A MODEL OF CONSTRUCTION PLANNING PROCEDURE ACCORDING TO CONTINGENCY THEORY

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In construction operations uncertainty conditions interact strongly with the risk of non-conformance to the performance (quality, time and cost) required.

In designing organizational structure and management strategies most construction systems do not take enough account of environmental influences and choose a management and control system fit for a certain, deterministic process. Ironically, we may observe the way that environmental turbulence and technical uncertainty, which should require a flexible, dynamic and responsive organizational structure, most of the time actually cause all construction process operators to provide the opposite, a mechanical organization according to traditional .

The paper aims to define a basic planning procedure for designing efficient organizational structures in a turbulent environment like building constructions, appropriate for quality management according to ISO 9000 and TQM management principles.

The Contingency Theory by Lawrence and Lorsch is particularly suitable as the basis for designing reliable and efficient organizations structured in relation to the environment in which they operate.

A planning procedure model is proposed placing the planning at the centre, not only because of its technical performance, but above all for its capacity to integrate and structure human and social relationships, as well as technical and temporal ones: the same planning procedure constitutes the first integration device.

The proposed model can be also useful for understanding and implementing innovative construction management processes like concurrent engineering and partnering..

Keywords: contingency, planning procedure, uncertainty.

INTRODUCTION

The characteristic of uniqueness and the non-repeatability of the building product and the nomadic character of the building site have been historically used to sustain the argument of necessary weakness in every prediction, preparation or planning activity. However, a building process aimed at achieving quality needs a high level of prediction and activity planning, a deep understanding of the ways of producing product quality, and a participation of all the operators involved in whatever role to achieve the specific building objective (Mecca 1994).

Certainly the marked variability of the product and of the building market determine a very divided environment, typified by a high degree of uncertainty and therefore require the adoption of suitable organizational strategies that follow the steps of the identification of organizational structures, integration and controlling devices of the

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whole building "project" able to combat the structural uncertainty of the building sector, inducing a self-controlling behaviour, prerequisite for achieving reliability and efficiency on the level of quality, time and costs (Mecca 1996). The planning procedure proposed by PMI is founded on the hierarchical breakdown of the project into elements and operations. This procedure is developed within the theory definable as Scientific Management that in organizational studies is held to be inadequate and insufficient for the planning and management of productive processes in conditions of great uncertainty.

According to the principles of Total Quality Management "a successful organization will be skilled at developing and applying a range of appropriate systems, improvement tools and techniques" (British Standards Institute 1992). In building processes, in which the technological components of the transformation process is determinant, the organizational action can be orientated to give priority to the relationship between structure and technology, to the set of interdependencies between the process components (Thompson 1967). In other words, the organizational structure is the fundamental means for achieving a condition of "limited rationality" (Simon 1969), in that, on the one hand it identifies the limits of its components actions and therefore of reasonable expectations of efficiency results, and on the other determines the co-ordination conditions between these interdependent actions.

WHY A NEW SCHEME OF PLANNING PROCEDURE?

Growing uncertainty and market competitiveness, also in the building sector, accentuates interest in organizational innovations, that are typified by their effectiveness and economic viability compared to other innovations. The very orientation on the qualifications and certification of firms solicits organizational structure innovations aimed at increasing the effectiveness and efficiency of the production process (Coda 1989).

Building construction operators work in particularly accentuated and intense conditions of environmental turbulence because of uncertainties from the external environment (insufficient understanding of the cause-effect relationships of phenomena and contingency of external actions) and from the internal environment made up of a project that activates a non-repeatable and nomadic building site, technically and organizationally highly complex with respect to the amount of work (high degree of interdependence between the process components). Also in "project management" the assumption of uncertainty conditions has induced the development of project organizational models geared to anticipation management, (Giard 1992, Bobroff 1993, ECOSIP 1993) understood both as anticipated reliable information acquisition on the project, and as operator motivation and attitude to reacting on the basis of available information, that also can be useful in planning the building site.

Building a new approach to planning procedure requires understanding the impact of current controls and assuring that the planning system itself is under control. The performance of planning systems cannot be controlled until their underlying criteria are made explicit. While attention has traditionally been focused on the quality of initial schedules, we propose that control of planning processes begins with the assurance that assignments meet specific quality requirements, i.e. sequence, size and workability. Monitoring and acting on reasons for failing to complete assignments improves the processes for selecting assignments, and the processes for creating and maintaining a backlog of workable assignments from which to select. Applying this

same control process to every level of the planning system leads to continuous improvement in system performance and the assurance that project management is making the best decisions possible in the circumstances (Koskela 1992).

The planning of the organizational structure has to aim at the reliability of the process (understood as the capacity to absorb stochastic disturbance) both from the economic point of view and from that of product quality. The plan is the main tool able to assure the maximum reliability level of the project. In organizational model analysis, the organizational planning model deriving from the "Contingency Theory" of Lawrence and Lorsch (Lawrence, Lorsch 1967) should be indicated. In organizational model analysis the "contingent" organizational planning model is particularly useful, placing the programme at the centre of the process, not only for its technical performance, but above all for its capacity to integrate and structure human and social relationships as well as technical and temporal ones. The Contingency Theory considers the environment segmented into sectors typified by varying degrees of uncertainty. From the degree of uncertainty/diversity emerge the differentiation requirements of the functional units or subsystems, the influence relationships among the said functional subsystems, and among the organizational levels as well as among the integration and conflict solution devices.

A contingency approach implies that the very pertinence of a management technique does not only depend on its inherent qualities, but also on the way they can structure the social relationships in which they operate in relation to the specified technology. The organizational methods and the same tools vary if a project organizational logic is assumed instead of a single operator organizational logic. On the basis of these considerations it is necessary to closely examine the planning procedure most suitable to the specific environment and within this the relationship between structure and technology of the production processes.

HOW TO DESIGN AN ORGANIZATIONAL STRUCTURE ACCORDING TO THE CONTINGENCY THEORY

An organizational structure and its own planning procedure, should therefore have among its priorities, the aim of defining process subsystems that allow a capacity to act positively, producing and controlling the results for it, also integrating traditional control models into a new strategic structure. The Lawrence and Lorsch "Contingency Theory" model considers the environment not as a global entity, but subdivided, segmented in sectors (corresponding in a functional structure to the main functions or subsystems of the production system) typified by a varied degree of uncertainty. The degree of uncertainty/diversity of a system's environment determines the differentiation requirements of the units or functional subsystems and the integration requirements.

The organizational behaviour of a system is qualitatively satisfactory and therefore produces results (in terms of productivity, profitability, levels of individual satisfaction and individual and group development) if the states of differentiation and integration are coherent with the nature of the environment and that of the primary tasks. The workability of this paradigm depends in the first place on the possibilities of correctly defining differentiation and integration requirements emerging from the environment and the primary tasks and from the possibility of defining and activating the integration devices and of solving the conflicts necessary to achieve the states previously determined.

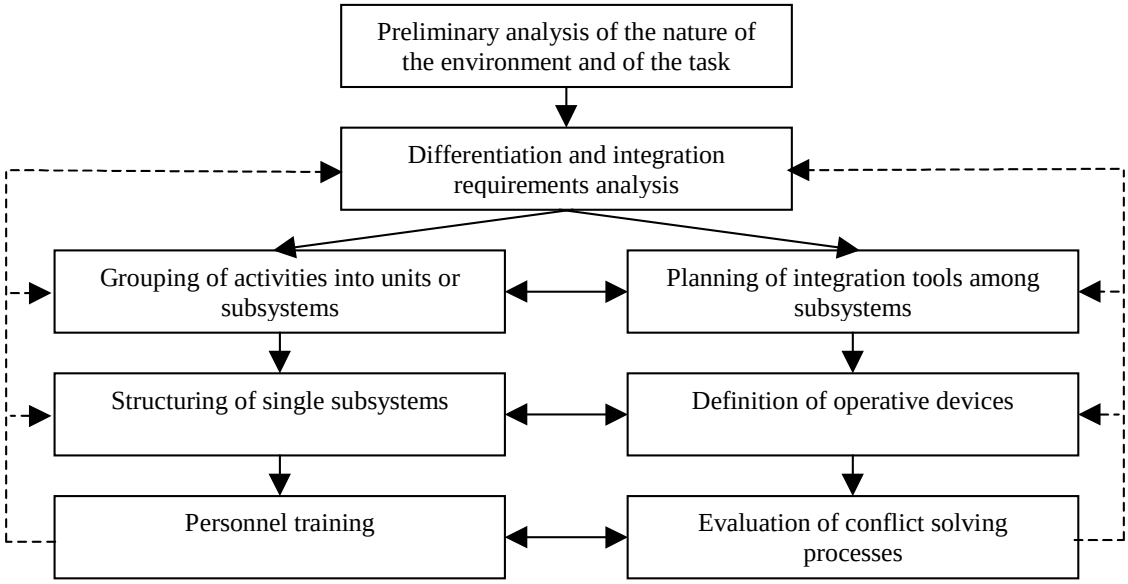

Figure 1: Scheme for the planning of an organizational structure

The realization of both the actions, tending to be antagonistic, can arise through two available tools:

- *integration devices*, consisting in management hierarchy, in formal programmes and controls or in other devices as co-ordinators, inter-functional work groups, entire co-ordinating subsystems (Thompson 1967, Mecca 1996): in production processes for projects it is the project management plan that constitutes the main integration device.
- *the conflict solving among groups model*, whose elements are the distribution model of influence and power in relevant decision-making across the hierarchical ladder, the degree of congruence between formal authority and competence authority and control of the understanding and information necessary for the decision, the method used for solving the conflict.

Lorsch (Lorsch 1970) to define structural planning in operating terms, suggests a planning operations sequence model, a procedure “scheme” to deal with the negotiated planning of the organizational structure. After having effected the activity of preliminary analysis of the nature of the environment and the tasks and having defined a theory of differentiation and integration requirements, the phases (figure 1) can be identified as follows:

- *grouping of activities into units or subsystems:* Applying the differentiation and integration principles those units that need a low degree of differentiation and a high degree of integration should be grouped together.
- *planning of integration tools among subsystems.*
- *structuring of single subsystems.* Specific operative devices are defined conforming to the task assigned to the subsystem and to the requirements of the individuals who operate them.
- *-definition of the operative devices applied to the whole system.*

- *evaluation of the conflict solving processes.* The basic structure and integration devices influence the conflict solving processes that arise between the parts of the system.
- *personnel training.* With training, apart from the technical aspect, motivation and behaviour, in case of conflict, is influenced.

WHAT IS INNOVATIVE FOR PROJECT PLANNING?

The model proposed by Lorsch places the planning at the centre, not only because of its technical performance, but above all for its capacity to integrate and structure human and social relationships, as well as technical and temporal ones: the same planning procedure constitutes the first integration device. The innovative elements with respect to a classic procedure are:

- the division into two hierarchical levels of the organizational structure: a first level made up of the set of subsystems or complex building phases (sequences) and of the relative interfaces, a second level made up of the individual building phases;
- the analogous division into two levels of the "integration devices" being operative programmes and control plans;
- the specific organizational action on the interfaces between the sequences;
- the organizational contingency of each complex building phase corresponding to a responsibility and autonomy of the operator within the basic programme;
- rendering each operator responsible on the basis of his own operative results and of the consequences on the whole project by means of formal acceptance;
- the relevance of training and information to operators;
- planning of the building site as the result of a transaction, of an orchestration among operators leading to their identification with a system of objectives and sub-objectives coherent with the structure of responsibility and controls.

In particular the organizational hierarchy, not only technical, of the programme allows a condition of "limited rationality" to be pursued for the building site operators: the identification of process sequences and interfaces as the basis of the organizational structure signifies identifying sub-objectives that constitute certain limits to the operators' actions, in other words a horizon for reasonable expectations of efficiency results, of co-ordination with other interdependent operators, of control and of self-control on the conformity of results.

TRANSFERRING THIS INNOVATION IN PROJECT PLANNING PROCEDURE SCHEME

When can we apply the contingency theory scheme?
Obviously planning procedure of the organizational structure of a building site is conditioned by:

- the phase of the process into which it is inserted, for example, if it is aimed at the formulation of a contract offer or at the planning of the building site production process;

- the organizational structure of the firm or system of the firms undertaking the work;
- time and technical tools available for analysis and planning. In particular, the drawing up of a complete organizational project for a building site requires a consistent amount of resources, often to be used in limited time, often overlapping with other contractual commitments, in particular if aimed at the formulation of a contract offer.

For the definition of a basic scheme it is therefore useful to suppose that, within an already defined contractual situation, the preparation phase of the construction process with an adequate duration and successive identification of direct and indirect building site operators, conforming to the Quality Management procedure, have all been programmed.

What can be a contingency theory scheme for planning procedure?
Developing Lorsch and Lawrence's (1970) proposals, a planning procedure scheme for a building process can be delineated, divided into the following phases:

Phase 1: Analysis and checking of the offer and contractual conditions. This first preliminary phase is aimed at the definition of all the contractual conditions that could make up constraints for the drawing up of the organizational project, on both the technical constructional and the temporal and economic levels.

Phase 2: Analysis of the contextual conditions of the building site, accessibility, infra-structural constraints, local and municipal regulations, climatic data. This second preliminary phase is aimed at the definition of all the technical conditions determined both by natural and resources market conditions, carefully analysing what effects they could have on building operations. In this phase risks for the overall development of the building site can be analysed and assessed and thus identify the building operations at risk because of environmental and organizational factors.

Phase 3: Identification of building conditions, interfaces, technical priorities. The first operation in the construction planning procedure is the breaking down of the project into elementary operations to obtain the definition of a list of operations, preferably in a logical-technical sequence. This phase is traditionally solved by the drafting of a Work Breakdown Structure (WBS). On the basis of an initial WBS the differentiation criteria and the related technical and organizational interfaces can be identified and on these develop an analysis of the technical and organizational interdependence relationships that they generate among the operators. This can lead to the identification of Work Packages that can be defined in terms of results of time, costs and value produced, and in terms of resources (technical and information), of their availability and of the process of transformation, as a theory of project structure. This operation enables a synthetic evaluation of the length of the process, the proposal of an initial time span and the identification of the linking up of probably critical activities.

Phase 4: Definition of the organizational structure of the building process. In this phase the definition of the organizational structure on the basis of the building process takes place, by means of the participation of the building process partners and the consensus of decisions. The operation consists of identifying the formation of building process subsystems that are most efficient on the level of interface simplification, delegating the operator/operators to undertake each activity, and therefore establishing the specific tasks assigned to them, their responsibilities, their hierarchical dependence

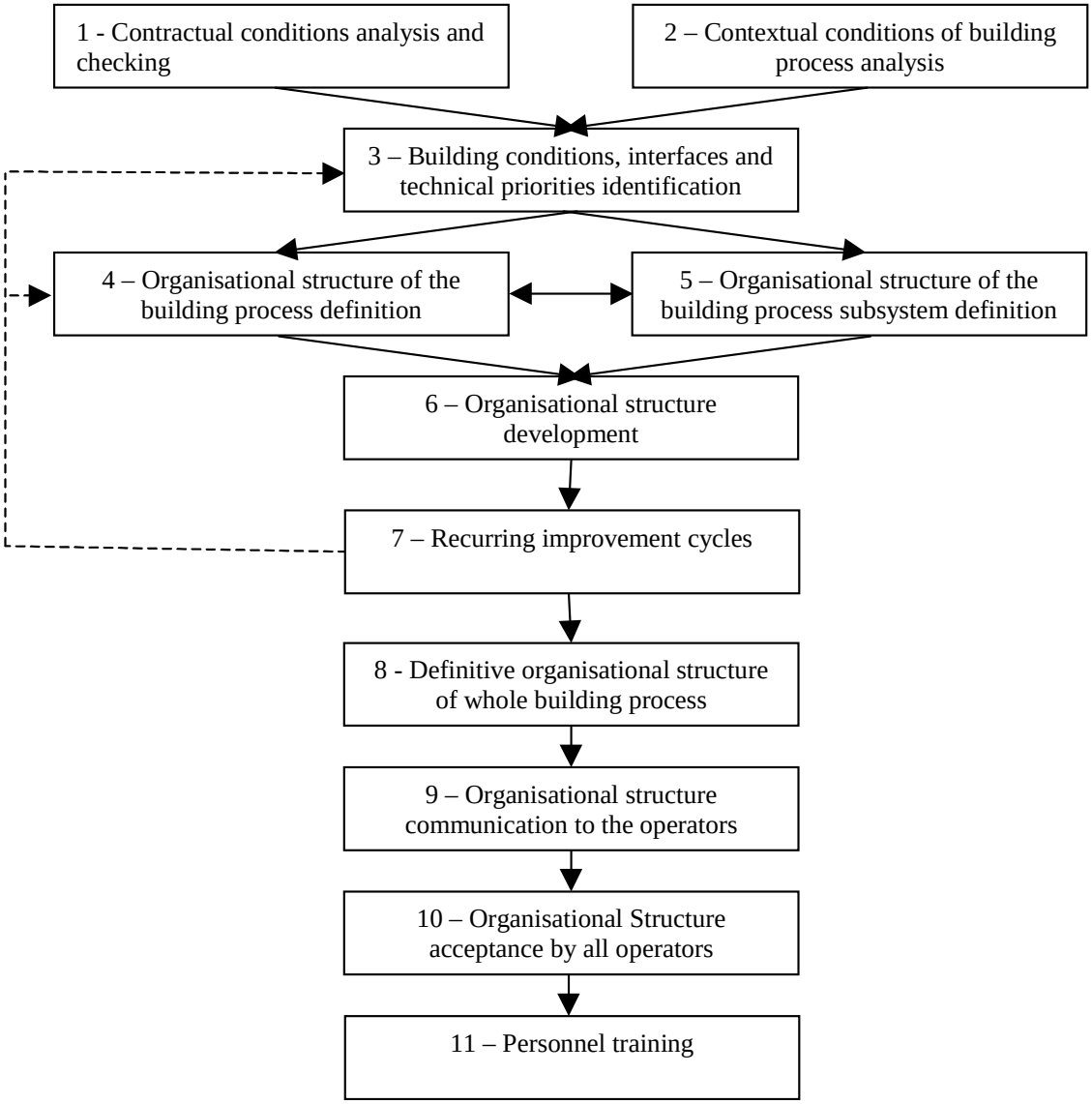

Figure 2: Planning procedure of the organizational structure of the building site according to the "differentiation and integration" model

in the organizational structure, the place units where the activity is carried out, the work control model and the conflict solving model, the information system and the flow of information.

Phase 5: Definition of the organizational structure of the individual subsystems or phases of the building process. The project of the basic organizational structure constitutes the strategy, the reference point in order that with the contribution of the operators involved, a project for the organizational structure specific, adapted and suitable to the tasks to be developed for each phase can be defined, and be made up of:

- the list of tasks assigned
- the organization chart and duty list of the operators
- a programme that thanks to the possibility of control on the part of the operator can aim at the optimum ordering of resources thus enabling the determination of:

    - the necessary resources for the execution of each activity, with special attention to:
    - human resources used, if necessary, procedure and interdependence analysis applied to the specific working context,
    - information resources necessary relative to the result to be achieved as well as to suitable production and control methods,
    - material and machine resources;
- the temporal division and duration of the determined activities, in particular by the human or mechanical resources identified;
- the specific priority constraints among the activities;
- the quality of the end results and/or intermediate results, the intermediate and end result procedures and modalities;
- the cost of each resource and overall cost of the phase;
- the place units of the activities to verify the divisibility and therefore the possible overlapping and linking up of the activities themselves.

Phase 6: Development of the organizational structure. The end of the preceding phase allows production of the first draft of the organizational project and of the elaboration of all the details (quality plan, technical-temporal plan, economic plan etc.) in communicable form to all the process operators involved.

Phase 7: Possible recurring improvement cycles for previous operations from phases 3 to 6. to improve the organizational structure and for the formation of adequate operator motivation it is opportune to set up programme verification and improvement procedures with the participation of all the operators.

Phase 8: Definitive project of the organizational structure of the building process and of each operator/subsystem. The end of the previous phase, the recurring cycles no longer being effective, allows the achievement of a final version of the building site organizational structure project, with the greatest degree of input from information resources, competence and participation of the process operators.

Phase 9: Communication of the organizational structure to the operators. The project, made up of the programmes and the whole graphic, procedural and tabular elaboration necessary for its reading and interpretation, must be formally communicated to all the involved operators, since its effectiveness also depends above all on its diffusion and the active participation of the operators involved.

Phase 10: Acceptance of the organizational project by all the operators. In some experimental processes the acceptance of the process plan or even of a single programme has proved to be of great importance in the pursuit of maximum building process effectiveness and efficiency

Phase 11: Training of personnel. A training and informing of personnel phase, preceding the start of building operations is indispensable for the maximum effectiveness of an organic organizational structure.

CONCLUSION

We may observe an ironic phenomenon in the way that environmental turbulence and technical uncertainty that should require a flexible, dynamic and responsive organizational structure, most of the time actually causes all the construction process operators to provide the opposite, a Tayloristic, mechanistic organization. The aims of efficiency, reliability and of systematic improvement that society demands of building process operators require an orientation of research towards new paradigms of building management. Tools are needed to understand and plan the complexity of processes, to develop innovative models of production process efficiency and reliability.

The Contingency Theory by Lawrence and Lorsch is particularly suitable as the basis for designing reliable and efficient organizations structured in relation to the environment in which they operate.

Several arguments need specific examination and could constitute interesting areas of research and experimentation. An initial issue is that regarding the criteria and tools for grouping building operations into subsystems, in building phases that when entrusted to an operator increase the reliability and efficiency of the process; the decision-making difficulty lies in the representation, interpretation and management of the multi-dimensional nature of building processes (technical, economic, temporal, information, but also social, psychological and human dimensions).

A second issue of great importance is that regarding the efficiency criteria with which to analyse and plan both the basic structure and the individual subsystems and, in particular, concerning the most efficient organization of human and technical resources within each phase of the building process to obtain higher levels of productivity.

A further relevant issue is that of the reliability of processes, of the efficiency of controls or rather of the control structure of the building process, in relation to the sequence of the building process operations and of the interdependencies between them.

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