REMOTE OPERATIONS AND ROBOTS IN NUCLEAR POWER PLANTS-OUT LOOK AND REALITIES

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Résumé : Ce document, tout en rappelant les différents domaines actuels et potentiels d'utilisation des robots, propose une démarche de développement dans ce domaine.

ABSTRACT

This document propose to discover why the robotic discipline has not become an integral part of current maintenance procedure, and shows some areas to be improved and tested.
It provides the different topics, where safety on workers and population could be improved by using robots and the means to reach this goal.

INTRODUCTION

Remote operation and robotics techniques were introduced into French nuclear power plants at the most seven years ago, particularly with the pilot repair of internal core structures in the CHINON A3 G.G.C.R. system, christened the I.S.I.S. Since then, E.D.F.'s operational and research sectors have been organized to officially encompass the notion of "*robotics*" development. However, these sectors remain somewhat on the fringe with respect to the overall development of equipment. The concept proposed i.e. that of robots or remote tools, often provides an altenative to the set, but much more dedicated notion of the "*special machine*". In the case of robots or remote tools, their versatility, both with regards to the tools used and to programming of a given task, offers the definite functional advantage of a large range of potential applications, but poses an organizational problem if they are to become directly operational.
The complexity of the system created also increases the level of training required, with regards to both control and maintenance.
This brings us to the crux of the problem : is the alternative a necessity in the unavoidable terms of technical means, safety and (or) cost ?

I DIFFERENT ASPECTS OF SAFETY

A) Aspects concerning the active population of nuclear power plants

These aspects stem from two basic problems :

- *the reduced accessibility of components :*

this first restriction, imposed by the question of accessibility, induces man to explore ways of remote intervention, which does not necessarily mean remote operation or robotics, since the tools used can be specific to a task and a given component (example : micro- mechanics).

- *dose rates :*

this aspect means that the designer must find a compromise between the development of remote working methods and duplication of the same tasks by an increasing number of personnel. The factors to be considered here are collective dosimetry and individual dosimetry. The solution will be optimized from this point of view by use of the ALARA method. In certain cases, analysis is rapid and remote controlled intervention is necessary (fuel).

The following fields come into play during the lifetime of a power plant :

1) *Normal maintenance*

This depends on the three complementary notions of productivity, safety and speciality. A typical example is that of steam generators, where control and maintenance (of tubes) are often dissociated, but where there is an increasing harmonization of the means being developed to solve the problems involved. The current aspects of dosimetry inside steam generators has led both operators and manufacturers to study the solution of robots and truly multi-task remote manipulators which have direct access from outside the water bowl. At the same time, safety will necessarily be reinforced by the need to use computer-based tools to memorize the work carried out (where, when, how).

2) *Incidents*

Incident-related phases are based on the assumption that a stable state of the system will be rapidly achieved. The robotics aspect must always be compared with the human aspects of intervention (rapidity, competence, physical potential). When it comes to the question of "*mobility*", robotics is currently slow to be implemented ; on the other hand, the "*remote operation*" aspect can offer a long term solution. Structures which facilitate logistics and communications (standby and backup facilities, tracks, maintenance networks, etc...) in order to solve the problems of rapidity, accessibility and communication (reduction of wiring times, etc...) could be discussed.

3) *Dismantling*

Remote operation methods are definitely a potential aid for the implementation of special machines which could work for long hours in a given place (transport aspect) or for direct work on components when the latter require particular skill and a degree of adaptability which cannot be either programmed or modellized beforehand.

B) Workers and the surrounding population - Accidents

The accident related situation covers two aspects :

- the immediate intervention solution which supposes both rapid organization and special means of intervention (aimed at protecting people and providing maximum confinement),
- maintaining and then going back to a specific configuration, which supposes appropriate logistics and on-going word carried out on a long-term basis.

Potential solutions have unfortunately been tested with varying degrees of success at CHERNOBYL and T.M.I.

With regards to intervention which is both internal and external to the reactor building, mobile land and air vehicules of the remote operated type and manipulator arms must be developed on a transborder level and with an exchange potential in mind.

This means, in particular, that it is possible to envisage the creation or reinforcement of structures :

- on a technological transborder level (eg. standardization, telecommunications),
- on a trans "*orderer*" level (eg. civil safety, armament, nuclear, space),
- on a financial level (industrial consortiums, insurance pools) in order to facilitate the development of appropriate means to separate budget-related aspects concerning normal maintenance from those concerning "*risk-related*" developments.

II POTENTIAL ACTION

A) Techniques

1) Means of analysis

It is essential that the following computer type analysis tools be developed or adapted to nuclear power plants :

- value analysis,
- simulation C.A.D.,
- definition of specifications and organization (eg. S.A.D.T.),
- analysis/dosimetric reports (eg. DOSIANA - DOSIECO, C.E.P.N. software).

Or of the physical type :

- benchmark and performance tests,
- on-line telediagnostics for maintenance and troubleshooting,
- reliability studies.

2) Improvement of logistics

3) Feedback on the design of new power plants

The integration of robotics can be envisaged :

- with regards to the actual design and construction of power plants, in so far as productivity is concerned (modularity, manufacturing control). This would facilitate the design of machinery to be used during the maintenance and development phases,
- with regards to the integration of standby facilities in proximity to components, thus facilitating maintenance work.

B) Structures and organizations

1) Stansdardization/training

2) Information networks

3) Consortium for reflection on future development

CONCLUSION

We saw above that many points remain to be studied and defined to quantify the real potential benefit of the robot or remote operation in the nuclear field.

There are two levels to be considered :

1) The Designer : Should be solve the problem in termes of a specially dedicated machine, a programmed robot with a certain modularity and versality or from a remote operated approach ?
2) The User : What is the best quality service and what motivation is there, given that robots turn operators into simple supervisors whereas remote operation necessistates a specific know-how of normally manual tasks ?

One could also ask, as concerns recent mixed (robot and remote-operated) instrumentation and control modes, if it is fruit of a purely technical nature or express desire to keep man's initiative computerized aid rather than a tailor-made pushbutton approach.

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