

CONSTRUCTION ROBOTICS
STATE OF THE ART IN FRANCE

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SUMMARY

From the initial programmes launched in 1984 to the present situation, a lot of actions have been initiated in France in the field of construction robotics. This paper draws out the main lines of the background resulting from this seven years period and describes the present situation with emphasis on the technical trends and the organization of professionals interested in these developments.

Keywords : robotics, construction, France : state of the art, research, industrial projects, applications.

1. INTRODUCTION

The first research programme in construction robotics in France was launched seven years ago by the Ministry of Construction.

This programme consisted in a feasibility study which took mainly into account the Building construction activity.

In 1985, the SOFFITO project started with a grant by the French Ministry of Research. This programme led to the experimentation in 1987 of the first experimental mobile robot for Building construction in Europe.

In 1987, the French Ministry of Construction made a call for research proposals which allowed to support both feasibility studies and experimentations in the field of Building Construction.

The interest for robotics in other activities than Building construction came later. Between 1988 and 1989, a feasibility study concerning robotics for roads construction was carried out.

These initiatives and their follow-up now form a set of research programmes, most of which are regularly presented and discussed within a working committee.

We will examine briefly some of these programmes, emphasize the participation of the different kind of actors and draw out the future developments.

2. THE PROGRAMMES : OBJECTIVES AND FUNDINGS

We will not describe in detail all the research programmes which have been carried out during the seven past years. Some of them and their developments have already been presented during previous ISARC meetings ([1] to [12]) or are presented during this Symposium ([13] to [16]).

Table 1 presents a general chart of these programmes and of their fundings. None of these programmes has been developed without Public fundings coming either directly from the French Ministries (Construction, Research, Industry) or from the European Economic Communities.

Automation of handling operations has clearly been a favourite subject. One of the earliest programme concerns the automation of tower cranes. The POTAIN Company still

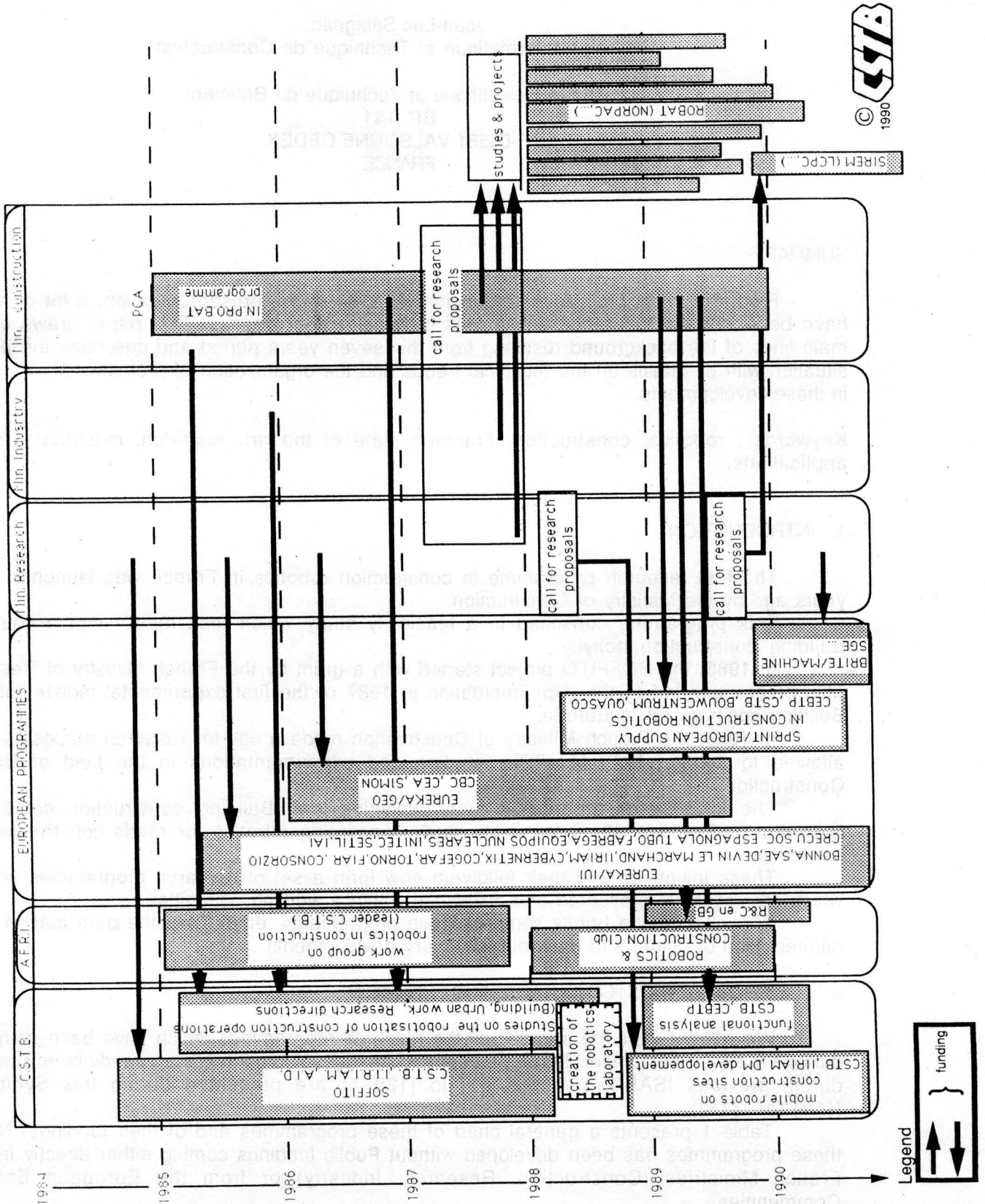


Table 1 : general chart of French programmes and their fundings

carries out development programmes with some contractors. From the early stage when an automaton was connected to the control unit of a tower crane and the more recent development of a computer controlled tower crane, many specific subjects have been studied such as the automatic slinging or the automatic positioning of a concrete bucket.

The automation of tower cranes is of the utmost interest for French contractors because of the major role played by this machine in our construction technologies. A significant reduction of manpower may be expected from these research works.

Other handling operations, such as horizontal movements, have also been considered. The aim of such projects is to improve the existing wheelbarrow. The economic interest of such a project will remain weak as long as the project will mainly consist in replacing the skill of the human operator by sensors and the related control units. It will become more interesting when construction techniques include features which will avoid either sophisticated sensors or the equipment of the environment.

The follow-up of the SOFFITO project has been an opportunity to carry out research works in this field [4], the applications of which will not be limited to operations on horizontal surfaces but also on vertical or tilted surfaces (façade cleaning).

Apart from the handling problems, the automation of the assembly of construction components will also influence their design. Preliminary studies have been carried out in laboratory and both contractors and components manufacturers are ready to go further in this direction. The objective of such a programme is to reduce the gap between the highly automated production process of some components (prestressed concrete panels, composite façade panels,...) and the traditional and poorly mechanized assembly process on site. The economic interest is high because of the potential reduction of man-power resulting from such developments.

3. ORGANIZATION AND TRENDS OF ACTIVITIES

Since 1984, a group has been active within the frame of the French Association of Industrial Robotics (A.F.R.I.). The names of this group have changed with time, but the important thing is that French professionals interested in the development of construction robotics now have a place where to meet and exchange ideas. Such a focal point allows the easy collection of information and the publication of booklets presenting these projects [17].

The present organization of this group consists in two subgroups. One is more interested in building activities applications and the other one in road construction applications.

As mentioned previously, the first subgroup mainly focusses on crane automation. The second subgroup is now interested in kerbstones and gutter placing. The objectives of these groups are to define research programmes corresponding to concrete needs of the participants. Therefore, the attendance at the meetings of these groups is rather small (about 10 to 12 persons), but this is a guarantee to gather motivated people. Such a light structure allows the creation of specialized subgroup as soon as needed.

Some other interesting projects are carried out out of these groups, most of the time with a contractor as a leading partner. These projects also consider the automation of handling processes as a favourite topic.

Both in the working group of A.F.R.I. and in these private projects (also supported by public fundings) participants wish a certain degree of confidentiality. This is fully comprehensible as far as no duplication of efforts is made.

The reflexion on constructability is also going on mainly in the field of the automation of the assembly of (building) components. An original solution has been proposed by a small contractor of the south of France. The proposed construction process has a high potential of automation and results from the application of the civil engineering technique (slipping forms) to building construction.

Though it is not strictly included in the construction process, the automation of cleaning activities forms the subject of some competitive programmes carried out by leaders in this domain in association with firms specialized in (mobile) robotics.

The logical development of these programmes will be the cleaning of vertical (or tilted) surfaces either for window or for stone façades.

A related topic is the inspection of cooling towers which is needed for the maintenance operations of nuclear power plant.

4. FUTURE

Construction robotics is no more considered as an illusion though it is considered only as a part of the future construction processes. Organization, management, data exchange are topics of the same importance of this future.

Short term progresses will obviously come from "private" programmes for which the confidentiality is the rule.

For longer term projects, cooperation is a way to go faster and to avoid wrong developments. French professionals (contractors, industrials, research centers,...) are ready to participate in joint ventures. The short overview presented above gives the main lines of the present developments and contacts are wished with other countries on these subjects. Side developments (for instance : positioning systems, tasks analysis, ergonomics, economics, ...) could also be considered either within common projects or by the mean of exchange of researchers.

BIBLIOGRAPHY

- [1] CROWLEY (J. L.).- "Navigation and world modeling for a mobile robot, a progress report", in : Colloque CAO et Robotique en Architecture et BTP, CSTB, GAMSAU, IIRIAM, Marseille, 25-27 juin 1986.- Paris, Hermès, 1986
- [2] JOLY (J-M).- "Vers l'automatisation des opérations de manutention sur les chantiers de construction", in : Colloque CAO et Robotique en Architecture et BTP, CSTB, GAMSAU, IIRIAM, Marseille, 25-27 juin 1986.- Paris, Hermès, 1986
- [3] TONDU (B.), CLEMENT (G.), ROUVEAU (C.), COLAS (R.), ASHWORTH (D.).- "Presentation of EUREKA/GEO project : a facade working robot", in : 4th International Symposium on Robotics and Artificial Intelligence in Building Construction", Haïfa, Technion, 22-25 juin 1987.- Haïfa, Technion, 1987
- [4] SALAGNAC (J-L.), SIINO (S.), GALLAIS (G.), CHEVALAZ (E.).- "SOFFITO : a mobile robot for finishing works in buildings", in : 5th International Symposium on Robotics in Construction, 6-8 juin 1988, Tokyo, Japon.- Tokyo, JIRA, 1988
- [5] JUGE (D.), SCHMITT (A.).- "Study of the various means of perception in mobile robotics applied to the building industry", in : 6th International Symposium on Robotics in Construction, 6-8 juin 1989, San Francisco, California.- Austin (Texas), CII, 1989
- [6] SALAGNAC (J-L.).- "A general purpose positioning system for construction robotics, in : 6th International Symposium on Robotics in Construction, 6-8 juin 1989, San Francisco, California.- Austin (Texas), CII, 1989
- [7] SALAGNAC (J-L.), VINOT (B.), PUJOL (D.).- "Positioning with ultrasonic sensors : review of techniques and presentation of a new system", in : 7th International Symposium on Robotics in Construction, 5-7 juin 1990.- Bristol, CIB, 1990
- [8] LE CORRE (J-F.), PEYRET (F.).- "SIREM : the absolute location of civil engineering equipment", in : 7th International Symposium on Robotics in Construction, 5-7 juin 1990.- Bristol, CIB, 1990
- [9] MARIGNIER (J.), LEROY (M.).- "A telecontrolled Apparatus for measuring road pavement density, in : 7th International Symposium on Robotics in Construction, 5-7 juin 1990.- Bristol, CIB, 1990
- [10] SCHMITT (A.), JUDE-HUBERT (D.).- "Conception of multisensors system for mobile robot applied to the building industry", in : 7th International Symposium on Robotics in Construction, 5-7 juin 1990.- Bristol, CIB, 1990

- [11] SALAGNAC (J-L).- "Manuplation and assembly of small components history, trends and future", in : 7th International Symposium on Robotics in Construction, 5-7 juin 1990.- Bristol, CIB, 1990
- [12] SALAGNAC (J-L.), MOREL (A.), BENSIMON (G.).- "The functional analysis : results and applications to the robotization of construction operations", in : 7th International Symposium on Robotics in Construction, 5-7 juin 1990.- Bristol, CIB, 1990
- [13] GOURDON (J-L.), PEYRET (F.).- "Modelling and controlling the road finishing progress, in 8th International Symposium on Robotics in Construction, 3-5 juin 1991.- Stuttgart, à paraître
- [14] LEMARQUAND (Ph.).- "The PANORAMA project approach, first results and potential applications", in 8th International Symposium on Robotics in Construction, 3-5 juin 1991.- Stuttgart, à paraître
- [15] LE CORRE (J-F.) GARIA (G.).- "Determination of the six degrees of freedom of a moving civil engineering vehicle, in 8th International Symposium on Robotics in Construction, 3-5 juin 1991.- Stuttgart, à paraître
- [16] SALAGNAC (J-L.), VINOT (B.), SCHRIVE (E.), BRAS (P.).- "Mobile robots on building construction sites : specifications based on tasks requirements and geometrical analysis, in 8th International Symposium on Robotics in Construction, 3-5 juin 1991.- Stuttgart, à paraître
- [17] SALAGNAC (J-L.), LAFAILLE (A.), LEPRETRE (D.).- "Robotics in construction : projects and perspectives", CSTB Cahier n°2412, mai 1990