A Site-Based Computerized Production Planning & Control Model for The Plants which Produce Prefabricated Building Components

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ABSTRACT

The "open systems" in building prefabrication may be qualified more flexible to some extent compared to the closed ones and may use the tools and approaches used in industrial production areas for the estimation of demand and production. As for the closed systems in particular, it is not possible for these systems to apply this kind of approach. Their production must be based on absolutely assured demands and projects. Because of this, they need detailed projects and assembly schedules for production. As a result of this, their production modes can be qualified "custom-made" type and production planning functions must provide the demand values from the assembly schedules of contracted projects. The problem can be solved by integrating the work schedules of the sites that are served by factory. Integration of data on a computerized system will be preferable and it is possible to realize the model in two alternative ways. The first is developing a new conceptual model and convert it into a software and the second is developing an approach for customizing general purpose project planning and programming software for using them in production planning. The second solution is studied in the paper following this. The aim of this study is to develop the principals of a conceptual model for an Integrated Data Flow and Evaluation System for production planning in prefabrication and to convert this model into an applicable and objective computer-aided model.

1 THE NEED FOR PRODUCTION PLANNING IN BUILDING PREFABRICATION

It is obviously seen that the progress speeds of the countries taking place on different points of development line differ from each other related to their location on the line. Thus, distances between the societies at right and left sides relatively reach new and uncoverable dimensions as the time goes by. So, it can be claimed that backward countries have no way out except accelerating their development process and trying to pass the phases that the others passed before as fast as possible. Today, most of the problems coming up in these countries are caused by the accidents originating from this kind of uncontrollable accelerations without having a plan sufficiently studied on.
When we reduce the topic to the scale of building production, it is possible to observe similar problems at this level too. As an inevitable consequence of explosion of population and condensation of the investments at certain regions, great masses of people flow from one place to another. Traditional or Conventional building production systems do not seem to be able to cope with the problem. Because they do

not have required characteristics for providing the speed that is necessary to cover the growing distance between demand and supply within a reasonable time.
Finally, because of this fact, it is possible to see a number of technologies started to be used for producing the buildings required relatively in a short time and economically. Besides rationalized mould techniques, prefabricated systems also take their places in production this way.
Due to the characteristics of product and production processes, which are used conventionally, building production shows a tendency of deviating from schedule. For this reason, especially the efforts aiming to minimize the activities on site come up as an effective solution, which lessens the deviations stated above. From this point of view, Prefabricated Building Production Systems have some advantages in fastening site production by integrating various subsystems, which constitute the building structure formerly in factory.

1.1 **Determination of Problem and Its Background**

It is known that the concept of production has got two dimensions in fact; *technology* and *management*. In theory, technology is an important factor to increase product number in a certain period and can be defined as the basic component of prefabrication. But it is not adequate to reach the targets of production when considered alone. This can be pointed out one of the main wrongs in the countries trying to progress in that kind of acceleration stated before. Without having a managerial support, technology can never reach its targets in prefabricated building production. For this reason, these two dimensions of prefabrication have got the same importance but may be technology can be qualified as "primus inter pares".
Though various technologies are used within the content of prefabricated building production systems, managerial problems and functions are universal. As a result of this fact, the studies that aim to reach a solution and to make the technology more efficient must be focused on this point. In chapter two, beside the technological side of prefabrication, its managerial dimension is emphasized and the problem is determined to be originated from the lack of the models responding the problems taking place at this dimension and the integrated data flow systems required by the models.
After determining the problem and its origin, the managerial functions in industrial production activities are studied under the title of Production Planning and Control within the research project originating this paper. Related to this stage, prefabricated building production systems are analyzed from the viewpoint of "Production Types". Thus, the differing sides of building prefabrication from the other industrial production systems are tried to be determined. It is clear that, the system, which is planned to be designed for production planning will be shaped by the characteristics of production type. Apart, this analysis is necessary for determining the problem and its boundaries in detail and developing a rational model to solve it.
Managerial functions take place in a wide range from country to sector and company level in prefabrication as they do in other industrial production fields. These functions have got different contents according to their level and term they consider. In this

chapter, the qualifications and contents of these functions are also analyzed from all aspects and finally the problem is restricted by company level and short-term functions.
As a result of the analysis stated above, it is seen that the features of prefabricated building production systems are shaped by three main factors. The first of these factors is related to the characteristics of demand. As it is known, long-term planning is hardly possible especially for the countries suffering from high inflation rate and economical instability. It is too difficult for the people who are vitally in need of a house to convert their wishes into demand in economical sense in these countries. Because of these conditions, the support of central authorities can not also be continuous for providing a stable demand for building production, which is the most important factor for prefabrication.
Except for the demand characteristics, the features of the product, and production processes in factory and site do not allow the standardization, which is one of the basic requirements of industrial production. As a result of these factors, it is not possible especially for the Closed Systems in prefabrication either to maintain a "continuous" or "process" type production nor to estimate the demand by time series analysis related to past. The open systems may be qualified more flexible to some extent compared to the closed ones from this point of view and may use the tools and approaches stated above for the estimation of demand and production.
As for the closed systems in particular, it is not possible for these systems to apply this kind of an approach. Their production must be based on absolutely assured demands and projects. Because of this, they need detailed projects and assembly schedules for production. As a result of this, their production modes can be qualified "custom-made" type and production planning functions must provide the demand values from the assembly schedules of contracted projects. It is obvious that in spite of these data production plans can not be static because of the variable and unstable characters of either factory or site productions.
In prefabrication, basically there are two phased - factory & site - and a multi-centered production and these two phases have got different features. The capacity flexibility of factory depends on technology and production factors. As for the sites, demands of components may have different values according to current number of projects and their schedules. This situation causes the factory to develop and maintain its production plans in a great difficulty. Mostly the required production speed and economical targets can not be reached and delivery program loses their currency because of the lack of coordination and sufficient data flow between production centers. Because of the delays of revisions in production plans, some of the components can not be produced in time while some others are produced unnecessarily before their delivery schedule. Consequently, the coordination and control functions of management can not be completely fulfilled and production loses its rationalism.

1.2 **The Aim of Study**

The problem stated above can be solved by integrating the work schedules of the sites that are served by factory. Integration of data on a computerized system will be preferable and it is possible to realize the model in two alternative ways. The first is developing a new conceptual model and convert it into a software and the second is developing an approach for customizing general purpose project planning and programming software for using them in production planning. The second solution is studied in the paper following this.

This study has got three consecutive purposes completing each other in solving the problem stated above. The first aim is to determine the modes of operations and the factors affecting them; to define the content of Production Planning and Control Function in prefabrication.

The second aim is to develop the principals of a conceptual model for an Integrated Data Flow and Evaluation System, which:

- Integrates all the required data obtained from all production centers and provides the coordination between the two phase of prefabrication
- Helps the factory to prepare the required production plans targeting to use its capacity in an optimum way
- Allows these plans to be revised in a sufficient speed according to real progress in both production centers.

As for the third aim, it is to convert this system into an applicable and objective computer-aided model.

2 ANALYSIS OF THE COMPONENTS & FUNCTIONS OF THE SYSTEM TO BE DEVELOPED

The functions mentioned above can be expressed as follows:

- Determining the assembly schedules
- Determining the delivery schedules
- Monitoring factory and site productions
- Updating and revising programs
- Integrating (mergeing) the projects and preparation of reports

Related to these functions, the components of the system, which will fulfill these functions are designed as follows:

- Project Planning/Programming (scheduling) Subsystem
- Building/Plan Types Definition Subsystem
- Prefabricated Building Components Definition Subsystem
- Inventory Control Subsystem
- Factory Mould Types Definition Subsystem
- Projects & Data Integration/Evaluation Subsystem

3 SYNTHESIS OF THE SYSTEM DEVELOPED FOR PRODUCTION PLANNING IN PREFABRICATION

3.1 **Synthesis in Conceptual Dimension: Definition of the System Components & Interrelations**

Project Planning/Programming Subsystem is the first component of the system aiming to prepare the work schedules of projects to which the factory serves and uses The Critical Path Method for this purpose. It makes detailed analysis about time, resources and money at the same time. The work schedules can be qualified a database and are used by Data Integration/Evaluation Subsystem in order to constitute assembly schedules.

Building/Plan Type Definition Subsystem aims to make up a data-base, which determines the number and types of building components in all building and plan units in current projects.

The system uses component data-base created by Building Components Definition Subsystem. As for this subsystem, its aim is to prepare a database as it is stated above. In this process, all building components are defined by their physical qualifications in three consecutive levels. This database is used also for constructing Inventory Control Subsystem.

Inventory Control Subsystem records and saves all data about factory production and delivered amounts and types of components in project and date base. Thus it is possible for Data Integration/Evaluation Subsystem to compare planned and realized values and updating the assembly and delivery programs.

Mould Definition Subsystem also creates a database defining the types and numbers of the moulds located in factory and determines current factory capacity in this way.

The last component of the system is Data Integration and Evaluation Subsystem. This system uses all the databases created by other subsystems and produces a wide range of reports, which have got different contents according to different purposes. The system integrates all data obtained from project work schedules, sorts the data related to assembly activities and by combining building/plan type data-base and the schedule of assembly activities prepares assembly and delivery programs for every building component type.

3.2 **Synthesis in Practical Dimension: Converting the Conceptual System into a Computer-Based Model**

After developing the conceptual model it is converted into a computer program using GW-Basic Programming Language. The modules of software and structures of these modules are given below (figure 3-9) and the outputs of the software in Appendices.

CONCLUSIONS

Prefabricated Building Production Systems may compete the other systems that are still in use widely if they can stay under the cost limits. For this reason, they need managerial tools and methods supporting their technological advantages for obtaining productivity and effectiveness required.

In this study, the general principles of this kind a tool are described at first stage. In second stage, a computer-aided model that aims to integrate and evaluate the data and to create the reports for production planning in prefabrication is developed by converting the system stated before. The third point carrying originality in the study is the evaluation of prefabrication from the viewpoint of industrial production systems that is necessary for developing the tool explained above.

It is not necessary to say that the author is not a professional computer programmer and the software developed in this study is not aimed to be used for real problems. Since it has always been too difficult to explain the structure and working of the model it has been inevitable to convert the conceptual model into an applicable and easy understandable software, that's all!

Figure 1: **Schematic Illustration of Components & Interrelations of Conceptual System**

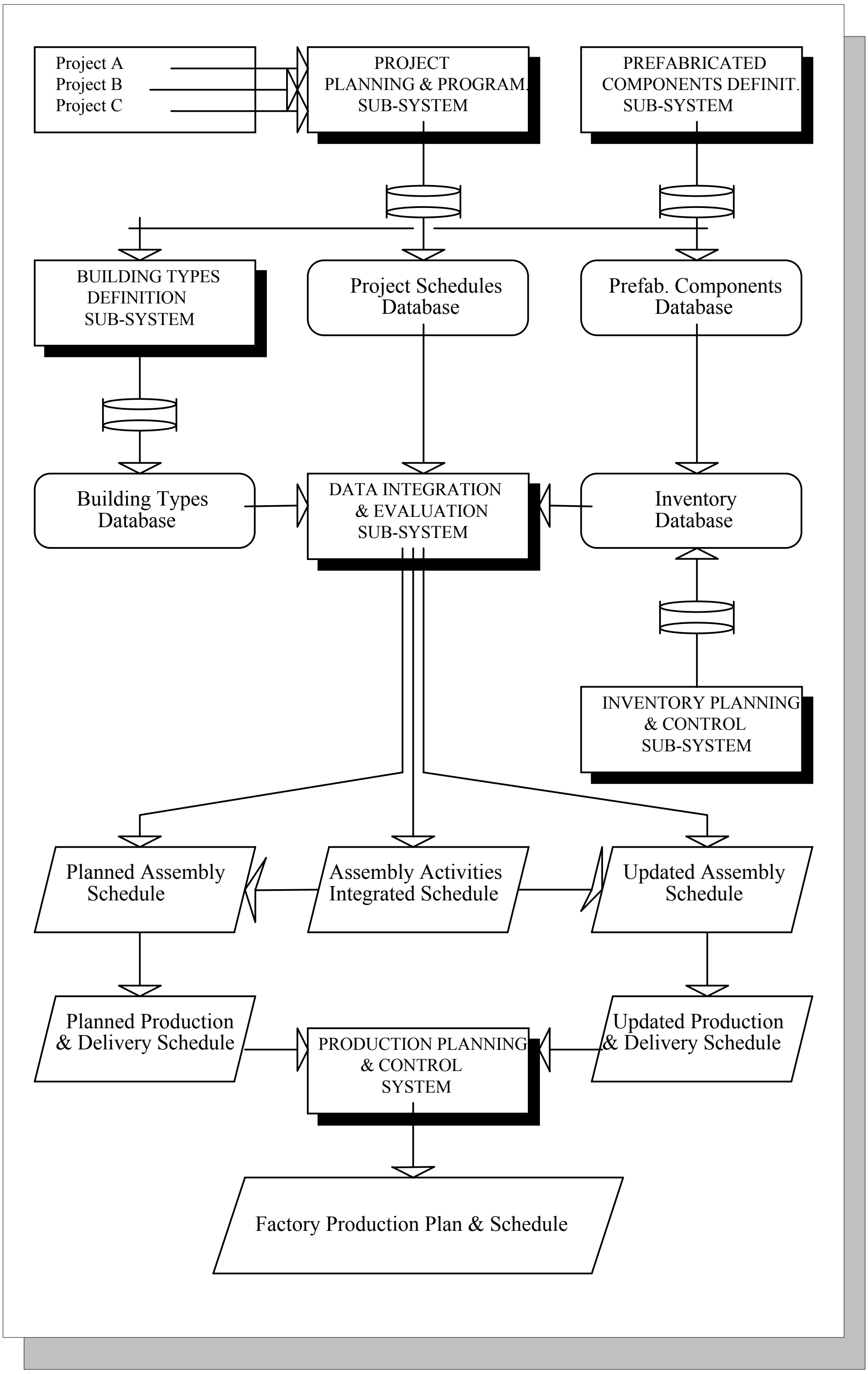


Figure 2: **The Structure of Coding System for Data & Report Organization**

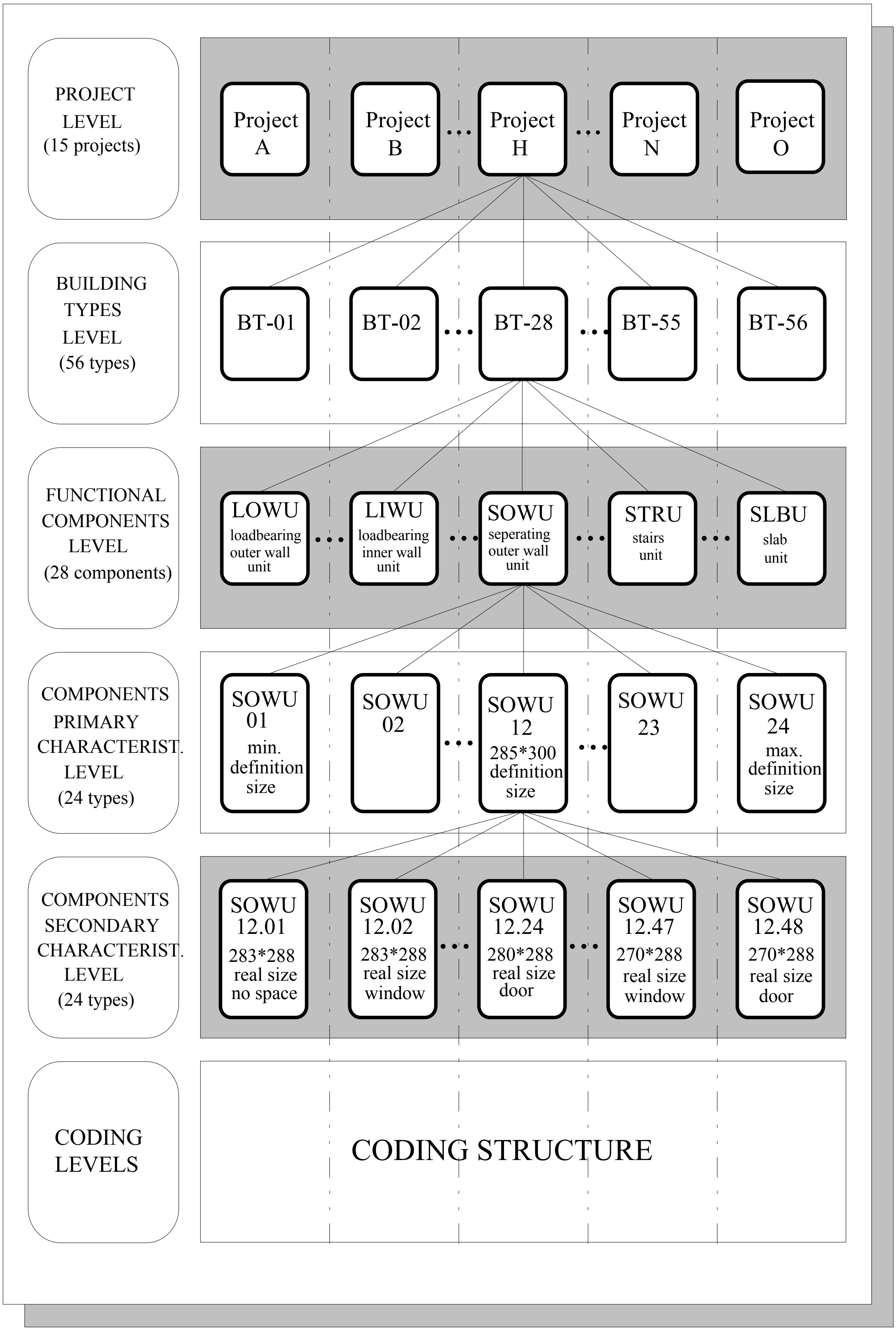


Figure 3: **The Structure of The Computer Program**

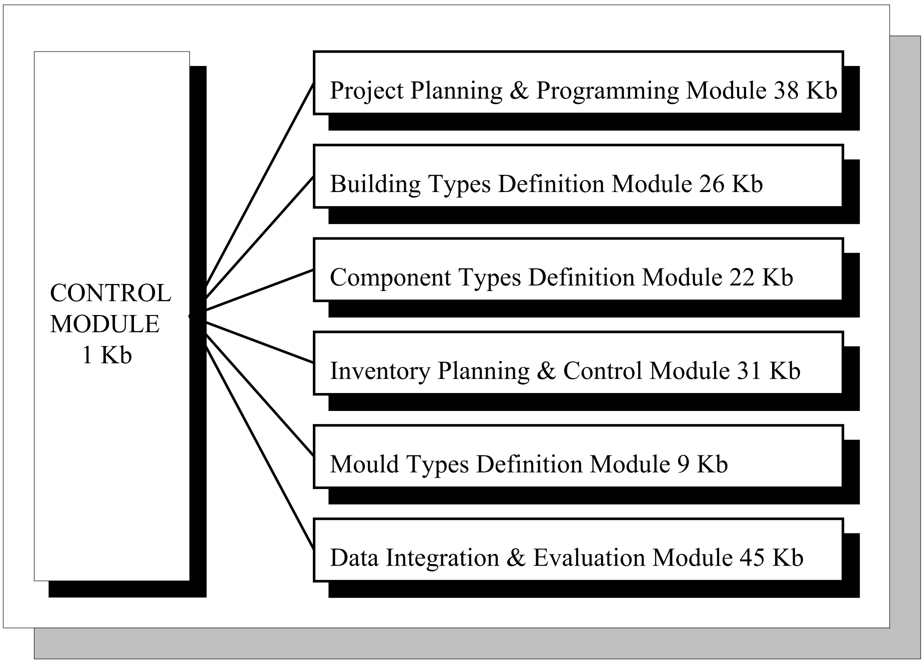


Figure 4: **Structure of Inventory Planning & Control Module**

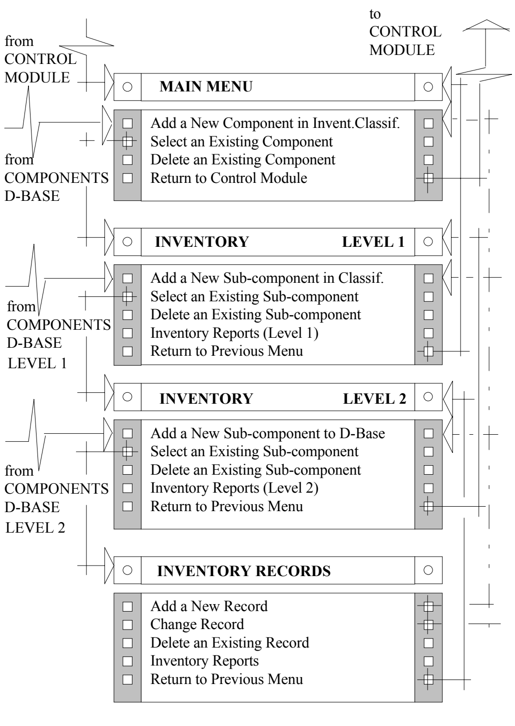


Figure 5: **Structure of Building Type Definition Module**

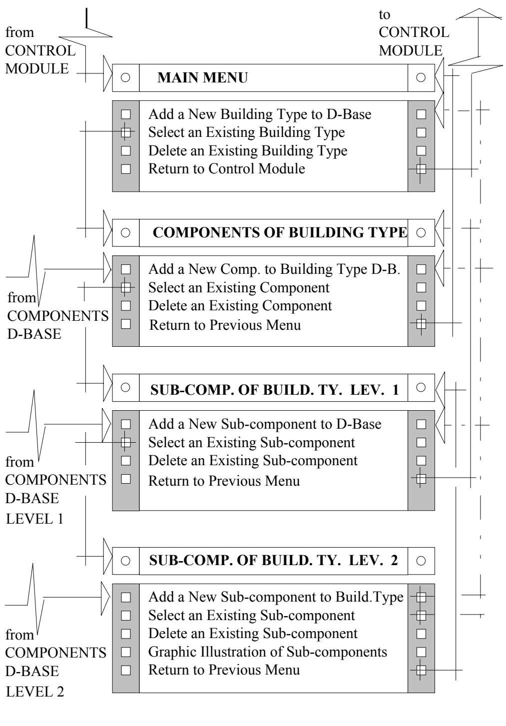


Figure 6: **Structure of Prefabricated Comp. Definition Module**

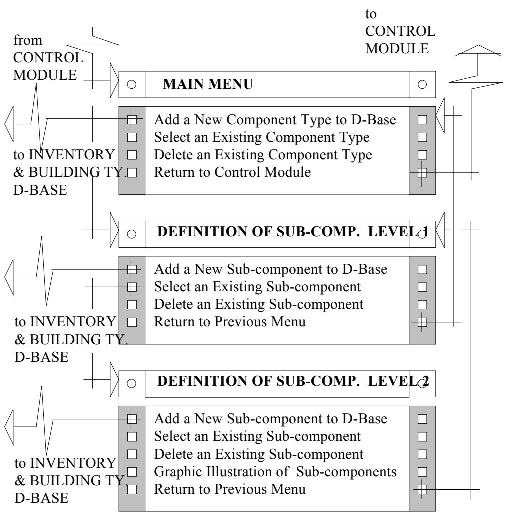


Figure 7: **Structure of Mould Definition Module**

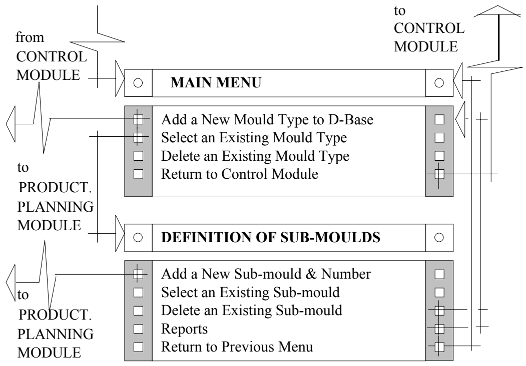


Figure 8: **Structure of Project Plann. & Programming Module**

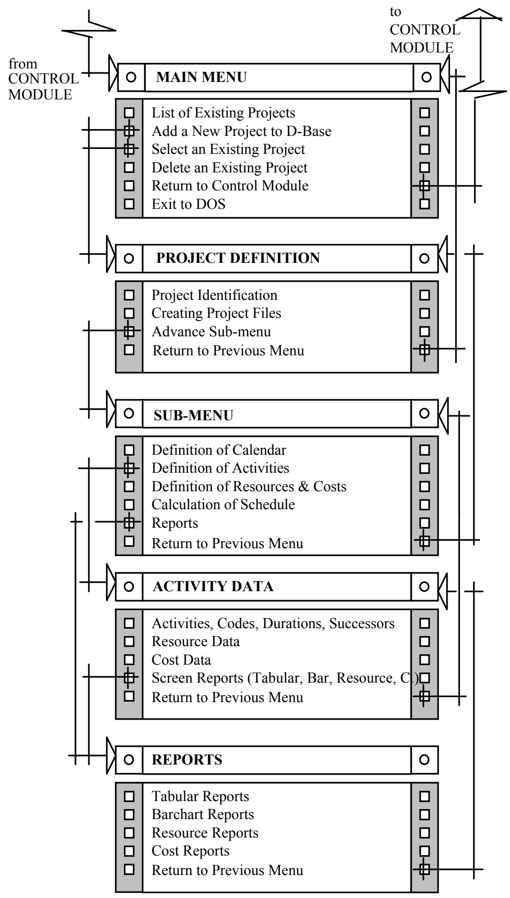
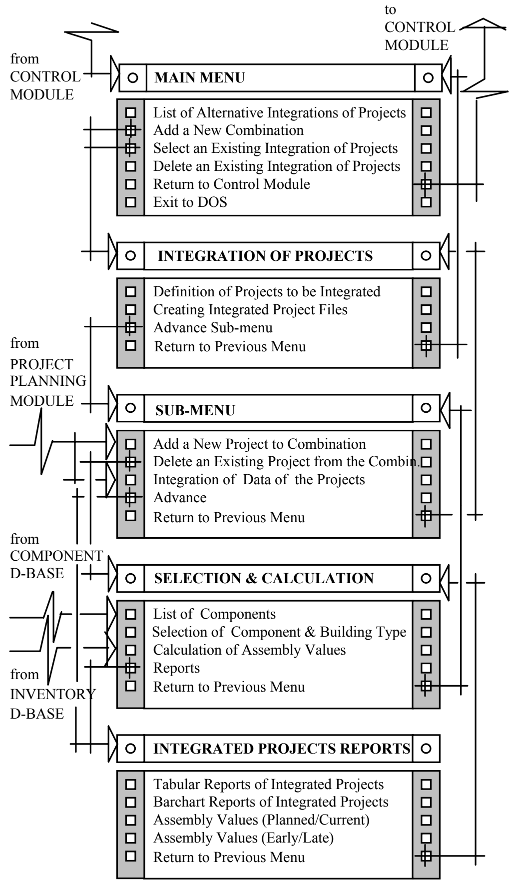


Figure 9: **Structure of Data Integr. & Evaluation Module**



REFERENCES

Hatz D., (1974) Production Planning for Prefabricated Reinforced Concrete Units within an Integrated Data Flow in Construction Process, *Proceedings of CIB 6.th Congress*, Budapest, 1974, II, pp.257-264

Kanoglu, A., (1991) A Computer-aided Integrated Data Flow & Evaluation Model for Production Planning in Prefabricated Building Systems, Ph.D. Thesis, I.T.U. Institute of Science & Technology, Istanbul

Sey Y., Tapan, M., (1987) The Analysis & Evaluation of Construction Systems Used for Housing, The Research Report Supported by TUBITAK Building Research Institute, Publishing No. U.6, Ankara, p.14

Warszawski, A., (1984) Production Planning in Prefabrication Plant, *Building & Environment*, Vol.19, No.2, p.146

Warszawski, A., Ishai, E., (1982) Long Range Planning of Prefabrication Industry in a National Economy, *Building & Environment*, Vol.17, No.1, p.47

Warszawski, A.,(1982) Managerial Planning and Control in Precast Industry, *ASCE Journal of Construction Division*, Vol.108, No.2, p.303

Warszawski, A., Avraham, M., Carmel, D., (1984) Utilization of Precast Concrete Elements in Building, *ASCE Journal of Construction Division*, Vol.110, No.4, pp. 476-485

APPENDICES

EXAMPLES OF BASIC SCREENS AND OUTPUTS OF THE COMPUTER PROGRAM

Figure 10: **Prefabricated Component Types Database Screen**

```
________________________________________________________________________________
      NO CODE DEFINITION            MOD          NO CODE DEFINITION           MOD
________________________________________________________________________________
COM * 01 LOWU L.BEARING OUTER WALL  30    COM * 15
COM * 02 LIWU L.BEARING INNER WALL  30    COM * 16
COM * 03 SOWU SEPERATING OUTER WALL 30    COM * 17
COM * 04 SIWU SEPERATING INNER WALL 30    COM * 18
COM * 05 SLBU SLAB UNIT             30    COM * 19
COM * 06 STRU STAIRS UNIT           30    COM * 20
COM * 07 PRPU PARAPET UNIT          30    COM * 21
COM * 08 CLMU COLUMN UNIT           30    COM * 22
COM * 09 BAMU BEAM UNIT             30    COM * 23
COM * 10 SPCU SPECIAL UNITS         30    COM * 24
________________________________________________________________________________
COMMANDS:Add   Delete   Edit   Print   Select   Help   Return
________________________________________________________________________________
```

Figure 11: **Prefabricated Component Types Database Screen (Level 1)**

```
********************************************************************************
COM * 01 LOWU L.BEARING OUTER WALL
********************************************************************************
________________________________________________________________________________
LOWU
________________________________________________________________________________
      NO  RLEN  MN  HEIG  LYR—01  LYR--02  LYR--03  LYR—04  WD    SQRM   VOLUM
________________________________________________________________________________
LOWU  01   180   6   300  CON  8  INS   4  CON  16          28     5.4   1.512
LOWU  02   240   8   300  CON  8  INS   4  CON  16          28     5.4   2.016



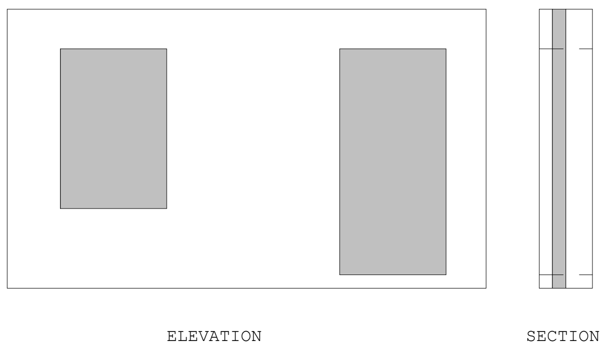

________________________________________________________________________________
COMMANDS:Add   Delete   Edit   Print   Select   Help   Return  More
________________________________________________________________________________
```

Figure 12: **Prefabricated Component Types Database Screen (Level 2)**

```
********************************************************************************
COM * 01 LOWU L.BEARING OUTER WALL
********************************************************************************
________________________________________________________________________________
LOWU  02
________________________________________________________________________________
          NO SW1 SH1 SD1 UD1 SSQ1 SW2 SH2 SD2 UD2 SSQ2 SW3 SH3 SD3 UD3 SSQ3 TSSQ
________________________________________________________________________________
LOWU  02  01  80 140  30  70 1.12  80 230 130  70 1.84                      2.96
LOWU  02  02  80 140  30  70 1.12  80 140 130  70 1.12                      2.24
________________________________________________________________________________
COMMANDS:Add Delete Edit Print Select Help Return More deTail Form spaCe
________________________________________________________________________________
```

Figure 13: **Prefabricated Components Graphic Illustration Screen**

```
________________________________________________________________________________
LOWU 02.01   80 140  30  70 1.12  80 230 130  70 1.84                       2.96
________________________________________________________________________________
```




```
________________________________________________________________________________
COMMANDS:Add Delete Edit Print Select Help Return More deTail spaCe
________________________________________________________________________________
```

Figure 14: **Updated Production Plan Report**

```
********************************************************************************
UPDATED PRODUCTION PLANNING TABLE                            UPDATE DATE: 23.01.91
********************************************************************************
________________________________________________________________________________
CODE.NO.NO    STOCK    PRODUC    PLANND    PERIOD   FINAL    PRODUC   %VARIAN
              VALUES   VALUES    VALUES    REST     TOTAL    REST      VALUE
________________________________________________________________________________
LOWU.01.**    000002   000099    000090    000009   000124   000025   +10
LOWU.01.01    000006   000046    000052    000006   000072   000026   -11.53
LOWU.01.02    000002   000053    000039    000014   000053   000000   +35.89
________________________________________________________________________________
```

Figure 15: **General Inventory Report**

```
********************************************************************************
LOWU   01.**  L.BEARING OUTER WALL
********************************************************************************
________________________________________________________________________________
Start Date:  15.12.90    Dpt.Code:****  Prj.Code:****
________________________________________________________________________________
________________________________________________________________________________
RC.NO. COMPO DD.MM.YY INVEN ENTRY DEPT EXIT      PROJ  EXPLANATION         STOCK
________________________________________________________________________________
00001  01.01 15.12.90    0    13 QQQQ   11      XXXX  NO DAMAGE               2
00002  01.02 15.12.90    0    14 QQQQ   10      XXXX  NO DAMAGE               4
00003  01.01 16.12.90    2     8 QQQQ    9      YYYY  NO DAMAGE               1
00004  01.02 16.12.90    4    13 QQQQ    9      YYYY  NO DAMAGE               8
00005  01.01 17.12.90    1    11 QQQQ    9      XXXX  NO DAMAGE               3
00006  01.02 17.12.90    8    12 QQQQ   17      YYYY  NO DAMAGE               3
00007  01.01 18.12.90    3    20 QQQQ   17      XXXX  NO DAMAGE               6
00008  01.02 18.12.90    3    16 QQQQ   17      YYYY  NO DAMAGE               2

TOTAL                    :   107        99                                    8
________________________________________________________________________________
COMMANDS:Add  Delete  Select  Viev  More  Print  Help  Update  Return
________________________________________________________________________________
```

Figure 16: **Inventory Report Filtered by Project**

```
********************************************************************************
LOWU   01.**  L.BEARING OUTER WALL
********************************************************************************
________________________________________________________________________________
Start Date:  15.12.90    Dpt.Code:****  Prj.Code:XXXX
________________________________________________________________________________
________________________________________________________________________________
RC.NO. COMPN DD.MM.YY INVEN ENTRY DEPT EXIT      PROJ EXPLANATION          STOCK
________________________________________________________________________________
00001  01.01 15.12.90    0    13 QQQQ   11      XXXX NO DAMAGE                2
00002  01.02 15.12.90    0    14 QQQQ   10      XXXX NO DAMAGE                4
00005  01.01 17.12.90    1    11 QQQQ    9      XXXX NO DAMAGE                3
00007  01.01 18.12.90    3    20 QQQQ   17      XXXX NO DAMAGE                6

TOTAL                    :    58        47                                   11



________________________________________________________________________________
COMMANDS:Add  Delete  Select  Viev  More  Print  Help  Update  Return
________________________________________________________________________________
```

Figure 17: **Tabular Schedule Report**

```
*******************************************************************************
COMBINATION CODE:AAAA                                      START DATE   : 01JAN91
REPORT CENTER    :ITU FACULTY OF ARCH.      ***            FINISH DATE  : 26JAN91
REPORT TYPE      :TABULAR REPORT                           PAGE         :      01
*******************************************************************************
_______________________________________________________________________________
ACT  PROJ  ORG  ACTIVITY       PLAN   EARLY     LATE      EARLY     LATE      TTL
NUM  CODE  DUR  DEFINITION     TYPE   START     START     FINISH    FINISH    FLO
_______________________________________________________________________________
001  XXXX    2  PANEL MONTAGE  ST-1   09JAN91   10JAN91   11JAN91   12JAN91     2
                Workday        A-01   9         10        11        12
002  XXXX    2  PANEL MONTAGE  ST-2   11JAN91   12JAN91   13JAN91   14JAN91     2
                Workday        A-01   11        12        13        14
003  XXXX    2  PANEL MONTAGE  ST-1   11JAN91   12JAN91   11JAN91   12JAN91     0
                Workday        B-01   11        12        11        12
004  XXXX    2  PANEL MONTAGE  ST-2   13JAN91   14JAN91   13JAN91   14JAN91     0
                Workday        B-01   13        14        13        14
005  YYYY    3  PANEL MONTAGE  ST-1   19JAN91   21JAN91   21JAN91   23JAN91     2
                Workday        B-01   19        21        21        23
006  YYYY    3  PANEL MONTAGE  ST-2   22JAN91   24JAN91   24JAN91   26JAN91     2
                Workday        B-01   22        24        24        26
007  YYYY    3  PANEL MONTAGE  ST-1   21JAN91   23JAN91   21JAN91   23JAN91     0
                Workday        A-01   21        23        21        23
008  YYYY    3  PANEL MONTAGE  ST-2   24JAN91   26JAN91   24JAN91   26JAN91     0
                Workday        A-01   24        26        24        26
_______________________________________________________________________________
```

Figure 18: **Barchart Schedule Report**

```
*******************************************************************************
COMBINATION CODE:AAAA                                      START DATE   : 01JAN91
REPORT CENTER    :ITU FACULTY OF ARCH.       ***           FINISH DATE  : 26JAN91
REPORT TYPE      :BARCHART-EARLY-PLANNED                   PAGE         :      01
*******************************************************************************
_______________________________________________________________________________
ACT  ACTIVITY              PROJ PLAN ACT
NUM  DEFINITION            NAME TYPE DUR                              Press Enter
_______________________________________________________________________________
001  PANEL MONTAGE ST-1 XXXX A-01  2 *......+.EE...+......+......+......+......+
002  PANEL MONTAGE ST-2 XXXX A-01  2 *......+...EE.+......+......+......+......+
003  PANEL MONTAGE ST-1 XXXX B-01  2 *......+...EE.+......+......+......+......+
004  PANEL MONTAGE ST-2 XXXX B-01  2 *......+.....EE......+......+......+......+
005  PANEL MONTAGE ST-1 YYYY B-01  3 *......+......+....EEE......+......+......+
006  PANEL MONTAGE ST-2 YYYY B-01  3 *......+......+......+EEE...+......+......+
007  PANEL MONTAGE ST-1 YYYY A-01  3 *......+......+......EEE....+......+......+
008  PANEL MONTAGE ST-2 YYYY A-01  3 *......+......+......+..EEE.+......+......+
_______________________________________________________________________________
CALENDAR DATES                       01JA91 08JA91 15JA91 22JA91 29JA91 05FE91
_______________________________________________________________________________
```

Figure 19: **Planned Assembly Report Organized by Component Type**

```
******************************************************************************
COMBINATION CODE:AAAA                                  START DATE   : 01JAN91
REPORT CENTER    :ITU FACULTY OF ARCH.      ***        FINISH DATE  : 26JAN91
REPORT TYPE      :ASSEMBLY PROFILE-EARLY-PLANNED       PAGE         :      01
******************************************************************************
------------------------------------------------------------------------------
COMPONENT TYPE   :LOWU.01.01    PROJECT CODE  :****        PLAN TYPE     :   ****
------------------------------------------------------------------------------
10        *......+......+......+......+......+......+......+......+......+
9         *......+...EE.+......+......+......+......+......+......+......+
8         *......+...EE.+......+......+......+......+......+......+......+
7         *......+.EEEE.+......+E.....+......+......+......+......+......+
6         *......+.EEEE.+......EE.E...+......+......+......+......+......+
5         *......+.EEEE.+......EEEEE .+......+......+......+......+......+
4         *......+.EEEE.+......EEEEEE.+......+......+......+......+......+
3         *......+.EEEE.+......EEEEEE.+......+......+......+......+......+
2         *......+.EEEEEE....E.EEEEEE.+......+......+......+......+......+
1         *......+.EEEEEE....EEEEEEEE.+......+......+......+......+......+
------------------------------------------------------------------------------
DATES     01JA91 08JA91 15JA91 22JA91 29JA91 05FE91 12FE91 19FE91 26FE91 05MA91
------------------------------------------------------------------------------
```

Figure 20: **Planned Cumulative Assembly Report Organized by Component Type**

```
******************************************************************************
COMBINATION CODE:AAAA                                  START DATE   : 01JAN91
REPORT CENTER    :ITU FACULTY OF ARCH.      ***        FINISH DATE  : 26JAN91
REPORT TYPE      :CUMULAT.ASSEMBLY PROFILE-EARLY-PLANNED  PAGE      :      01
******************************************************************************
------------------------------------------------------------------------------
COMPONENT TYPE   :LOWU.01.01    PROJECT CODE  :****        PLAN TYPE     :   ****
------------------------------------------------------------------------------
100       *......+......+......+......+......+......+......+......+......+
90        *......+......+......+......+......+......+......+......+......+
80        *......+......+......+......+......+......+......+......+......+
70        *......+......+......+....EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
60        *......+......+......+..EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
50        *......+......+......+EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
40        *......+......+......EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
30        *......+....EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
20        *......+...EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
10        *......+..EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
------------------------------------------------------------------------------
DATES     01JA91 08JA91 15JA91 22JA91 29JA91 05FE91 12FE91 19FE91 26FE91 05MA91
------------------------------------------------------------------------------
```

Figure 21: **Updated Assembly Report Organized by Component Type**

```
*******************************************************************************
COMBINATION CODE:AAAA                                    START DATE   : 01JAN91
REPORT CENTER    :ITU FACULTY OF ARCH.        ***        FINISH DATE  : 26JAN91
REPORT TYPE      :ASSEMBLY PROFILE-EARLY-UPDATED         PAGE         :      01
*******************************************************************************
-------------------------------------------------------------------------------
COMPONENT TYPE   :LOWU.01.01   PROJECT CODE  :****       PLAN TYPE     :   ****
-------------------------------------------------------------------------------
50        *......+......+......+......+......+......+......+......+......+......+
45        *E.....+......+......+......+......+......+......+......+......+......+
40        *E.....+......+......+......+......+......+......+......+......+......+
35        *E.....+......+......+......+......+......+......+......+......+......+
30        *E.....+......+......+......+......+......+......+......+......+......+
25        *E.....+......+......+.... .+......+......+......+......+......+......+
20        *E.....+......+......+......+......+......+......+......+......+......+
15        *E.....+......+......+......+......+......+......+......+......+......+
10        *E.....+......+......+.E....+......+......+......+......+......+......+
5         *E.....+......+......+.EEE..+......+......+......+......+......+......+
-------------------------------------------------------------------------------
DATES     01JA91 08JA91 15JA91 22JA91 29JA91 05FE91 12FE91 19FE91 26FE91 05MA91
-------------------------------------------------------------------------------
```

Figure 22: **Updated Cumulative Assembly Report Organized by Component Type**

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*******************************************************************************
COMBINATION CODE:AAAA                                    START DATE   : 01JAN91
REPORT CENTER    :ITU FACULTY OF ARCH.        ***        FINISH DATE  : 26JAN91
REPORT TYPE      :CUMULAT.ASSEMBLY PROFILE-EARLY-UPDATED PAGE         :      01
*******************************************************************************
-------------------------------------------------------------------------------
COMPONENT TYPE   :LOWU.01.01   PROJECT CODE  :****       PLAN TYPE     :   ****
-------------------------------------------------------------------------------
100       *......+......+......+......+......+......+......+......+......+......+
90        *......+......+......+......+......+......+......+......+......+......+
80        *......+......+......+......+......+......+......+......+......+......+
70        *......+......+......+....EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
60        *......+......+......+..EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
50        *......+......+......+.EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
40        *EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
30        *EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
20        *EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
10        *EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
-------------------------------------------------------------------------------
DATES     01JA91 08JA91 15JA91 22JA91 29JA91 05FE91 12FE91 19FE91 26FE91 05MA91
-------------------------------------------------------------------------------
```