Hittil i år
Budsjett
Samme periode forrige år
MILL. KR.
Totalkostnader:
Hittil i år
295.628 MILL. KR.
Budsjett
274.311 MILL. KR.
Samme periode forrige år
280.041 MILL. KR.
0 MATR
1 LØNN
2 SOS. UTG
3 KRAFT
4 FR.-YTLS.
5 OFF. UTG.
6 DIV. UTG.
7 LØNN ANDRE
8 INT. TRSP.
9


J5 13



A/S Sydvaranger.
Diagram nr. 10
TOTALRAPPORT
Kostnader pr. periode (akkumulert)
1980 Periode 10
Hittil i år
Budsjett
Forrige år
MILL. KR.
Omfatter K-NR.
1XXXX,40000-59999
Kostnader hittil i år:
291.899 MILL. KR.
17.340 MILL. KR.( 6.3 %)
over budsjett
12.521 MILL. KR.( 4.5 %)
over fjoråret.

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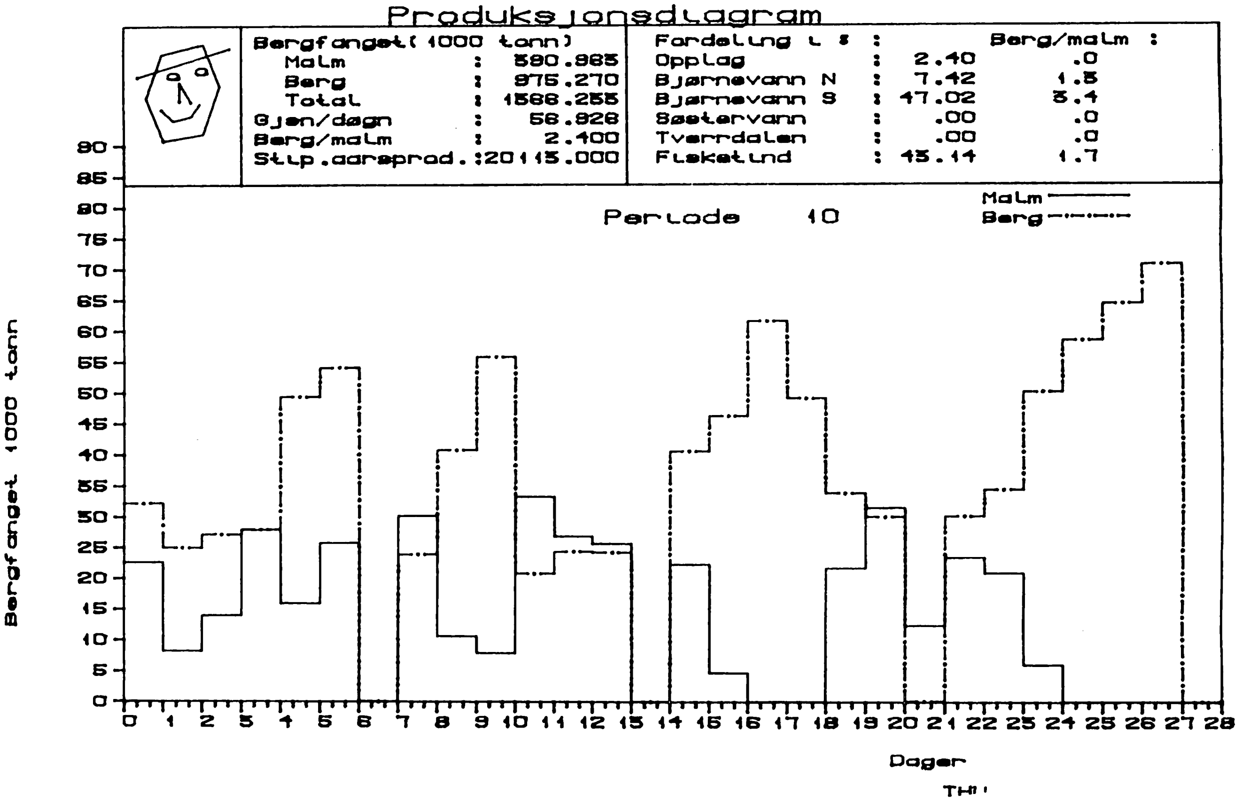
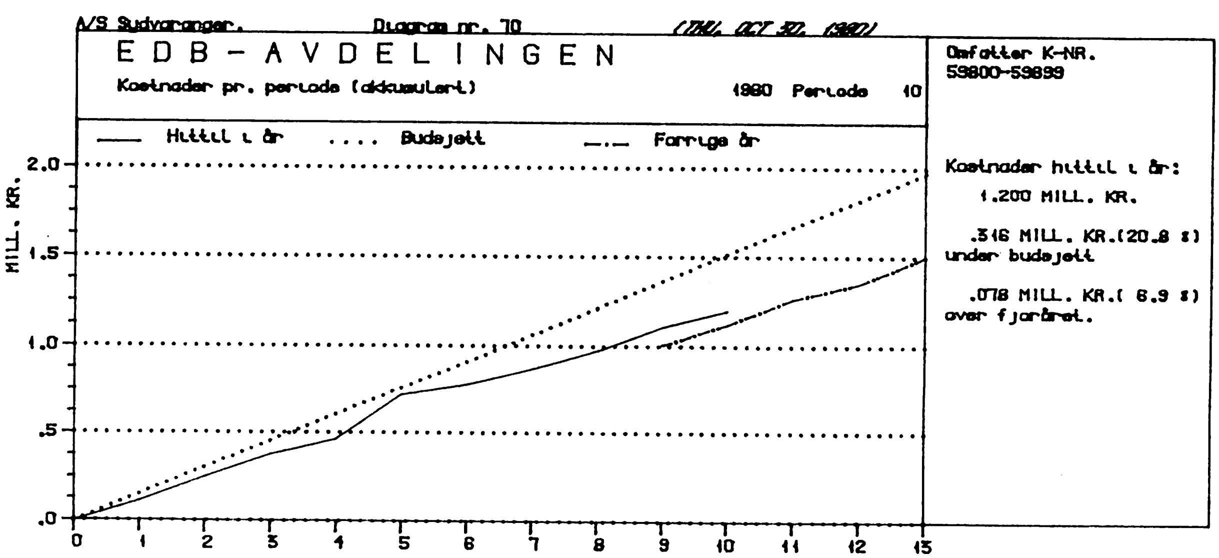
# A. S Sydvaranger.

## Driftsrapportering, Bjørnevatn

Produksjonsdiagram



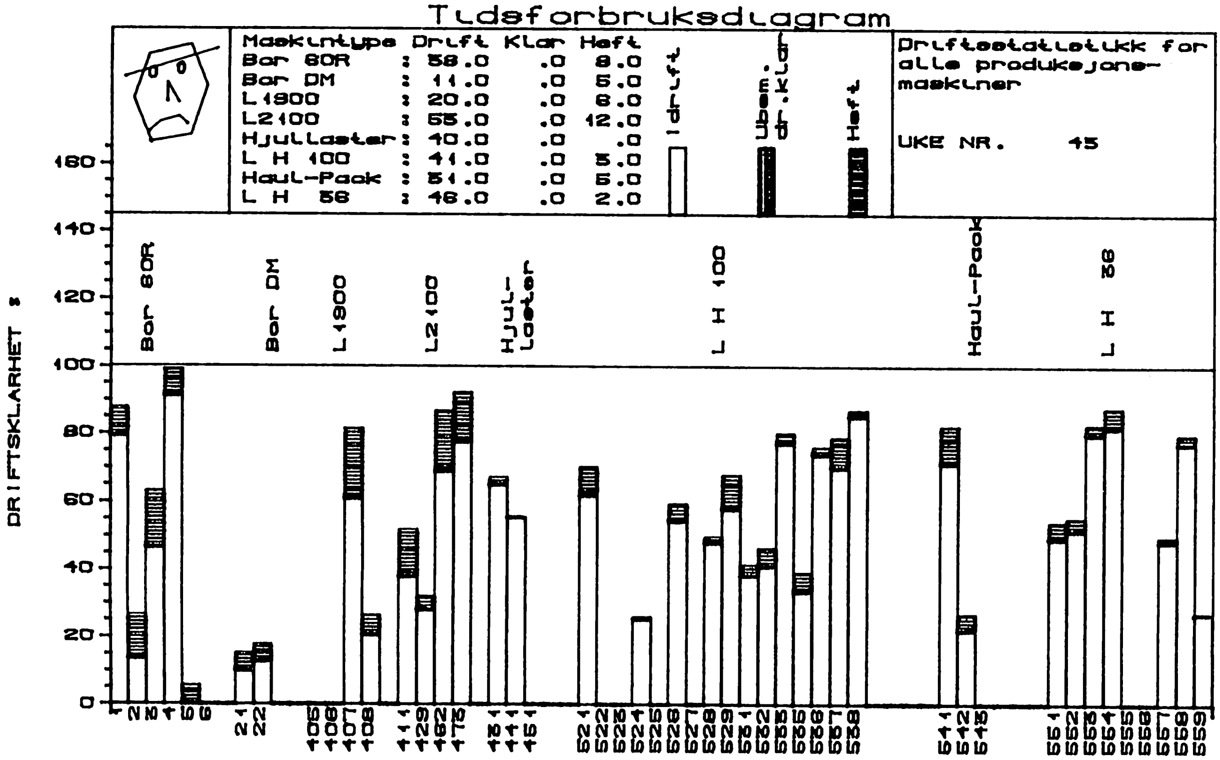

J5 15



# A/S Sydvaranger.

## Driftsrapportering, Bjørnevatn

### Tidsforbruksdiagram

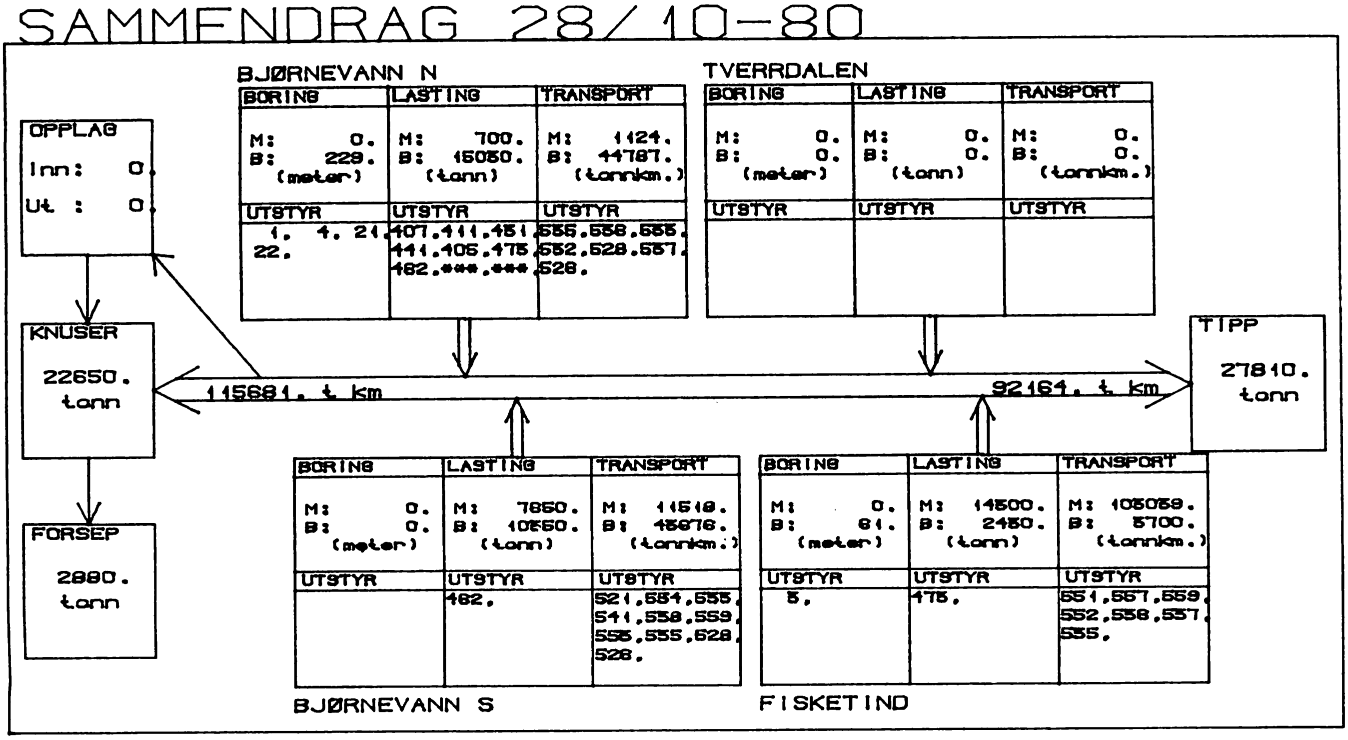



THU, OCT 30, 1980



# GRUBEN

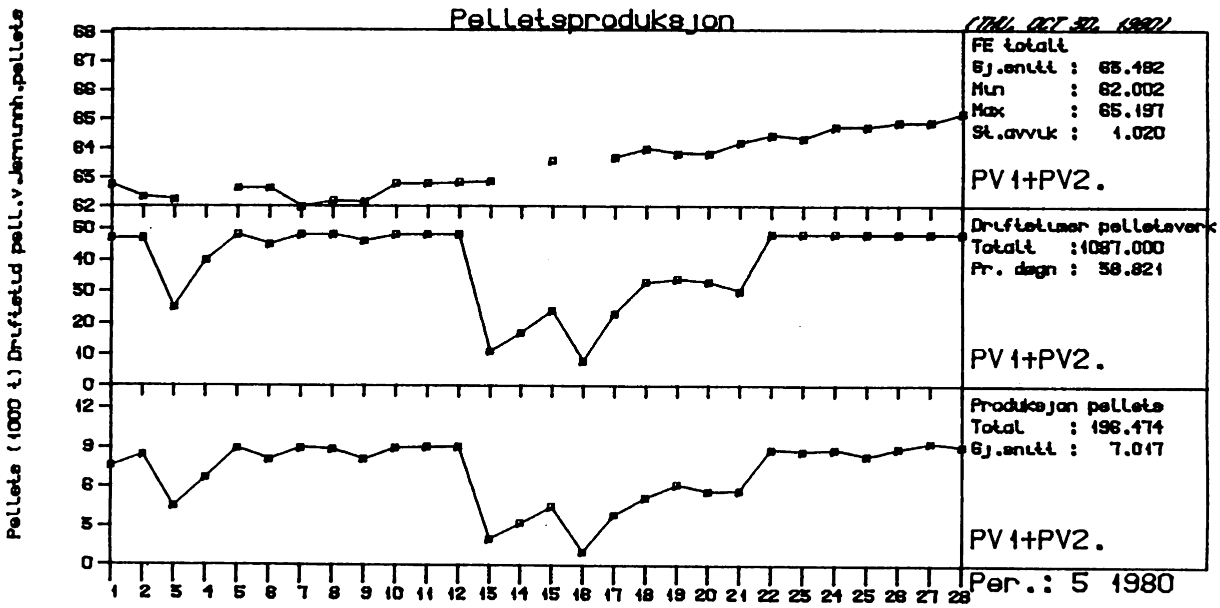
## SAMMENDRAG 28/10-80



J5 20

# A/S Sydvaranger.

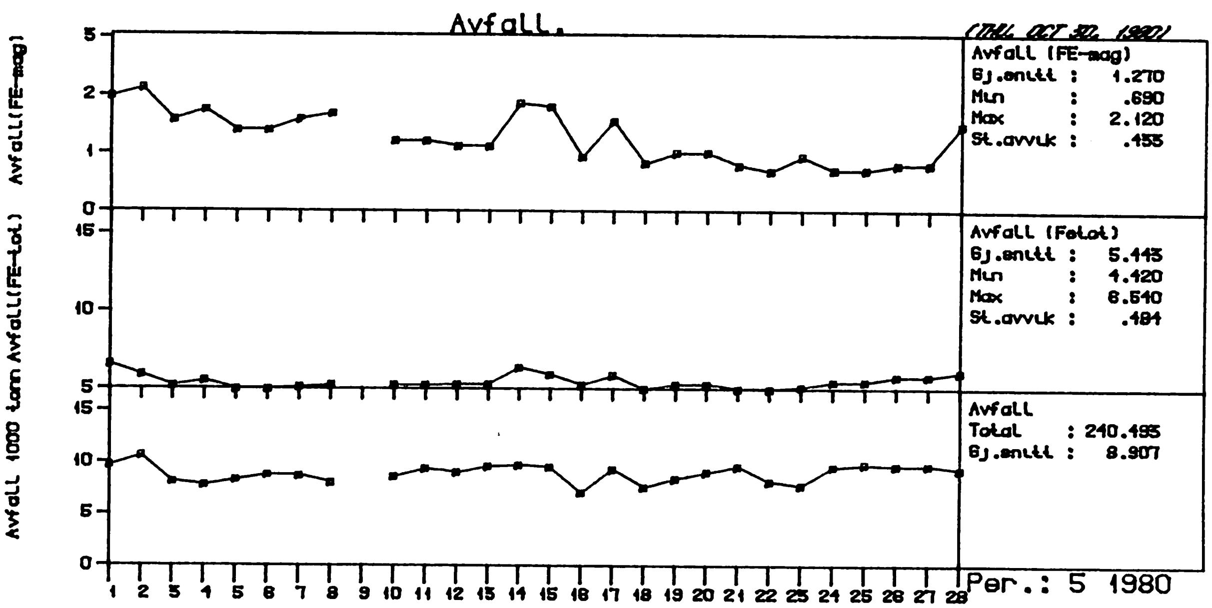
## Driftsrapportering,Kirkenes



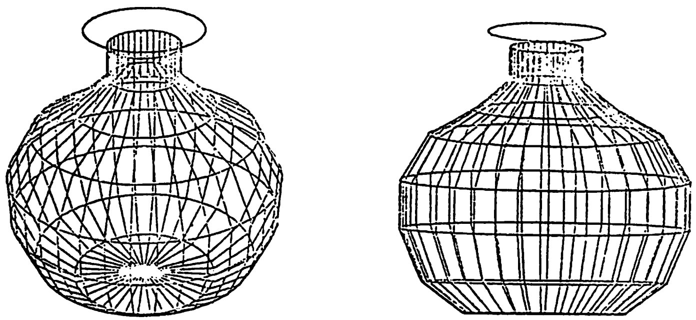

J5 19

# A/S Sydvaranger.

## Driftsrapportering,Kirkenes



## 2 GPGS-F, A PORTABLE DEVICEINDEPENDENT GRAPHIC SYSTEM



### 2.1 Background

During the early seventies, computer graphics was introduced in the research and commision work of The Ship Research Institute of Norway (NSFI). In this process lack of suitable standardized basic software was very badly felt.
About the same time similiar problems arose in other research institutions and in the industry.
A national special interrest group in computer graphics grew up from the loose attempts of cooperation between the involved parts.
NORSIGD (The Norwegian Special Group in Computer Graphics) was founded in 1975 and has since then formed the basis of a very good cooperation between most Norwegian computer graphics users.
The main task for NORSIGD has been developing a standard graphics software system for Norway.



### 2.2 History

The GPGS system was originally designed by Rekencentrum, Delft University of Technology, The Netherlands and Science Faculty, Catholic University Nijmegen, The Netherlands in 1972. A version of the system written in standard Fortran has been developed by NORSIGD. The first Fortran based version was released in 1975 and named GPGS-F. GPGS-F has been under continous development since the first version was released. This work has been guided by annual user meetings. The result of these meetings has been new features and minor changes to the system.

### 2.3 Device control

GPGS-F provides device independent programming with choice of graphic device at run-time.

Figure 1 shows how the device independancy is obtained. The device independant part produces the same picture code for all devices, and the device driver(s) translates this code to the bit pattern required for the actual device. The device independant code is put on such a level that advanced graphic devices may be used in an efficient way. Examples of such functions are character, circle and marker generation. GPGS-F will also be able to take advantage for the functions of more advanced refresh display such as hardware scaling, rotation and depth quing.

Table 1 shows the current implementation status for GPGS-f.

The status for GPGS-F implementations pr August 1,1981 is shown below:

(X=implemented, O=under implementation)

| | UNIVAC 1100 | HP-3000 | VAX 11 | CDC CYBER | DEC 10 | IBM 370 | NORD 10 | PDP 11 | PRIME | LSI 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| GPGS-F | X | X | X | X | X | X | X | X | X | X |
| FILSYS | X | X | | X | | X | X | X | | |
| GRAPHISTO | X | X | X | X | X | X | X | X | | |
| SURRENDER | X | X | X | X | X | X | X | | | |
| CALCOMP | X | X | X | X | X | X | X | X | | |
| KINGMATIC | X | | | X | | | X | X | | |
| PRINTER | X | X | X | X | X | X | X | | | |
| HP 7221 | X | X | X | | | X | X | | | X |
| TEK 4662 | X | X | | | X | X | X | | | X |
| TEK 4663 | X | X | | | | | X | | | |
| VERSATEC | X | | | | | | X | | | |
| TEK 4010 | X | X | X | X | X | X | X | X | X | |
| TEK 4014 | X | X | X | | X | X | X | X | X | |
| HP 2648 | X | X | X | | | | X | | | |
| TEK 4025 | X | | | | | | X | | | |
| TEK 4027 | X | | | | | | X | | | |
| RAM 6002 | X | | | | | | | | | |
| ALPH VDUS | X | | | X | X | | | | | |
| PSEUDO | X | X | | X | X | X | X | | | |
| FILE | X | X | | X | | X | X | | | |
| ICAN | | | | | | | | | | X |

Unaproved (preliminary) implementations: Honeywell Bull
MYCRON } micros
CROMEMCO



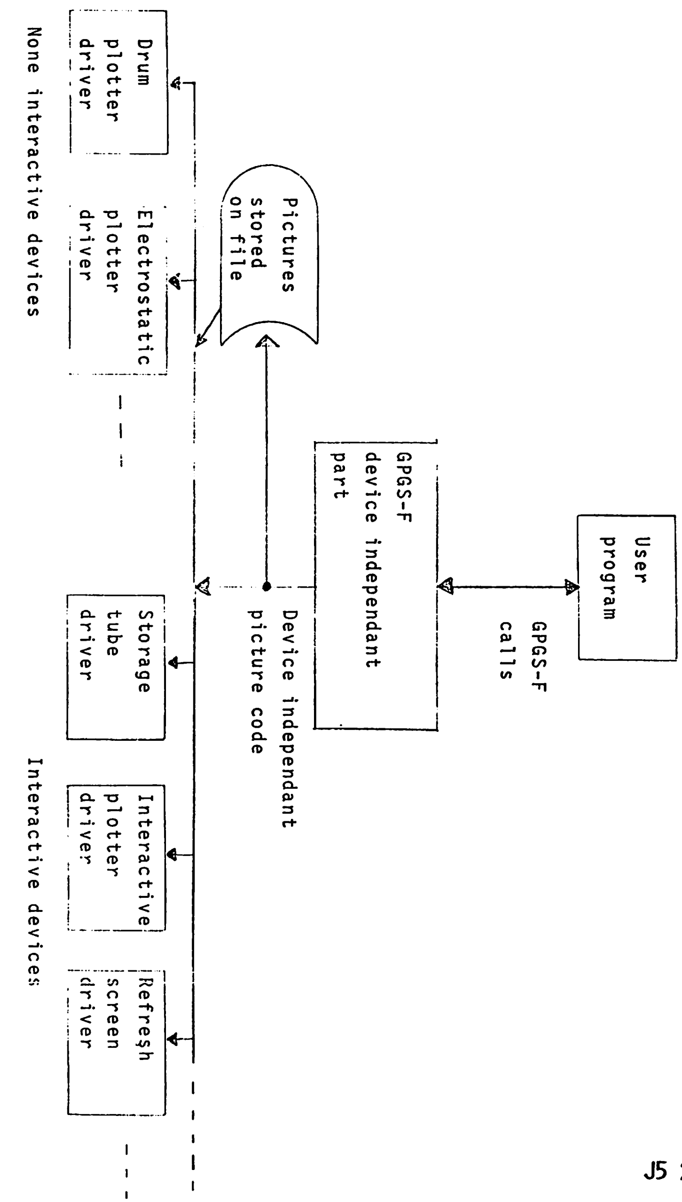



Fig. 1. MAIN STRUCTURE OF GPGS-F.

## 2.4 Graphic elements

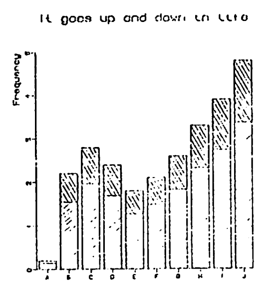
By single calls to the basic routines of GPGS-F, the following graphic elements may be generated:

- straight lines
- set of straight lines
- circles/circle areas
- text
- markers
- functions

All graphic elements may be hardware generated by the graphic device.

The elements are defined in a user defined coordinate system (2-or 3-D Kartesian) and are fully transformable.

## 2.5 GRAPHISTO - Graph and Histogram plotting




GRAPHISTO(6)is a subroutine package which using the basic routines of GPGS-F can produce curve-, bar- and piecharts.
The package was designed to remove programming effort from the tasks of producing standard plots. GRAPHISTO is aimed at easy presentation of one variable data.
An advantage when using this package is that it can be entered at different levels. When the user wants to produce one of the standard charts of the system this can be done by one simple call. If this standard chart does not satisfy the requirements for the plot, user can enter the system on a lower level, composing the plot he wants. The user can even go down to the basic routines of GPGS-F and mix these with the GRAPHISTO calls.



GRAPHISTO provides 4 so-called 'chart' routines that will in answer to a single call draw a complete diagram with annotated axis, texts on axis and datapoints.

The types of plots provided through these 4 routines are:

- Histogram with labels under each bar and linear or logaritmic axis in x and y.
- Table of lines with straight lines between plots.
- Smooth curve through specified points.
- Pie chart.

These 4 routines use the basic GRAPHISTO routines as axis drawing, range computation, 'nice' value computation and curve plotting. The lower level routines are also available to the user and offers possibilities for sophisticated non-standard plots like multiple axis, marking special data points etc. Appended to this chapter are some plots to demonstrate the use and possibilities of GRAPHISTO.

Figure 7 Shows some plots produced with GRAPHISTO.

<u>Available facilities are:</u>

Chart plotting:

- Simple and smooth (cubic spline) curves in different linestyles.
- Histograms. They may be plotted with or without hatching of bars in any angle.
- Pie charts with texts and percentage of total pie.

Axis drawing

- Near to plot on either side of plot.
- Through any data or page value.
- Several parallell with different units.

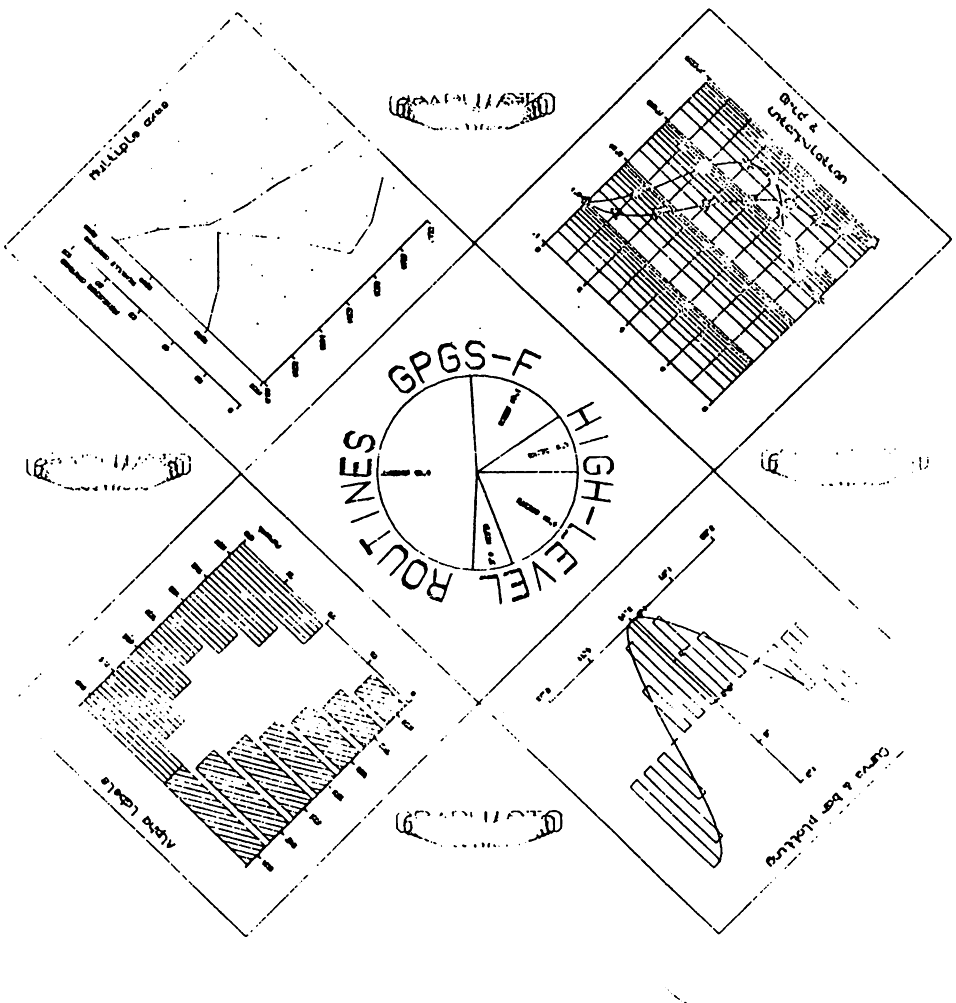



Figure 7. GRAPHISTO example plots.



Axis annotation:

- On either side of axis
- Numeric or text labels
- Any character size and angle
- Upper and lower case
- Extra tick marks
- Title

Grid:

- Along x- or y-axis
- Linear or logaritimic
- Any line type or '+' at grid crossings

Dataplotting:

- Table of values in x- and y or functions
- Simple connected points
- Interpolated curve through points
- Markers at points
- 'Undefined' points
- Automatic data indexing
- Automatic data incrementing

Page layout:

- Centered heading
- Positioning of dataplotting area in users window
- Bar and curve legends
- Frame

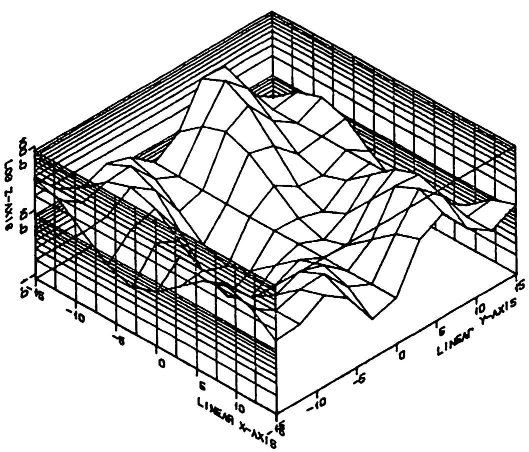
Miscellaneous:

- 'Best-fit' range computation of data contained in array or function.
- 'Best-fit' label format computation.
- Conversation between coordinates in users window and in plotting coordinates.

Error Reporting:

The routines in the GRAPHISTO system uses the error system of GPGS-F. This includes parameter checking and print of routine number, where error occured. Also the number of calls made to GRAPHISTO routines and wrong parameters are printed. This makes it easier for the user to find place and reason of error.

## 10. SURRENDER, 3-D SURFACE PLOTTING




SURRENDER (5) is a subroutine package for drawing bivariate surfaces in 3 dimensions. GPGS-F basic routines are used for line drawing and GRAPHISTO routines for axis drawing and curve smoothing.



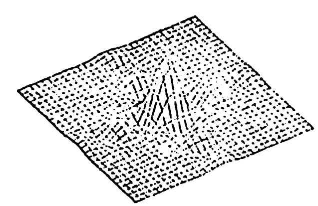
Base for all SURRENDER plotting is a rectangular x-y grid (matrix) with z-values in each node. A surface with M grid points in x-direction and N grid in y-direction will be stored in a Fortran DIMENSION ARRAY (N,M).

This grid may be rendered as a 3-D perspective plot of the grid (Isolines any combinations of x,y and z) with hidden lines removed or as a 2-D contour map (Isolines for any of x,y or z). Also other usefull facilities like drawing axes, marking points etc. are available and will be further explained later.

The package is built up much the same way as GRAPHISTO with some routines that makes a complete plot in one call, and others to add features for a more sophisticated plot.

Example of minimum effort plot:

```
      DIMENSION IWORK(200),VP(4),ZMAT(31,31),IOPT(3)
      DATA IDEV/8/,VP/0.0,0.3,0.0,0.3/
      DATA IBLUE/20/,IRED/60/
C
C  COMPUTE THE FUNCTION 'SIN(X)*SIN(Y)/(X*Y)'
C
      DO 1000 IY=-15,15
         Y=FLOAT(IY)
         SINYY=1.0
      IF (IY.NE.0) SINYY=SIN(Y)/Y
      DO 1000 IX=-15,15
         X=FLOAT(IX)
         SINXX=1.0
      IF (IX.NE.0) SINXX=SIN(X)/X
         ZMAT(IX+16,IY+16)=10.0*SINXX*SINYY
 1000 CONTINUE
C
C  MAKE MINIMUM EFFORT PLOT
C
         CALL NITDEV(IDEV)
         CALL BGNPIC(1)
         CALL PLOMA3(ZMAT,31,31,-15.,15.,-15.,15.,IWORK,200)
         CALL ENDPIC
```



Hidden line removal:

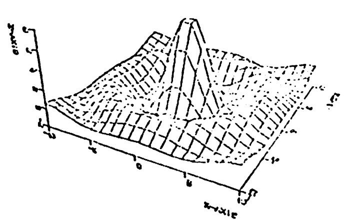
By default the hidden lines will be removed. To do this the system uses a working array to be supplied by user. As the needed size of this array is dependant upon the number of points to plot, this method gives no restrictions about number of points.

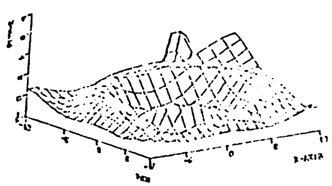
Setting focal point and eye position:

The surface may be seen from any point in space and some routines are used to set this point either using cartesian or spherical coordinate system. The viewing may be either axonometric or perspective.

Adding axes to the plot.

Axes may be added by a call to a single routine giving standard axis annotation or by several calls to GRAPHISTO Axes routines for special labels and format.

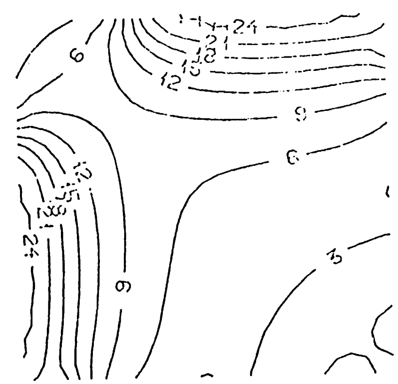






Contour plots.

Contour plots consists of isolines in the z-direction. The range and number of contour lines may be given, and they may be added to the perspective plot or plotted as a separate 2-dimensional plot.



Default contour plot.

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