Chapter 7

3RM: a spatial relational reference model

M. deJong

7.1 Introduction

In this chapter we hope to provide the reader with an impression of the objective, framework and possibilities of 3RM in the construction industry.

In Dutch, 3RM stands for 'Ruimtelijk Relationeel Referentie Model' (Spatial Relational Reference Model). The model could begin to be used as an information-bearer in the building industry within which the specific trade information for each of the building participants could be interrelated, including drafting symbolism, building costs, physical qualities and building regulations. In this way, the model can be used as a means to a more efficient running of the building process and enabling the integration of information, at project level, provided by various building participants.

The project should be defined in the same way as is a typical architectural project, whereby the actual development as well as the project management is carried out by architects. For the time being, development is limited to integral use at the design stage, but it also offers sufficient expansion possibilities to be able to function as a new communications model throughout the complete building process.

We shall first provide information as to the origin, the objective and the execution of the project. Thereafter, we shall attempt to state the theoretical information problem within the building industry and the solution to this offered through 3RM. Finally, we shall report upon the results of the first phase of the 3RM project.

7.2 The origin of 3RM

In June 1984 the BNA (the Dutch equivalent of the British RIBA) organized for its members a discussion afternoon with the theme 'Integral Design with the Aid of the Computer'. The subject of discussion was the feasibility study carried out by the firm 'Metaform' with regard to the development of its own software requirements. As a result of this meeting the BNA was approached by several architectural practices that wished to be involved in developing these programs.

After two meetings of this group, it had been determined that the necessary program could best be developed from within the professional discipline, utilizing the expertise available in this field. This would have the advantage of a greater guarantee for the linking of a development to the requirements of the designers due to the developers themselves being building experts with much knowledge in the field of building information theory. Further, this could prevent the valuable experience gained so far being drawn off to software firms, and thus less influence exerted upon the eventual utilization and further development of the system.

With regard to the latter, one should consider the considerable erosion to which the architectural profession has been subjected in the last few years whereby, in particular, advisors in the field of project management, construction costing and environmental physics have taken over much of the architect's activities. It is feared that if the architect does not master automation in the building industry, the erosion process shall continue, resulting in a restriction of tasks and a reduction in employment. It will be clear, then, that automation must be grasped with both hands as an instrument for raising the level of this branch of the industry.

It is for this purpose that a group of four architectural practices, the BNA and the NEHEM have set up the 3RM project. These practices represent a reasonable cross-section of the professional group, each with different experience in the field of automation *(Figure 7.1):*

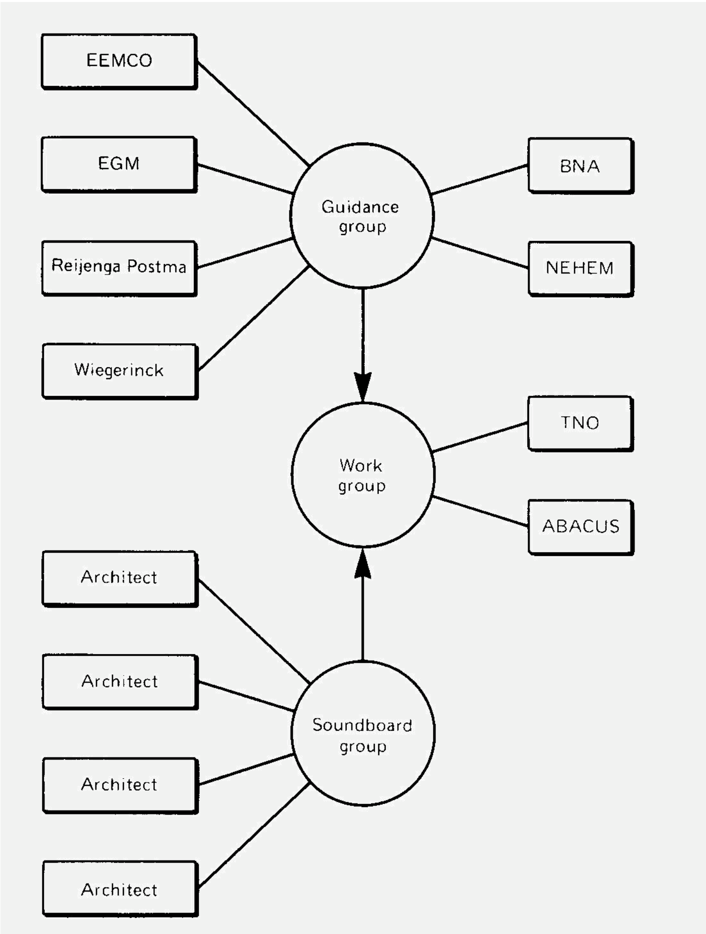

Figure 7.1.

(1) The firm of Eemco in Soest is a cooperative association of three smaller architectural practices together with a landscape architect, who together use an Intergraph system.
(2) EGM Architects is a large architectural practice in Dordrecht with experience in the field of design evaluation and building administration. To this end, a Burroughs mainframe computer, the ABACUS programs GOAL and BIBLE (Vista), and several self-developed programs are used.
(3) Reijenga Postma BV is a medium-sized architectural practice where administrative matters and production drawings are almost entirely processed and produced on microcomputers. For this, Corvus and IBM microcomputers, the drafting program ARCOS and selfdeveloped software is utilized.
(4) The firm of Wiegerinck is a medium-sized architectural practice which for some considerable time has been orientating itself in CAD systems but was unsuccessful in finding a suitable system.

In addition to these four practices, the BNA and the NEHEM play an important role:

(5) The BNA is a representative and intermediary between the project and the profession; and
(6) The NEHEM (a consultancy specializing in restructuring branches of industry) provides for project coordination with regard to the financing and marketing of the results of the project.

For the execution of the project a cooperative association was formed within which architects, who possibly only become interested in the project later on, may take part. The execution of the project is performed through a working group consisting of a project leader and two programmers who have been delegated from the existing personnel of the initiating firms. Furthermore, a 'sounding-out' group was set up, comprising a selected group of architects and practices with experience in the field of automation, which will be requested to appraise the results of the project.

During development, further use was made of the knowledge of both TNO (a large research institution in the Netherlands) and ABACUS, of whom regular comment was requested with regard to the actual development.

Due to the architects themselves being unable to fund such a development, a government subsidy was applied for. Thanks to the award of a subsidy from the Ministry of Housing, Urban Planning and Environmental Control, the first phase of the project, namely the development of a prototype 3RM, could commence.

7.3 Objective of the project

The objective of the 3RM project is the development of a methodology and a program which would enable the architect in a relatively short time to enter a building design, in the form of an abstract digital model, into the computer and to subsequently allow the use of the input model for various exercises and applications. The model must further contain information relevant to the application in order that optimum use can be made of all existing software. *(Figure 7.2).* Therefore the project adds to existing developments and does not eliminate or replace them.

Although the development is primarily directed to use in the design stage, it should, however, be possible to use the input model as a basis for the consequent production process within as well as outside the architectural practice.

Because the model functions as a communication model to aid the existing software, it also offers more up-to-date possibilities in the performance of the communication process in the building industry. The model may thus be compared to a hat-stand whereby the information from the various participants may be 'hung up' or 'collected'.

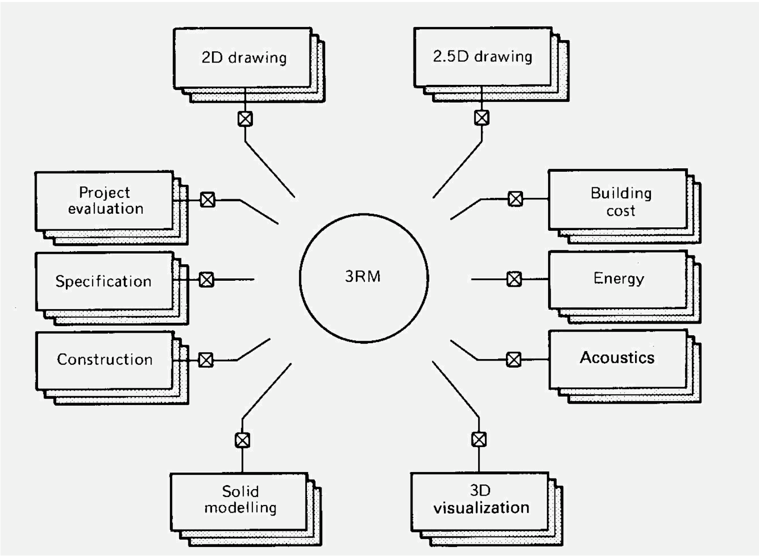

Figure 7.2.

7.4 Accomplishing the objective

In order to achieve the objective it is necessary to have a model at one's disposal which contains all the information on the applications. Experience with various automation aids has shown that such a model is not required to have all these data physically within it but that reference can be made to this information at a higher level. Therefore information bearers have been introduced on four levels.

It has become evident that constructional information can always be referred to as an abstract information bearer in a certain dimension. A temperature is a typical spatial factor, a heat resistance is a typical surface factor, a connection detail is a typical linear factor whilst a building junction is a typical location factor.

With the four basic types an abstract model will be built up with a three-dimensional data structure. This is because the model represents reality, and reality is three-dimensional. Experience with two-dimensional and 2.51) techniques has shown that by such means a sufficient three-dimensional model can never be assembled and that the assembly is extremely time-consuming. The step from three to two-dimensions is more obvious than vice versa.

As an example, to relocate a window frame in an elevation, in a two-dimensional system this must be done three times; once in plan, once in cross-section and once in elevation. In a three-dimensional model, this can be achieved in a single action. The data structure must be three-dimensional, but in the making of this structure, two-dimensional and 2.51) techniques could be used, especially considering that the input medium, the monitor, is two-dimensional. As the final condition for the realization of the objective, the relationship between the building components will be established because it has become evident that, based upon the relationship of the building components, more may be determined as to the necessary input for the application.

If, for instance, two different areas adjoin, they can set conditions regarding the qualities of the construction of their partition or influence the type of partition (elevation or internal wall). The determining of these relationships offers the possibility of developing expert systems for the building industry because more is known from the relationship about the significance of the relationship and therefore, for similar relationships, the significance does not requires to be determined anew.

7.5 The 3R-model

The 3R-model is defined as a collection of entities of which the mutual relationship, as well as the type of relationship and the geometric qualities of each, is known. An entity represents a constructional function, such as a living room, a partition wall or a connection line. A constructional function can always be represented as an entity of the type space, surface, line or location.

Each entity comprises two types of qualities:

(1) The model-qualities in the sense of relationships with other entities and geometric qualities within the model; and
(2) The qualities outside the model that may be referred to the entity.

The external qualities can have a bearing on the graphic representation of the entity. These are physical qualities such as weight and heat resistance, calculation conditions, minimum and maximum values, regulations, descriptions, costs, etc. All these qualities can, during the running of a project, acquire another significance and may be used by each participant in a different way. The initial starting point is that the external qualities of the model remain stored with the building participants and that the model will be exchanged between the participants.

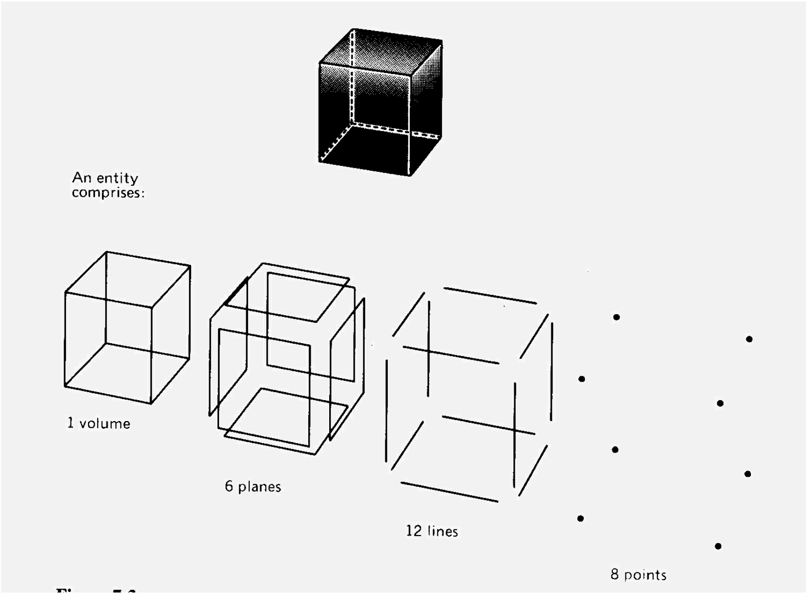

Figure 7.3

To make all of this possible it is necessary to develop a universal classification system for constructional information in order to work with a code. If such a code does not exist, a file containing all cross-reference codes (pointers) to the external files would suffice.

Figure 7.4 indicates how the model could be used as a communications model in the building industry whereby, in each phase, each participant can contribute his information to the model or withdraw information from it.

7.6 Results of the prototype phase 3RM

The aim of the first phase of 3RM was the development of a prototype for a model teaching program through which the developers, on the one hand, could gain an insight as to whether their ideas were realizable, whether it was possible for such software to be implemented on microcomputers and whether the ideas could gain more theoretical support. On the other hand insight could be given to others as to what would eventually require to be developed.

This phase has now reached a successful conclusion, and action is currently being taken to achieve financing for the complete project.

The first phase has resulted in a report containing a description of the theoretical support and arguments upon which 3RM is based, and a prototype program with which it is possible to compile a 3RM model

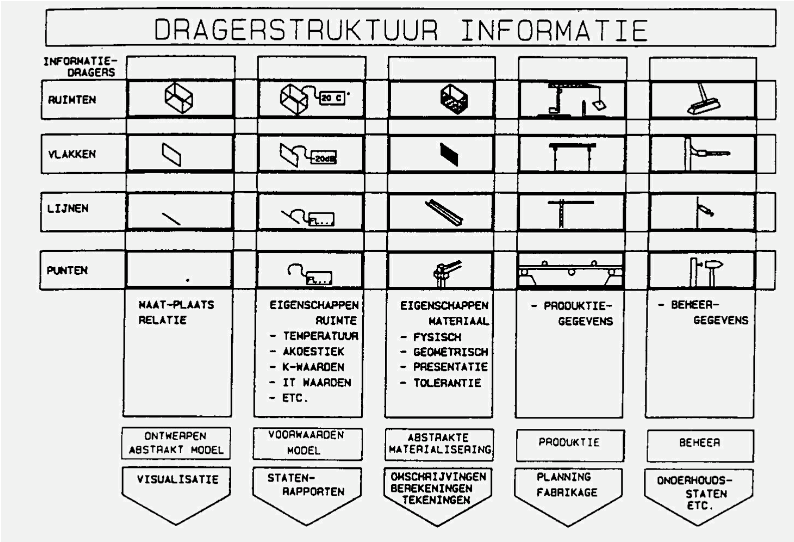

Figure 7.4

structure. For this purpose, the program makes use of a command file which can be compiled in three different ways: interactive graphically, alphanumerically and with the help of a text-editing system. The model structure is calculated by means of this command file.

The assembled model gives information regarding geometric qualities such as total volume of the building, surface areas, etc. In addition, a crosssection of the model can be made for two-dimensional drafting program systems, with which the model, with the aid of that system's symbols, can be graphically represented. A third possibility is to make a shaded picture with the help of TNO's software. Furthermore, TNO has carried out research into the calculation methods to help with the consistency of the model.

Although the number of possibilities of the prototype is limited, this sufficiently illustrates what 3RM could mean for the building industry.