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S.I.PREL.

A METHODOLOGY FOR MONITORING THE PRELIMINARY DESIGN TASKS

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COSTRUZIONI AERONAUTICHE G.AGUSTA S.P.A

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ABSTRACT

In order to carry out and coordinate different design activities, it is essential to have a design methodology available. It consists in focusing the activities and in understanding their right sequences and correlations, that is in identifying the design flow. The S.I.PREL. (Information System for Preliminary Design) has the aim of supporting the sizing stage (feasibility study), since it is strictly correlated to the sequential steps of design. The instrument has been planned to facilitate the designer in using application programs and in entering data into files and consists in a series of menus which show the possible selections in a user oriented language. This paper will describe characteristics, structure and benefits of the developed system, and will show an example in using it how it appears from the designer's viewpoint.

1. INTRODUCTION

As a general rule, a helicopter design, starting from requirements defined by engineering external departments (typically marketing and military organizations), develops in the feasibility study (sizing) from the Preliminary Project dept., continues with a detailed definition of the various systems from the technological departments and, finally, it is checked by flight tests (required for the product qualification).

Particular consideration shall be given to the preliminary design stage, since the contribution to the sizing stage is strictly correlated to the subsequent steps of design. In fact, finding, when the design is already in the detail phase of the different systems, that unsuitable choices have been made in the preliminary stage, can result in considerable changes and global revisions, extremely heavy, in addition to extending times for the product construction.

It appears, then, desirable to provide a methodology for carrying out and coordinating the various activities concerning the preliminary design.

On the other hand, in the last years, parallel to the methodologies of air design, there has been a continuous progress in using the computer. The designers have surely taken advantage of these capabilities and, then, a significant growth is followed, leading to the automation of many computing procedures and activities.

Historically, the computer has covered limited computing requirements only, supported by separate application programs. It is evident that such an approach can not fully solve the problems of a complex department where data exchange and check are essential and, then, the need for an integration between automated procedures and data centralization is arisen.

The entry of an information system represents, undoubtedly, an informatic support suitable for solving complex design problems.

2. DESIGN METHODOLOGY AND INFORMATION SYSTEM

According to the current design practise, the preliminary design is performed with a job flow involving the intermediation of technical, economic and logistic features opposing each other, in order to reach the best solution complying with the requirement.

Establishing a methodology consists in focusing the activities and in understanding their proper sequences and correlations, that is in identifying the design flow.

The methodology targets are as follows:

a) to provide designers with a standard GUIDANCE

This means that the experienced designer is facilitated in performing his activity, because it is correlated to the overall design system, whereas the designer under training has a clearer outlook on the environment where he is working and a standard method to conform to;

b) to MONITOR DESIGN FLOW

Knowing the sequenced activities allows the design development to be monitored at any moment;

c) to STANDARDIZE and VALIDATE design data;

Data are better standardized and validated at company level because of their integrity and uniqueness, confirmed by any information on where they are stored;

d) to set up the TECHNICAL STORAGE;

The sequenced storage of efforts and problems encountered during the execution of a design allows to improve design quality and to reduce risks and times.

The introduction of an information system allows a design methodology to be adopted, since it gives instruments for achieving each of the established goals.

The main instrument of the information system is the monitor, which AIDS the designer's work by providing hierarchical menus and an application oriented language, by suggesting acceptable alternatives and by pointing out possible errors or discrepancies that he may encounter.

Also, the monitor CHECKS the DESIGN FLOW so that it complies with the flow being identified.

Design parameters and data used from application programs reside on the design data-base and on other support data-bases, the access to which is assured by the expressly designed interfacing programs.

Information used for designing new helicopters is filed into historical-company data-bases and consists of the accepted parameters for the already designed helicopters, but also of alternatives and problems encountered during the previous designs.

The assembly of these files STANDARDIZES and VALIDATES data and sets up the TECHNICAL STORAGE.

3. DESIGN ACTIVITIES AND E.D.P. FUNCTIONS

During the development of the information system design, the requirement for correlating the E.D.P. viewpoint to the designer's viewpoint is arisen.

For the E.D.P., the information system is an assembly of programs, procedures, data-bases, option menus, etc., whereas the designer desires a system transparent to these features too technical and not very familiar to him.

For example, the implementation of an application program affects an assembly of E.D.P. functions, involving different activities such as research for necessary data in the various files, subsequent preparation of these data to be acquired in the program required format, its execution and storage of results in suitable files.

For the designer, these functions constitute an only design activity which, starting from an assembly of data, computes other design parameters.

A design activity can be then defined as the aggregation of E.D.P. functions which contribute to its realization.

The sequence for implementing the E.D.P. functions is strictly related to the availability of input data to functions, that is to the information flow.

The sequence for the design activities is also related to data availability, but it is also affected by organizational requirements, consolidated experience, know-how and design practice.

For these reasons, the design methodology has its own design flow, which evolves together with the design environment.

The S.I.PREL. (Sistema Informativo di progettazione PRELiminare) is provided with a monitor which manages the design flow model, suitable for the preliminary design and checks that the design activities conform to the flow itself.

The following paragraph describes the procedures for implementing the model in the system and how it is used for checking the activities.

4. MONITOR CHARACTERISTICS

In order to define a design environment model, it is necessary to use MODELLING TECHNIQUES which, on the one hand, allow to record the performed activities (Design Progress) and, on the other hand, be able to describe existing logic relationships and forcing priorities in carrying out these activities (Design Flow).

The instruments used for meeting these two requirements are the "vector of the performed activities" and the "matrix of the activity relationships".

Whereas the "matrix" is single for the information system, being determined by the methodology, there will be a "vector of the performed activities" for each outstanding design.

According to this modelling technique, each row of the matrix corresponds to an elementary activity, which shows, in a coded form, all the activities required for performing that under examination (for instance, if the activity A-i necessitates, for its implementation, the activities A-j and A-k, the terms $M(i,j)$ and $M(i,k)$ are positioned to "1", whereas all remaining terms of the i-th row are to "0").

Also, it has been possible to differentiate the matrix symbols so as to highlight that, although some activities do not strictly require others, their execution is however recommended to properly comply with the design methodology.

The vector of the performed activities has as many storage locations as are the activities to be performed; at the beginning of a new design, the vector is fully reset, whereas, then, the locations corresponding to those activities being performed are positioned to "1".

The selection of these instruments has allowed easy implementability in the monitor, good readability also in the presence of many activities highly interconnected, and quick adaptability of the system to changes in methodology.

The use of such a technique also allows to identify the main activities, the availability of which is priority for continuing the design, and those sequenced activities which are independent and, then, practicable also in parallel.

The information system, through the monitor, provides designers with a helpful support, comparing the required activity with the already performed activities, so as to allow, by means of the matrix implemented in the system, the execution of the activity itself, if in accordance with the identified design flow.

The information system also provides the Preliminary Project responsible with an effective instrument for checking a design progress.

In fact the monitor gives a functions by which through the readout of the performed activities vector for given design, it allows all the design activities to be displayed.

5. SYSTEM ORGANIZATION

The information system has been designed to facilitate designers in using the application programs and in entering data into files.

It consists of a series of MENUS, which describe the possible selections in a user oriented language; its structure is of tree TOP-DOWN type on different levels.

The implemented functions can be divided into two different types, according to whether they are user dedicated or system oriented.

The user dedicated functions include, in turn, application functions, auxiliary functions, and support and historical data bases access functions, whereas the system oriented functions include data management and system management functions.

The targets of the different S.I.PREL. function groups are detailed below.

5.1 APPLICATION FUNCTIONS

The application functions are that assembly of activities which constitute the real design core, intending the assembly of procedures for defining design parameters and all those calculation programs concerning them.

Different levels can be identified, corresponding to:

- Departments forming a part of Preliminary Project (weight, performance, architecture and cost), identified during the analysis;
- Different design stages, studied from each department;
- Single operations within each stage, concurring to identify or compute design parameters; in general, they can be divided no more, unless they consider further possible selections.

These functions gain access to information contained in the design data-base, through the initial identification of the helicopter code under examination.

5.2 AUXILIARY FUNCTIONS

The auxiliary functions are a set of functions available to the user which allow him to carry out all those auxiliary activities required for completion of the specific design stage.

In particular, they cover:

- Consultation of the involved operational requirements;
- Loading of keys relating to the design to be developed for initialization of its execution;
- Printing, at any moment, of one or more documents (files) containing design data and information collected and processed;
- Knowledge of the design progress status;
- History of the design evolution by printing all changes made to design data.

5.3 HISTORICAL AND SUPPORT DATA-BASES ACCESS FUNCTIONS

The support data-bases are files including design reference data, that is auxiliary information regarding installable equipment, available engines, currently used airfoil sections, most common types of mission and so on.

The historical data-bases, on the contrary, record concise information on helicopters already designed either inside or outside the company.

The data-bases access functions cover the data-base information management, its printing and the possibility of conducting statistical analysis to obtain estimations and regressions for the design parameters.

5.4 DATA MANAGEMENT FUNCTIONS

The data management functions include the standard recovery procedures executed for historical, support and design files. These procedures are carried out by the operational personnel following a determined scheduling; therefore, they can also be performed at system manager's request, working in the Preliminary Project department, in accordance with the amount of user work and as needed.

It is to be pointed out that making a change to helicopter design parameters while using the application functions, the superseded data are automatically recorded on a suitable file. This is necessary to retain the design data evolution and to correlate the results from simulations to inputs referring to these.

Another management function has been then provided to allow superseded data to be transferred from the in-line file to an off-line unit.

Finally, the S.I.PREL. gives the possibility of off-line filing all data of an already finished design, as well as of restoring in-line these data, should a change to an aircraft, previously developed with the S.I.PREL., become necessary.

5.5 SYSTEM MANAGEMENT FUNCTIONS

The system management functions cover the possibility of changing the system control facilities, so as to allow its compliance with the requirements which may arise in the future. In fact, the design methodology is not static but can evolve because of entry of new computing instruments and/or simplification of some procedures: in this case, the system must be so flexible as to conform to the methodology evolution. The system compliance with the new requirements, namely its personalization by changing the activities and/or priorities and the flow chart, can be carried out by means of the "relationship matrix" applying functions for exclusive use from the software's manager.

6. GENERAL CONSIDERATIONS

The information system has been designed with the following characteristics:

- FLEXIBILITY: for conforming to design flow evolution;
- EXPANSIBILITY and MODULARITY: to allow a gradual and continuous implementation of functions having to be incorporated;
- UNIQUENESS and COMPATIBILITY: as regards the information;
- INTEGRATION: with other resources (data-bases already existing and available s/w and h/w);
- SIMPLICITY: as regards the user oriented language.

The system is available on work-stations already existing within the design environment and networked to company main frames.

7. PROCEDURES FOR USING THE SYSTEM

As regards the use of the system from the user's viewpoint, much attention is paid to his approach, aided and controlled by the monitor, in performing that sequence of operations which more occur during the design activity.

A standard formula has been studied to carry out calculation programs characterized by three elementary operations (that is ultimate, not further subdivisible), managed by the system user and controlled by the monitor.

These operations constitute the interfacing software between the monitor and the programs and are the following:

- Entry of input data which are not appropriate to design, but to the calculation program being used (e.g.: altitude or temperature range for computing performance, mission code, engine rating, etc.);
- Execution of the calculation program preceded by the automatic input creation, searching for necessary data on the different data-bases;
- Output consultation with subsequent possible unloading on data-base;

In addition to these operations, other three can be required:

- Graphic-interactive display of simulation program results;
- Execution of the calculation program in an off-line manner. By this definition it is meant the program is executed by using, as input data, those of a specific design, and by changing a limited number of parameters without altering the data-base contents;
- Non-generalized calculation.
The generalized output of some programs is kept on data-base, and this is the starting point should the user desire it in a particular form. In this way, saving both in terms of time and of disk storage allocation result in.

These last two operations require no output unloading on data-base.

8. BENEFITS

This system provides users and design department with several benefits:

- Availability of a consolidated methodology;
- Reliable data for engineering;
- Decreased times in the input stage;
- Easy entry of input data, since the user is supported with a series of maps;
- Considerable decrease in making errors in the same stage, also due to the monitor checks;

- Output storage with possibility of consultation at any moment;
- Possibility of changing the algorithms of the various programs, following, for example, the development of new theories;
- Possibility of entering new programs into the system without altering the structure already existing;
- Easy acquisition of the methodology for the designer under training;
- Verification in real time of a choice impact on the aircraft under design;
- Increased concentration to specific design requirements;
- Increase in the number of designs and/or parallel versions.

In conclusion, the S.I.PREL. information system is a significant support to designers within the Preliminary Project department and provides Technological and other Engineering departments with more standardized and consolidated documents.

9. SAMPLE DIALOG MAPS AND GRAPHIC FACILITIES

```

----- ISPF/PDF PRIMARY OPTION MENU -----
OPTION ==> 8
                                USERID...- CGT
                                PROCEDURE.- PPR
                                TERMTYPE..- 3278
                                TIME.....- 16:02
                                DATE.....- 85/07/09

0 ISPF PARMS - Specify terminal and user parameters
1 BROWSE     - Display source data or output listings
2 EDIT       - Create or change source data
3 UTILITIES  - Perform utility functions
4 FOREGROUND - Invoke language processors in foreground
5 BATCH      - Submit job for language processing
6 COMMAND    - Enter TSO command or CLIST
7 DIALOG TEST - Perform dialog testing
8 SIPREL     - Sistema informativo PROGETTO PRELIMINARE
C CHANGES   - Display summary of changes for this release
L LIBRARIAN  - Add, Get, Save, Delete, List, Index LIBRARIAN modules
7 TUTORIAL   - Display information about ISPF/PDF
X EXIT       - Terminate ISPF using los and list defaults

Enter END command to terminate ISPF.

```

```

--- SIST. INF. PROG. PRELIM. ---

CODICE ==> 1

1 - FUNZIONI APPLICATIVE
2 - FUNZIONI DI SERVIZIO
3 - HELP/TUTORIAL
4 - DATA BASE STORICI

PER TERMINARE BATTI END KEY

```

```

--- SIST. INF. PROG. PRELIM. ---
      FUNZIONI APPLICATIVE

CODICE ==> 2

1 - PESI
2 - PERFORMANCE
3 - ARCHITETTURE
4 - COSTI

PASSWORD ==>

PER TERMINARE BATTI END KEY

```

```

----- SISTEMA INFORMATIVO PROGETTO PRELIMINARE -----
      FUNZIONE PERFORMANCE
CODICE ==> 3

1 -DEFINIZIONE SIZE ROTORI E PARAMETRI AERODINAMICI
2 -CALCOLO VELOCITA' DI STALLO
3 -CALCOLO DIAGRAMMI POTENZA/VELOCITA'
4 -DEFINIZIONE DEL MOTORE
5 -CALCOLO DEI CONSUMI
6 -CALCOLO PRESTAZIONI IN HOVERING E TRASLATO
7 -VERIFICA REQUISITI MANOVRABILITA' (PGM-AUTOR)
8 -VERIFICA REQUISITI MANOVRABILITA' (PGM FLYAWAY)
9 -VERIFICA FINALE POTENZE E PRESTAZIONI

PER TERMINARE BATTI END KEY

```

SISTEMA INFORMATIVO PROGETTO PRELIMINARE
FUNZIONE PERFORMANCE

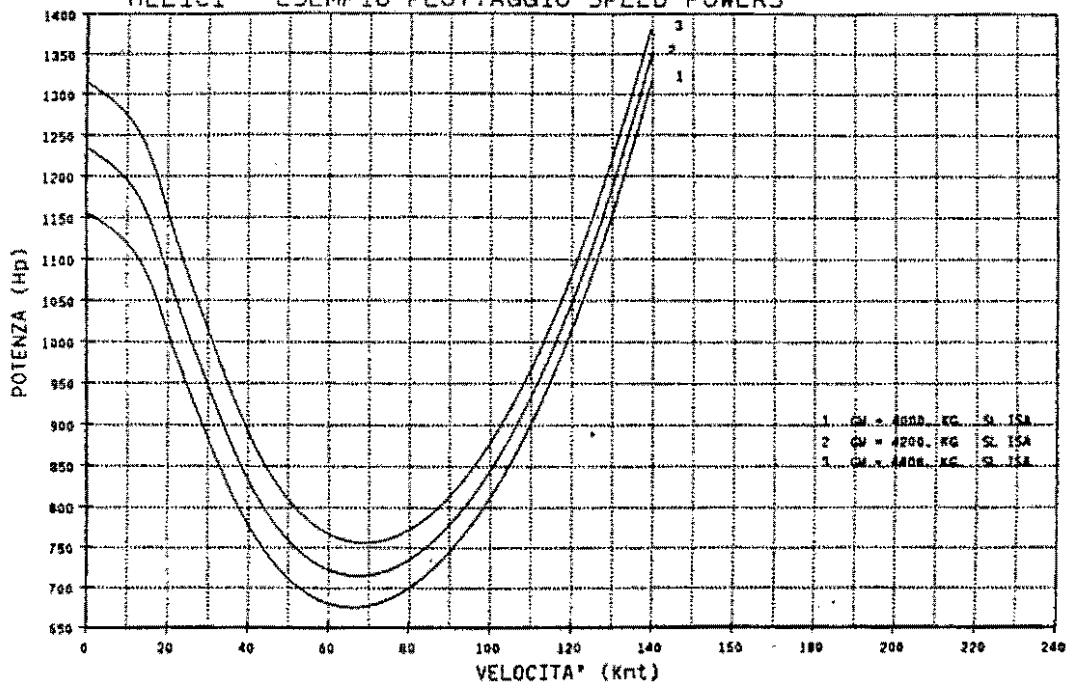
CALCOLO DIAGRAMMI POTENZA/VELOCITA'

CODICE ==> 5

- 1 -PREPARAZIONE DATI DI INPUT PGM PERCA
- 2 -CALCOLO DIAGRAMMI POTENZA/VELOCITA' (S.L. ISA)
- 3 -CARICAMENTO OUTPUT PERCA SU DATA BASE
- 4 -ELABORAZIONE FUORI SISTEMA PGM PERCA
- 5 -CALCOLO POTENZE NECESSARIE

PER TERMINARE BATTI END KEY

HELIC1 - ESEMPIO PLOTTAGGIO SPEED POWERS



AGGIORNAMENTO POTENZE

FUNZ. MOTORI

CODICE MOTORE = MODEL XXXX

RATING DI POTENZA : 30' / 1H

TEMP. I (G.C.)	POTENZE (KW)					
	(0 M)	(1000 M)	(2000 M)	(3000 M)	(4000 M)	(5000 M)
-50	0.0	0.0	0.0	0.0	0.0	0.0
-35	800.0	712.0	630.0	555.0	488.0	428.0
-20	760.0	670.0	600.0	524.0	465.0	405.0
-5	696.0	620.0	550.0	485.0	430.0	380.0
10	665.0	590.0	525.0	465.0	410.0	360.0
25	642.0	570.0	500.0	436.0	382.0	0.0
40	550.0	483.0	425.0	0.0	0.0	0.0
55	456.0	400.0	0.0	0.0	0.0	0.0

PER CONTINUARE BATTI ENTER
PER TERMINARE BATTI PF2

----- SISTEMA INFORMATIVO PROGETTO PRELIMINARE -----
 DISPLAY MESSAGGI DI ERRORE

SEVER ERROR : (ATTIVITA' NON SVOLTE PUR ESSENDO PREREQUISITE)

```

=> DEFINIZIONE SIZE ROTORE E PARAMETRI AERODINAMICI      DOC. 40
=> CALCOLO DELLE VELOCITA' DI STALLO                     DOC. 81
=> CALCOLO DIAGRAMMI POTENZE VELOCITA' (A SL ISA)        DOC. 80
=> DEFINIZIONE DEL MOTORE                                 DOC.180
  
```

WARNING ERROR: (ATTIVITA' NON SVOLTE SE PUR CONSIGLIABILI)

```

=>
=>
=>
=>
=>
  
```

SELECT OPTION ==> NO

IN CASO DI SOLI WARNING BATTERE SI PER CONTINUARE NELL'ATTIVITA'
 NO PER TERMINARE L'ATTIVITA'

S.I.PREL.

FUNZIONE PERFORMANCE

PLOTTAGGIO V.R.O.C. (M/S)

HELIC1 PRESENTAZIONE FORUM LONDRA 1985

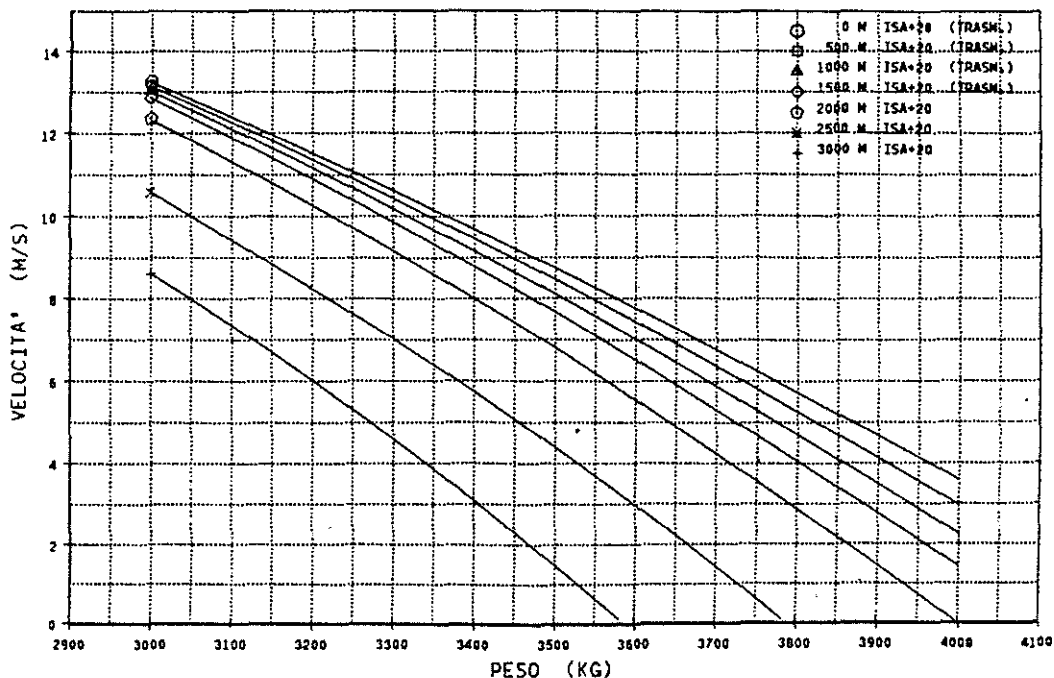
2 MOTORI MODEL XXXX RATING: 30' / 1H RPM: 100 % PERD.: 7.5 % T: ISA+ 20.

QUOTA (M)	3000.	3200.	3400.	3600.	3800.	4000.	LIM ITE
0	13.25	11.50	9.68	7.78	5.76	3.58	1
500	13.16	11.33	9.44	7.45	5.33	2.94	1
1000	13.03	11.13	9.15	7.02	4.74	2.23	1
1500	12.87	10.89	8.77	6.54	4.12	1.42	1
2000	12.36	10.22	7.98	5.59	2.96	-0.04	2
2500	10.58	8.25	5.74	2.97	-0.20	0.00	2
3000	8.61	6.00	3.10	-0.24	0.00	0.00	2

LIMITE : 1 ==> TRASMISSIONE 2 ==> MOTORE

PER PLOTTARE BATTERE PF4 PER CONTINUARE BATTERE PFB PER TERMINARE BATTERE PFB

HELIC1 - V.R.O.C.



----- SISTEMA INFORMATIVO PROGETTO PRELIMINARE -----
FUNZIONI DI SERVIZIO

CODICE ==>

- 1 -- CONSULTAZIONE REQUISITI
- 2 -- CARICAMENTO CHIAVI
- 3 -- AGGIORNAMENTO COMESSE
- 4 -- STAMPA DOCUMENTI
- 5 -- SITUAZIONE DEL PROGETTO
- 6 -- STAMPA DATI DI PROGETTO SUPERATI
- 7 -- STAMPA CHIAVI PROGETTO-VERSIONE

PER TERMINARE BATTI END KEY

----- SISTEMA INFORMATIVO PROGETTO PRELIMINARE -----
*** CALCOLO PESI,CG,INERZIE ***

SELECT OPTION ==>

A) ELICOTTERO BASICO

B) ELICOTTERO VERSIONE

- 1 = BAIA
- 2 = DITTA
- 3 = MODIFICA
- 4 = ISSUE
- 5 = MODULO
- 6 = AREA TECNICA
- 7 = MODULI PER P/N

- 8 = BAIA
- 9 = DITTA
- 10 = MODIFICA
- 11 = ISSUE
- 12 = MODULO
- 13 = AREA TECNICA

CLASSE DI OUTPUT ==> T
DESTINAZIONE " ==> R4

PRESS END KEY TO TERMINATE

----- SISTEMA INFORMATIVO PROGETTO PRELIMINARE -----
GESTIONE DESCRIZIONE ATTIVITA'

CODICE SELEZIONE : 26

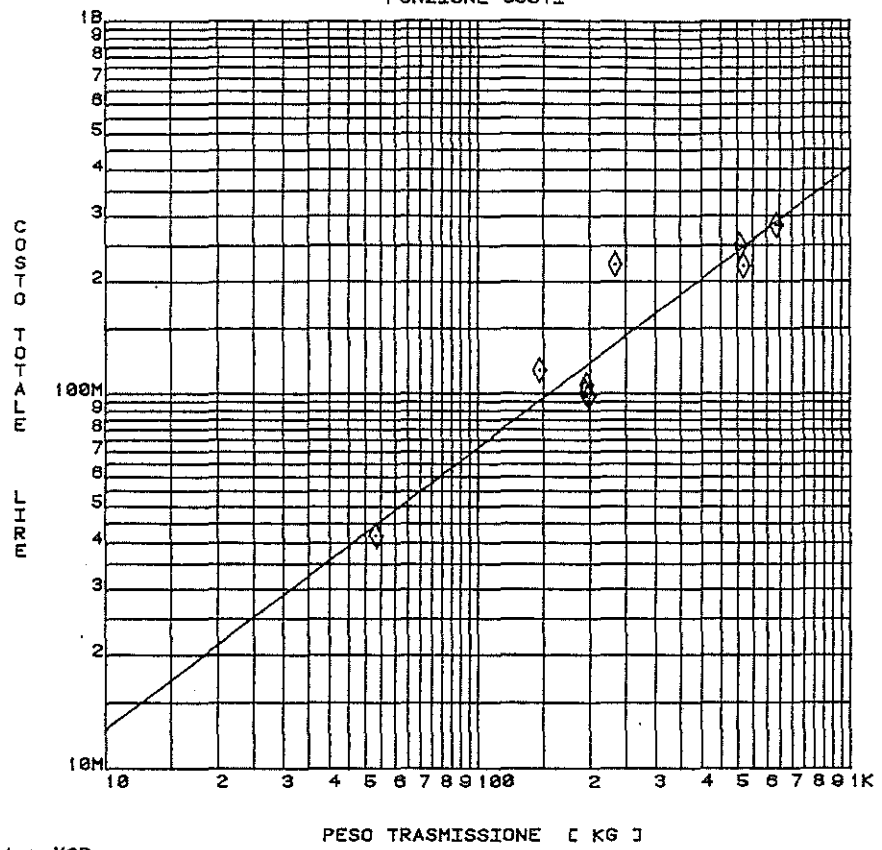
MESSAGGIO ==> CALCOLO PRESTAZIONI IN HOVERING E TRASLATO DOC.120
0-----x-----1-----x-----2-----x-----3-----x-----4-----x-----5-----x-----6

----- SISTEMA INFORMATIVO PROGETTO PRELIMINARE -----
GESTIONE MATRICE CONTROLLO SEQUENZE ATTIVITA'

CODICE SELEZIONE : 2.6.2

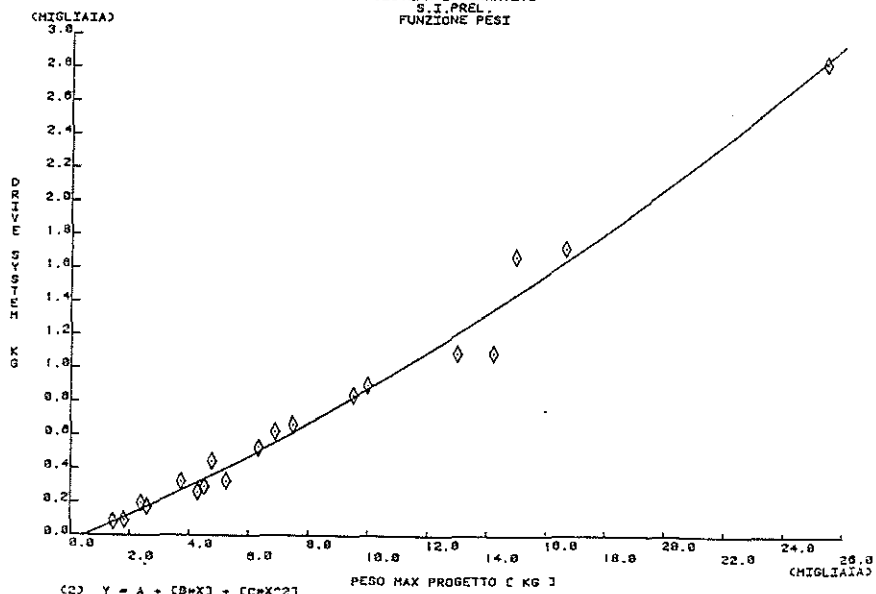
RIGA MATRICE ==> 0000000000000101010100010000000000000000000000000000
0-----x-----1-----x-----2-----x-----3-----x-----4-----x-----5

SISTEMA INFORMATIVO
S.I.PREL.
FUNZIONE COSTI



(7) $Y = A * X^B$
 A = 2248123.020320
 B = 0.752418
 FORUM LONDRA 1985 % LEARNING = 188.48

SISTEMA INFORMATIVO
S.I.PREL.
FUNZIONE PESI



(2) $Y = A + [B * X] + [C * X^2]$
 A = 32.541433
 B = 0.070108
 C = 0.000001
 FORUM LONDRA 1985

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