NINETEENTH EUROPEAN ROTORCRAFT FORUM

Paper n. I1

"HELOISE": THE AGUSTA PROJECT TO CONCURRENT ENGINEERING

by

P. CAMERINO

AGUSTA, ITALY

September 14-16, 1993
CERNOBBIO (Como)
ITALY

ASSOCIAZIONE INDUSTRIE AEROSPAZIALI
ASSOCIAZIONE ITALIANA DI AERONAUTICA ED ASTRONAUTICA

1. INTRODUCTION

In the last two-three years a considerable effort has been dedicated to reach cost-effective products in order to afford a difficult market environment.

Customer satisfaction is of paramount importance but even the costs afforded by the producer are of an equivalent importance.

The only way to reach an equilibrium between these two opposite trends (more and more stringent Customer requirements, Producer costs to be cut-down) seems to radically change the processes to develop, to manufacture and to support complex systems.

The old sequential way is no more suitable to answer to the sophisticated customer requirements in terms of Safety, Reliability and Life Cycle Cost and, on the other hand, even to give products with a time-to-market proportional to the market expectations at a profitable cost for the Producer.

The new approach to design-development of complex systems known as "Concurrent Engineering" (CE) seems to be the right way to be followed.

In every kind of meetings at all levels of importance in our technical environment, when some difficulties are evident "on the road", the "panacea" is always the same: " Let's apply a Concurrent Engineering approach, and all the problems will disappear!".

Unfortunately CE is not available "Off-The-Shelf" and the TIME runs and runs and the COST increases more and more.

In this paper some concepts of CE, as intended in AGUSTA, are described and the first steps towards the CE direction we are implementing are illustrated.

The difficulties and the "big mountains" to climb are said sincerely in order to give to the reader the opportunity to compare his/her reality with ours.

2. THE CE ENVIRONMENT: HOW AGUSTA HAS CHOSEN ITS APPROACH

The CE environment is a very complex and "fearful" environment. In this environment it is possible to meet several terrific "spectra":

- the ORGANISATION
- the TOOL
- the METHOD

These three "spectra" run around in a "spectral" scenario where:

- Customers require products more and more reliable at a lower cost

- Competition imposes time-to-market reduced by an order of amplitude

- Life Cycle Cost (LCC) is frozen at its 90% already during the conceptual phase when we are still thinking about the "6W" i.e. : "what?", "when?", "where?", "who?", "which way?", and for all "why?".

In this environment just one "stone" is clearly market with this words:

" WE MUST IMPROVE OUR DESIGN AND DEVELOPMENT PROCESS "

On the same "stone" we found written the 6 laws of Concurrent Engineering, which show only a difference with the 10 laws of MOSES i.e. luckily they are only 60% in number!!!

The 6 laws of CE are:

1. CE is a SYSTEMATIC APPROACH to design and it considers "ALL" the elements of the life cycle

2. CE is an INTEGRATED APPROACH to design which takes into account "ALL" the downstream characteristics during the upstream phases in order to produce a MORE ROBUST design tolerant of the manufacturing and use variations, at a lower cost than the sequential design

3. CE shall be applied from the conceptual phase up to the end of development

4. CE shall define contemporary the Product, the Manufacturing Process and the Logistic Support

5. CE is not the arbitrary elimination of a phase of the traditional sequential/feed-back design process but the co-design of all the downstream processes by an omni-comprehensive and cost-effective optimisation

6. CE is not "Simultaneous Engineering" i.e. contemporary design of the product and its manufacturing, which is a "low quality" and "multi-looped" and expensive approach.

With these three "huge" laws well present in our mind we have tried to better analyse the three "spectra" (Organisation, Tool and Method).

On their "white sheets" we have read the following words:

- ORGANISATION

  CE imposes the formation of multi-disciplinary design teams, organised in a structured way and with a TQM (Total Quality Management) orientation. The Engineering, Manufacturing and Support functions of the Customer, the Producer and the Suppliers are to be present in these structured teams.

- TOOL

  CE imposes the adoption of computerised design tools which integrate different SW and data. CE imposes to create basic product data once and suitable to be shared and used as sources of aggregation for different functions and processes (design, manufacturing and support). CE tools have to be compliant with CALS standards (IGES, SGML, CCITT 4, CGM etc.) and CITIS.

- METHOD

  CE imposes the utilisation of formal methods, including special ES/AI models, of analysis, synthesis and optimisation of design, manufacturing and support (e.g. RAM/CAD, ILS/LSA, Statistic Control, Experimental Design, Computer Aided CM, Soft Simulation, Cause-Effect Diagrams, Quality Function Deployment, Value Analysis/Value Engineering/Value Management, TQM etc. etc.)

After a long time spent to identify viable solutions suitable to implement such a "huge" list of constraints we have drawn down an "heroine" called HELOISE, which we hope will drive our orientation to solve all the problems we will meet during our wandering through the CE environment and will help us to be competitive in the next future.

3. THE HELOISE PROJECT

HELOISE (Highly Extended LOgistic Information Software Environment) is the AGUSTA project towards CE.

The heart of HELOISE is a common Integrated Data Base (IDB) on which, with different access authority, internal and external specialists of the three fundamental disciplines (Design, Manufacturing and Logistic) have the opportunity to contemporary interact. This approach overcomes the classical time-consuming, paper-oriented process to exchange information illustrated in Fig. 1. The long range HELOISE objective is the development and installation of an integrated automation environment where the Product Data of Engineering, Manufacturing and Logistic of AGUSTA, are shared with Customers and Suppliers on a common network (Fig. 2).

On this way it is possible to pursue the objective to cut down the time to exchange information and to improve the global quality of the product at a reduced cost.

The functional requirements of HELOISE have been defined taking into account the following objectives:

- assure that new systems or modifications of existent are conformal with the customer needs and expectations
- reduce acquisition, manpower and operation and support costs
- reduce number and skill requirements of personnel
- improve operation capability, reduce maintenance levels and mobility requirements of support structures
- eliminate errors due to information non-updated or redundant
- speedy access to information
- reduce waiting time to acquire spares and related information
- reduce cost due to paper and maintenance of process including paper flow
- homogenisation and standardisation of configuration and identification coding between producer and customer and between their different organisation levels
- on-line support and disposition, in real time or remote, automated failure reporting and diagnosis, on-line support to maintainers

On the base of these objectives the structure of HELOISE has been built on a common shared IDB on which 13 software applications interact (Fig. 3). The 13 SW applications are:

3.1 **CONFMOD** : Configuration Management/Modification Control

CONFMOD will manage configuration information on both the physical composition and the associated documentation and will control the impact of change. It will reach compatibility between configuration needs of design, manufacturing and support using an integrated coding system oriented to the "end user" rather than to the particular problem of the internal AGUSTA process (ATA coding). This will eliminate the present proliferation of different peculiar coding systems which necessitate of "huge" filtering activities. CONFOMOD will be the "matrix" structure of IDB of HELOISE.

3.2 **IPLIPAC** : Initial Provisioning List/Illustrated Part Catalogue Management

IPLIPAC will manage IPL and IPC taking elements directly from CAD/CAE/CAM tools and from IDB i.a.w. the applicable civil and military specifications (MIL, AECMA).

3.3 **MOADMIN** : Material Management/Order Administration/ Invoicing Transmission

MOADMIN will manage its topics interacting with the "material system" wherever it is located and distributed. It will optimise response times and immobilisations, taking into account LCC constraints. It will assume availability information from IDB. It will monitor the progress of orders, deliveries and invoices in real time and using suitable alert messages to management. It will interact with the AGUSTA input and output communication system and it will be developed i.a.w. to MIL and AECMA standards.

3.4 **ROMAN** : Repair and Overhaul Management

ROMAN will plan and manage repair and overhaul activities, the related human resources, materials and documentation (including technical bulletins) interacting with IDB at different technical levels to optimise operation cost and time.

3.5 **SESTEM** : Servicing/Support/Test Equipment Management

SESTEM will manage all the servicing and support equipments and the test equipments from the definition to the field operation and maintenance interacting with the LSA module of IDB and the design and manufacturing

CAD/CAM tools.

3.6 **TECHDOC** : Technical Documentation Development/update Management

TECHDOC will manage the interface activities of development and updating of the technical documentation interacting with the CAD tools, the test, graphics and imagine manipulation tools, and archive facilities (CD,VD, etc.) in a way to optimise the utilisation of information in IDB by electronic transferring to the document production tools both on paper or on electronic media.

3.7 **TRAINEQ** : Training Programs/ Training Equipment Development and Management

TRAINEQ will manage the identification of training programs and equipments up to the planning of training courses and related tools, interacting with IDB without intermediate flows of non electronic data.

3.8 **ANARAMS** : Analyses (R&M, LSA, LCC)

ANARAMS is the module of HELOISE at highest level with respect to "Concurrent Engineering". Reliability, Maintainability, Supportability and Life Cycle Cost analyses will interact each other and with the CAD/CAM/CAE tools, in parallel with the design activities, in order to obtain a product optimised not only in performance but even in its attributes related to field and to the global cost. ANARAMS will integrate the definition of RAMSS requirements by cross-techniques of partitioning, prediction, and optimisation, allowing a dialogue with the customer during the feasibility analysis of requirements and definition of related implementation cost, based on objective, quantitative data and reproducible analyses.

3.9 **FINCONTR** : Financial/Accounting/Contractual/Admin

FINCONTR will manage the administrative and accounting and contractual activities using the physic, functional, time, specification and warranty data included in IDB.

3.10 **PERSFAD** : Personnel/Facilities/ Admin and PHST Mangmt

PERSFAD will integrate the activities related to the management of the resources of the support bases and the process of PHST (Packaging, Handling, Storage and Transportation) of the materials, with the data of availability and historical present in IDB.

3.11 **FIELCOL** : Field Data Collection

FIELCOL will storage all the data of configuration, identification, failure event, maintenance, use etc. coming from the field, updating the historical basis of IDB in a way in which ANARAMS and ROMAN can operate on significant and validated statistical data.

3.12 **COMMINT** : Communication/interface SW and Facilities Management

COMMINT will be dedicated to the management of the communication interface (networking) between the different modules and location and users of HELOISE; it will manage also interactively the traditional and advanced communication media (Fax, Telex, Teleconference etc.

3.13 **CUSTVEND**: Customer Support and Vendor Coordination

CUSTVEND interacting with IDB will manage the interface with Customers and Suppliers relatively to that data not directly managed by MOADMIN, in a way to optimise the interrelationship, to elaborate the opportunities of interchange and to improve the service.

At this moment HELOISE is in its second year of definition and we have planned it will be fully developed by end of 1997.

4. TWO CE LINK APPLICATIONS

In this paper we report two applications which are already usable. They are referred to two vital links of CE:

- ENGINEERING vs LOGISTIC LINK
- ENGINEERING vs MANUFACTURING LINK

Many other links are to be built as it is possible to deduce from the HELOISE description given in para 3.

4.1 Engineering vs Logistic link application

This SW application, called RAMREQ, is an integrated SW program where the Reliability, Availability, and Maintainability requirements are apportioned to the lowest logistic significant level of indenture of the components of an helicopter by a composed process of Apportionment, Prediction, Cost optimisation using advanced VA/VE techniques. It has been successfully applied to A129 and to EH101, and, under contract with ESA, to HERMES.

The flow diagrams in Figs. 4, 5, 6, and 7 illustrate the logic process, the primary and secondary inputs, the feed-back looping and the outputs of RAMREQ.

4.2 Engineering vs manufacturing link application

It has been noted that, if the design of a structural item was performed on a 3D tool, it is possible to eliminate the extensive re-working of a 2D drawing in order to have a drawing suitable to be transformed in a readable file of a NC machine (2D drawing developed on a plan i.e. the loft drawing). The application has been structured, from an organisational point of view, reconverting all the structural 2D drawing activity in a 3D, and filtering the 3D drawing, developed on the plan, in order to have a directly readable file for the NC machine.

This approach has dramatically reduced the time to production by an order of amplitude (days instead of weeks), increased the quality, and it has eliminated completely an intermediate step (and its related organisation and dedicated human and tools resources) between Engineering and Manufacturing Departments, with a consequent reduction of cost.

5. CONCLUSIONS

We are nowadays on the border line of the CE environment and, we already have met so many difficulties as far as the three "spectra" (Organisation, Tool and Method) are concerned, but we are confident to have, as a minimum, identified a "compass" to orient ourselves in that "spectral" environment.

Even if it can be seen as not a great achievement, we must consider that in few years we will be "catapulted" in that environment and therefore, if we do not have even a project we will be "devoured" by the the "spectra".

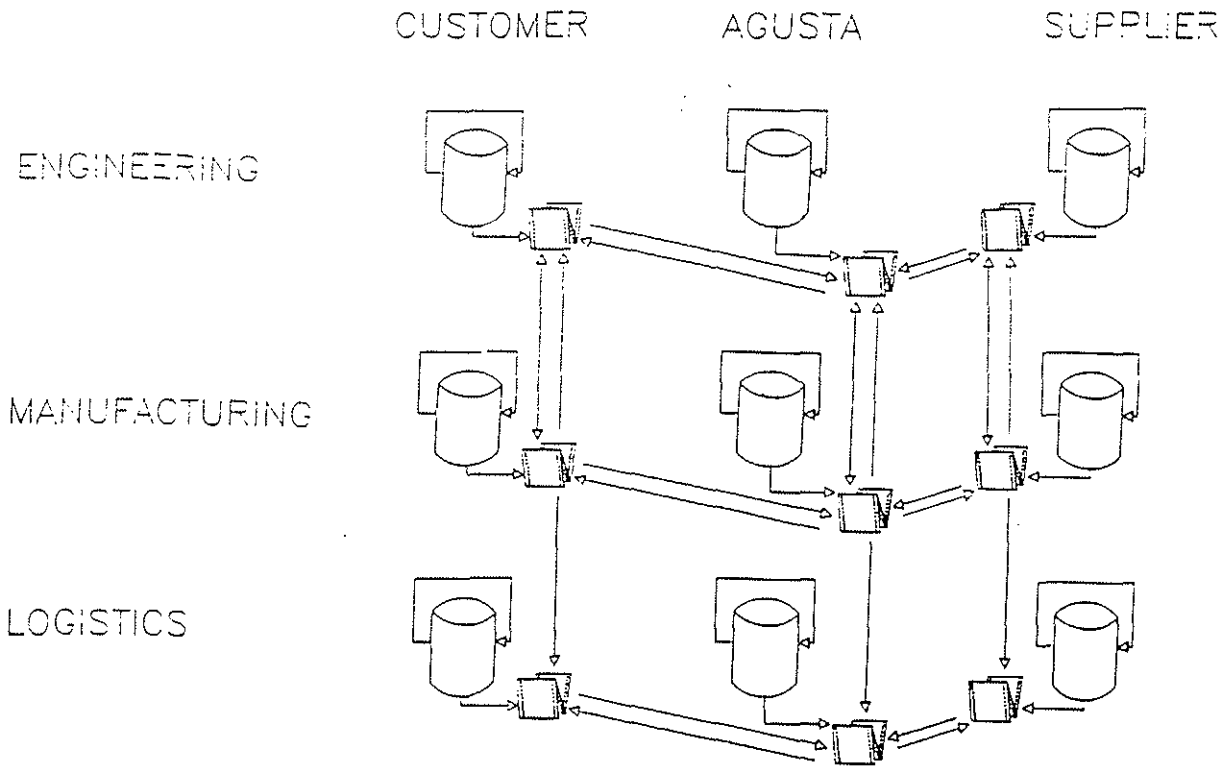
CUSTOMER
AGUSTA
SUPPLIER
ENGINEERING
MANUFACTURING
LOGISTICS

Fig. 1

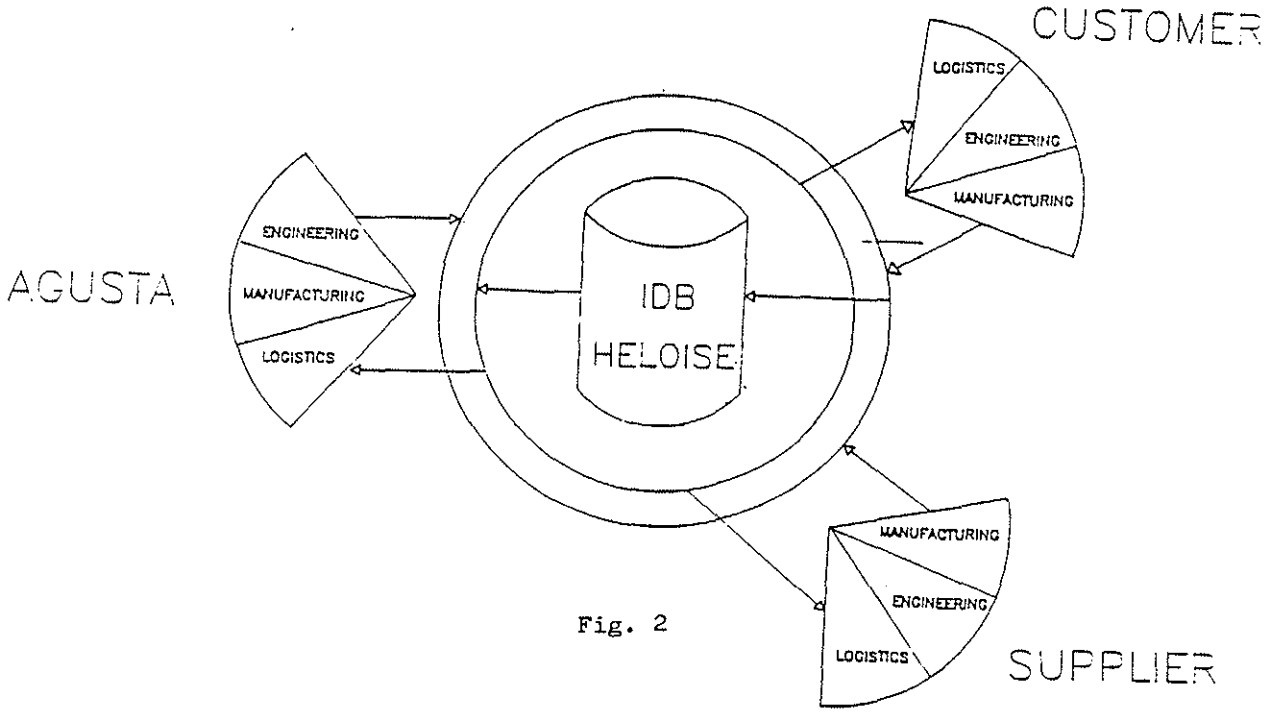
CUSTOMER
LOGISTICS
ENGINEERING
MANUFACTURING
AGUSTA
ENGINEERING
MANUFACTURING
LOGISTICS
IDB
HELOISE
MANUFACTURING
ENGINEERING
LOGISTICS
SUPPLIER

Fig. 2

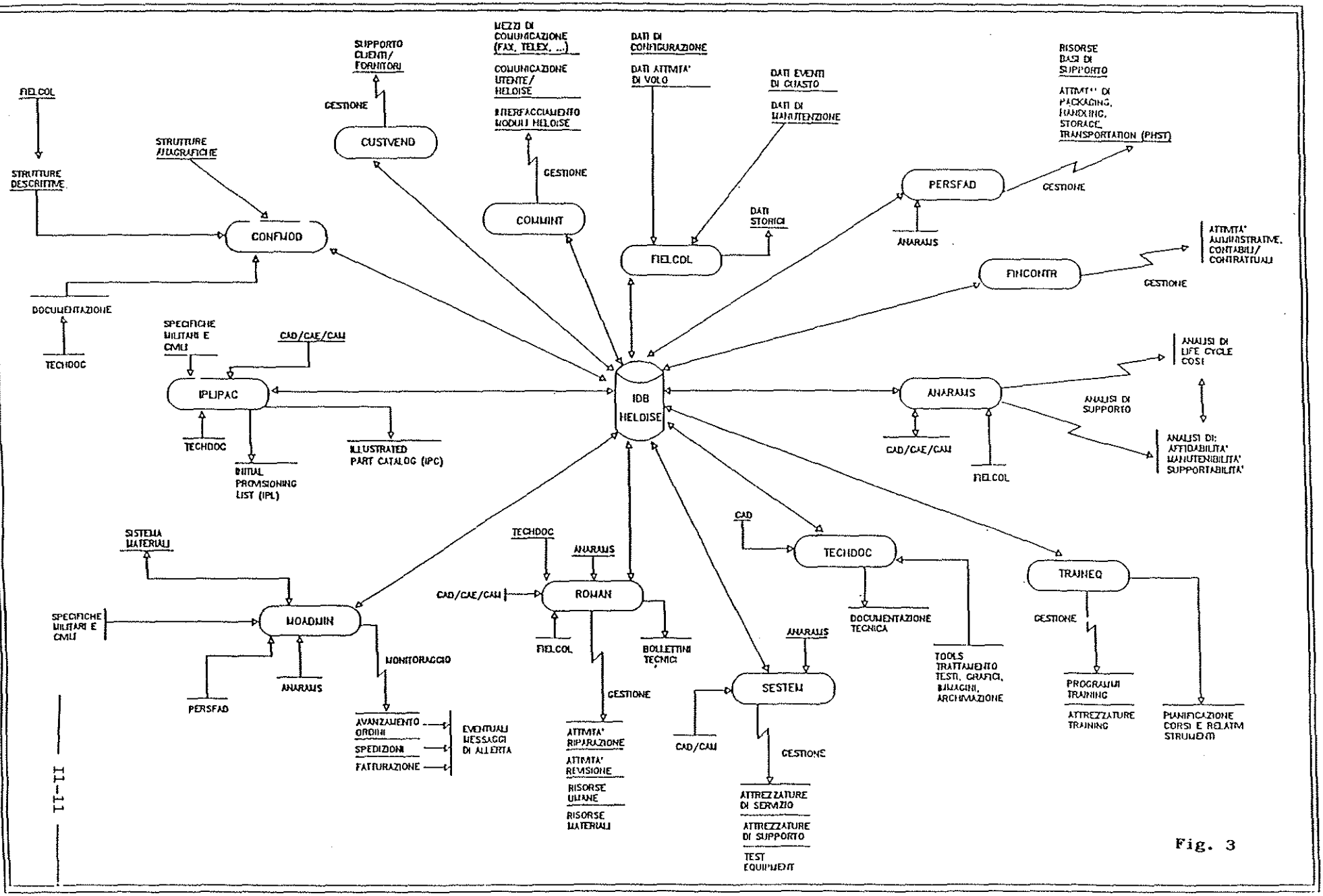
FIELCOL
STRUTTURE DESCRITTIVE
STRUTTURE ANAGRAFICHE
CONFMOD
DOCUMENTAZIONE
TECHDOC
SUPPORTO CLIENTI/ FORNITORI
GESTIONE
CUSTVEND
MEZZI DI COMUNICAZIONE (FAX, TELEX, ...)
COMUNICAZIONE UTENTE/ HELOISE
INTERFACCIAMENTO MODULI HELOISE
GESTIONE
COMUNT
DATI DI CONFIGURAZIONE
DATI ATTIVITA' DI VOLO
DATI EVENTI DI GUASTO
DATI DI MANUTENZIONE
FIELCOL
DATI STORICI
RISORSE BASI DI SUPPORTO
ATTIVITA' DI PACKAGING, HANDLING, STORAGE, TRANSPORTATION (PHST)
GESTIONE
PERSFAD
ANARAMS
FINCONTR
ATTIVITA' AMMINISTRATIVE, CONTABILI/ CONTRATTUALI
GESTIONE
SPECIFICHE MILITARI E CIVILI
CAD/CAE/CAM
IPLIPAC
TECHDOC
INITIAL PROVISIONING LIST (IPL)
ILLUSTRATED PART CATALOG (IPC)
IDB HELOISE
ANALISI DI LIFE CYCLE COST
ANARAMS
ANALISI DI SUPPORTO
ANALISI DI: AFFIDABILITA' MANUTENIBILITA' SUPPORTABILITA'
CAD/CAE/CAM
FIELCOL
SISTEMA MATERIALI
SPECIFICHE MILITARI E CIVILI
MOADMIN
PERSFAD
ANARAMS
MONITORAGGIO
AVANZAMENTO ORDINI
SPEDIZIONI
FATTURAZIONE
EVENTUALI MESSAGGI DI ALLERTA
TECHDOC
ANARAMS
CAD/CAE/CAM
ROMAN
FIELCOL
BOLLETTINI TECNICI
GESTIONE
ATTIVITA' RIPARAZIONE
ATTIVITA' REVISIONE
RISORSE UMANE
RISORSE MATERIALI
CAD
TECHDOC
DOCUMENTAZIONE TECNICA
TOOLS TRATTAMENTO TESTI, GRAFICI, IMMAGINI, ARCHIVIAZIONE
ANARAMS
SESTEM
CAD/CAM
GESTIONE
ATTREZZATURE DI SERVIZIO
ATTREZZATURE DI SUPPORTO
TEST EQUIPMENT
TRAINEQ
GESTIONE
PROGRAMMI TRAINING
ATTREZZATURE TRAINING
PIANIFICAZIONE CORSI E RELATIVI STRUMENTI

Fig. 3

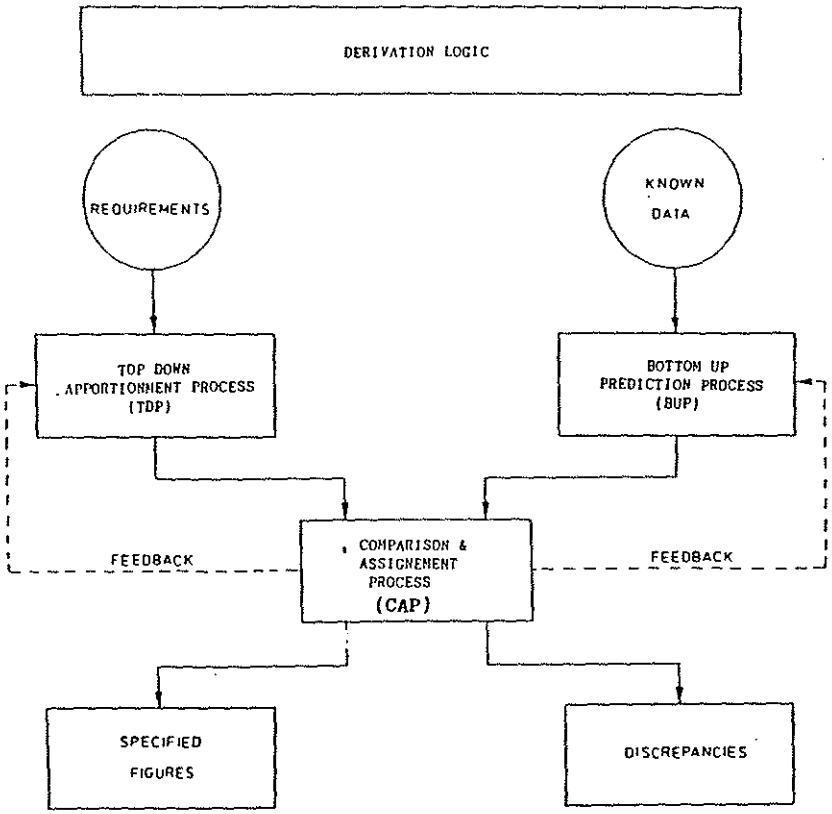
DERIVATION LOGIC
REQUIREMENTS
KNOWN DATA
TOP DOWN APPORTIONMENT PROCESS (TDP)
BOTTON UP PREDICTION PROCESS (BUP)
FEEDBACK
COMPARISON & ASSIGNEMENT PROCESS (CAP)
FEEDBACK
SPECIFIED FIGURES
DISCREPANCIES

Fig. 4

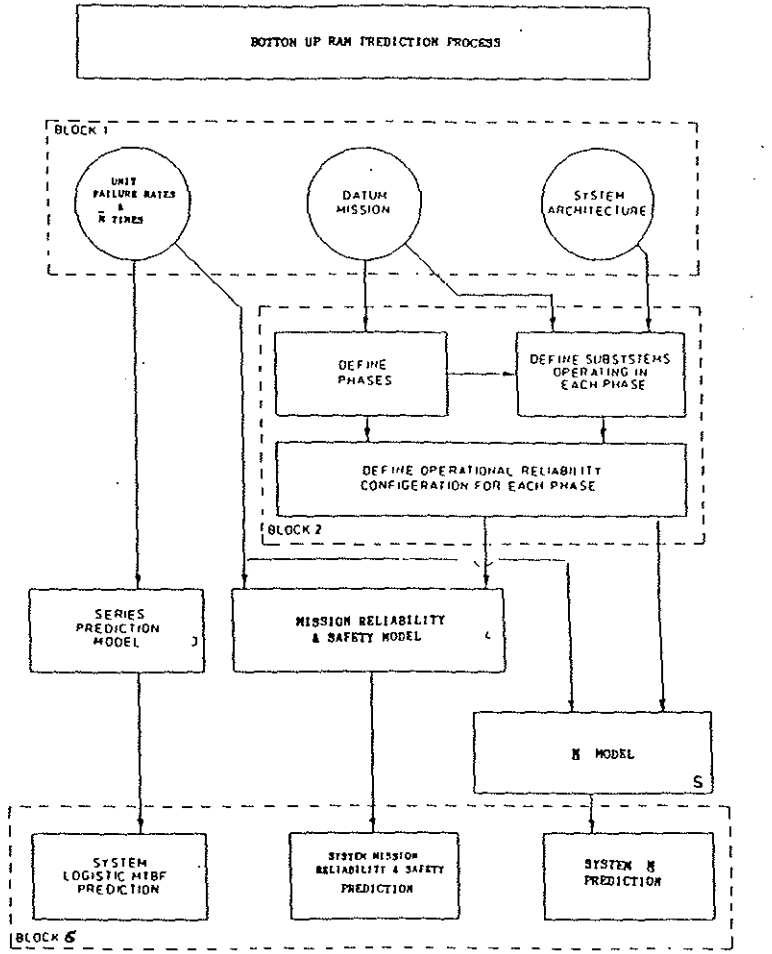
BOTTON UP RAM PREDICTION PROCESS
BLOCK 1
UNIT FAILURE RATES & R TIMES
DATUM MISSION
SYSTEM ARCHITECTURE
DEFINE PHASES
DEFINE SUBSTSTEMS OPERATING IN EACH PHASE
DEFINE OPERATIONAL RELIABILITY CONFIGERATION FOR EACH PHASE
BLOCK 2
SERIES PREDICTION MODEL
MISSION RELIABILITY & SAFETY MODEL
M MODEL
SYSTEM LOGISTIC MTBF PREDICTION
SYSTEM MISSION RELIABILITY & SAFETY PREDICTION
SYSTEM M PREDICTION
BLOCK 6

Fig. 5

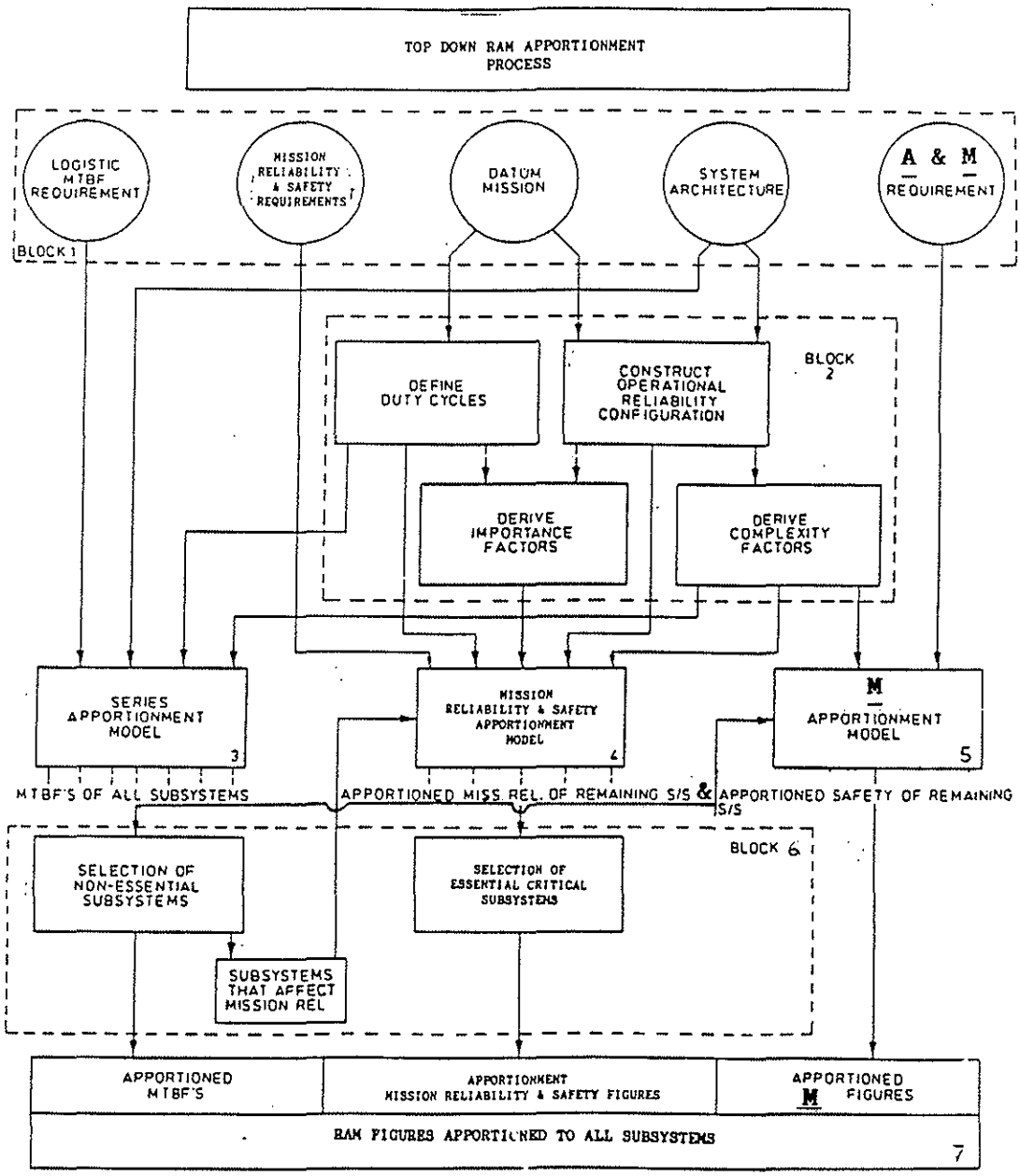
TOP DOWN RAM APPORTIONMENT PROCESS
LOGISTIC MTBF REQUIREMENT
MISSION RELIABILITY & SAFETY REQUIREMENTS
DATUM MISSION
SYSTEM ARCHITECTURE
A & M REQUIREMENT
BLOCK 1
DEFINE DUTY CYCLES
CONSTRUCT OPERATIONAL RELIABILITY CONFIGURATION
BLOCK 2
DERIVE IMPORTANCE FACTORS
DERIVE COMPLEXITY FACTORS
SERIES APPORTIONMENT MODEL 3
MISSION RELIABILITY & SAFETY APPORTIONMENT MODEL 4
M APPORTIONMENT MODEL 5
MTBF'S OF ALL SUBSYSTEMS
APPORTIONED MISS REL OF REMAINING S/S &
APPORTIONED SAFETY OF REMAINING S/S
BLOCK 6
SELECTION OF NON-ESSENTIAL SUBSYSTEMS
SELECTION OF ESSENTIAL CRITICAL SUBSYSTEMS
SUBSYSTEMS THAT AFFECT MISSION REL
APPORTIONED MTBF'S
APPORTIONMENT MISSION RELIABILITY & SAFETY FIGURES
APPORTIONED M FIGURES
RAM FIGURES APPORTIONED TO ALL SUBSYSTEMS
7

Fig. 6

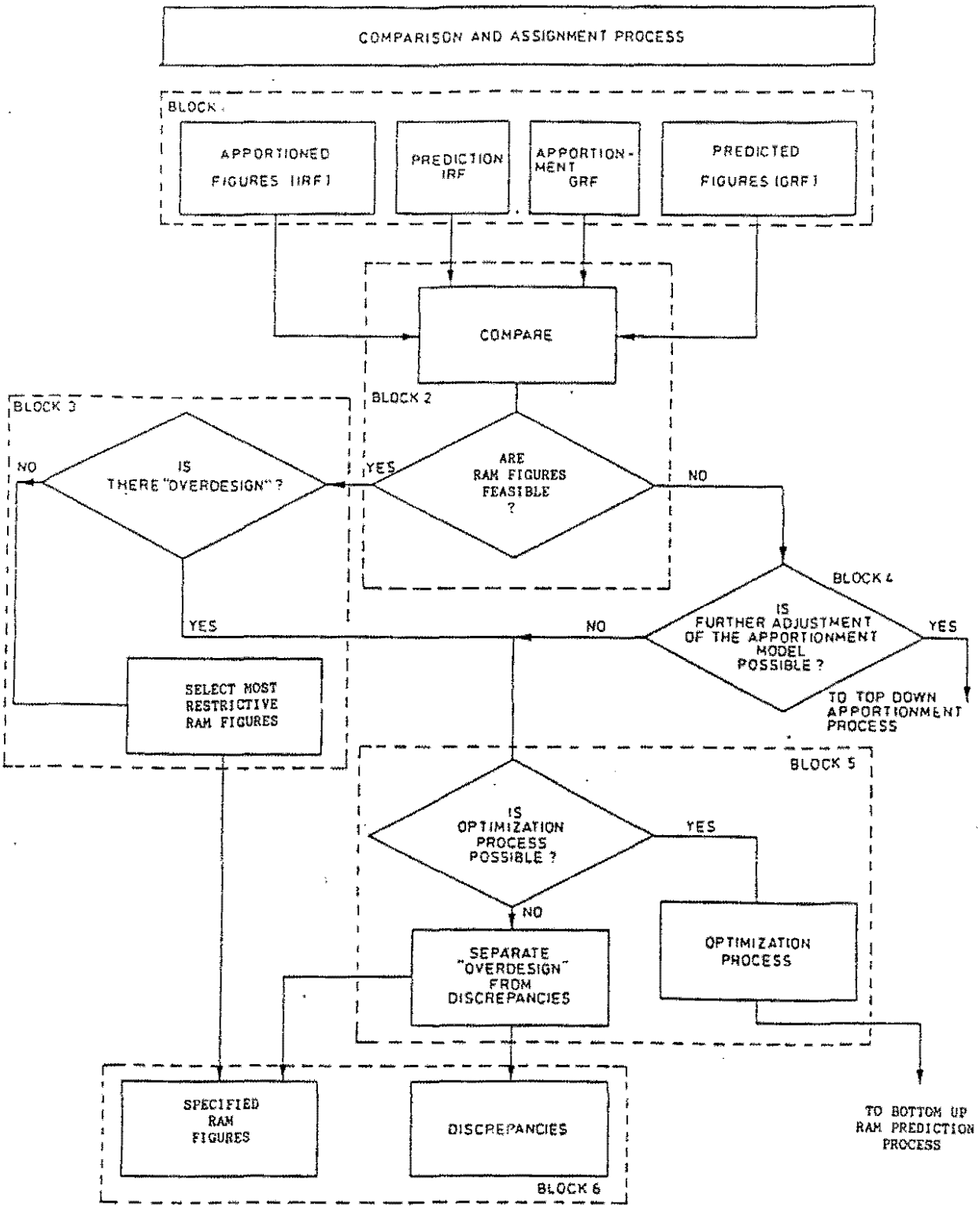
COMPARISON AND ASSIGNMENT PROCESS
BLOCK 1
APPORTIONED FIGURES (IRF)
PREDICTION IRF
APPORTION-MENT GRF
PREDICTED FIGURES (GRF)
COMPARE
BLOCK 2
ARE RAM FIGURES FEASIBLE ?
YES
NO
BLOCK 3
IS THERE "OVERDESIGN" ?
NO
YES
SELECT MOST RESTRICTIVE RAM FIGURES
BLOCK 4
IS FURTHER ADJUSTMENT OF THE APPORTIONMENT MODEL POSSIBLE ?
NO
YES
TO TOP DOWN APPORTIONMENT PROCESS
BLOCK 5
IS OPTIMIZATION PROCESS POSSIBLE ?
YES
NO
OPTIMIZATION PROCESS
SEPARATE "OVERDESIGN" FROM DISCREPANCIES
SPECIFIED RAM FIGURES
DISCREPANCIES
BLOCK 6
TO BOTTOM UP RAM PREDICTION PROCESS

Fig. 7