

# THE PROMOTION AND DEVELOPMENT OF CONSTRUCTION AUTOMATION TECHNOLOGY IN TAIWAN

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## 1. Introduction

For the past decade, Taiwan's construction industry has faced several challenges. The shortage of labor, increasing environmental consciousness, the competition of foreign construction firms, and the necessity to increase productivity are among the major concerns. In response to these problems, construction industry was included as one of the many industries targeted to promote and practice automation under the ten year national project "The Industrial Automation Plan of the R.O.C.", which was supported by the Executive Yuan, to strengthen competitiveness and increase productivity of Taiwan's construction industry. The promotion of construction automation was first administered by Architecture and Building Research Institute of Ministry of Interior (MOI), and then, in 1995, administration was turned over to Construction & Planning Administration (CPA) of MOI. The aims of construction automation are to reduce the demand of manual labor, to shorten construction time, to improve working condition, construction quality, and to

increase productivity.

In order to facilitate and implement the applications of construction techniques, Construction Automation Center (CAC) was founded in early 1997 within Taiwan Construction Research Institute (TCRI). The goal of CAC is to collaborate the efforts of government, academia, and industry to promote the research and applications of automation technology. CAC not only promotes research on construction automation combining with major on going domestic construction projects but also updates construction industry with advanced construction automation technology and information. Commissioned by CPA's project "The Promotion of Construction Automation through Technical Research Groups", CAC has been diligently working on promoting construction automation in four different fields including bridge construction, tunnel construction, precast construction, and concrete applications. Furthermore, technology service group, research group, and technical club are established under each field to bridge the gaps between government officials, research scholars from academia, and engineers from the industry.

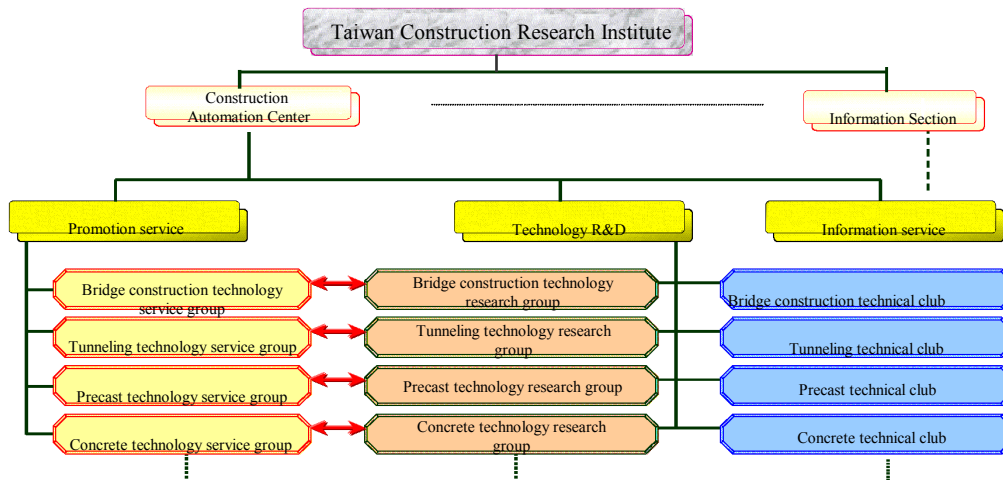


Figure1 Organizational structure of promoting construction automation of Taiwan Construction Research

## 2. Organization and Mechanism of Promoting Construction Automation

The organizational structure of promoting construction automation within TCRI is shown in Figure 1, except for inviting the specialists and scholars of the industry, academia and government to organize technology research groups and service groups in bridge, tunnel, precast and concrete, CAC also initiates to formulate four technical clubs in bridge, tunnel, pre-cast and concrete, etc., to establish a channel of exchanging information among various engineering sectors to facilitate the promotion of construction automation.

In the aspect of task allocation, the major work of technology research groups is to set up the project field research direction and strategy, specify research topics, and research to induce advanced construction technology. On the other hand, the technology service groups attempt to promote the advanced construction technology by providing diagnosis and assistance to contractors encountered with technical difficulties. Besides, technical clubs focus on promoting the upstream, midstream and downstream technology and information exchange in construction industry, to promote constructive interactions of the industry. by periodic activities such as on-site technical tour and symposium. The research groups, service groups and technical clubs on one hand feed back experiences to CAC, on the other hand, through coordination and cooperation, CAC may collect technical data, research and service promotion result. The operation connections of technology research group, service group and technical club are shown in Figure 2.

Under the promotion framework of technology research group, service group and technical club, CAC divide its work into three major stages as technology information collection, R&D and promotion (as shown in Figure 3). The first stage concentrate on gathering construction technical information. By transferring the collected technical information to the R&D stage, technology research group, organized by specialists and scholars of the industry, government and academia, plans and engages in various practical research projects conducted to solving the key technical difficulties faced by the industry. At last, the research result is transferred to the stage of implementation and promotion. In this way, under the operation mode of technology information collection, technology R&D, and technology promotion in gradual progress, with mutual reinforcement, the domestic construction level may be gradually upgraded in an effective manner.

CAC separately invites 17~21 specialists and scholars of the industry, government in four project fields as bridge, tunnel, pre-cast and concrete, etc., to establish individual technology research groups.

## 3. Current Status of Promoting Construction Automation

The major works and activity results in terms of technology information collection, R&D, promotion under progress shall be described briefly as follows.

### 1. Technology information collection

CAC has been active to engage in domestic/overseas construction technology information collection. Concerning the overseas part, work has been conducted through collection of journals and books, invitation of overseas specialists and scholars to offer lectures in Taiwan, and engagement of technology exchange with R&D sectors, etc. In the domestic part, contacts have been made with engineering sectors of government, engineering consulting companies, contractors, machinery and material suppliers, etc., to engage in related technology information collection concerning the construction methods, design, machinery, material, etc. in bridge, tunnel, precast, concrete and other fields of automation.

### 2. Technology R&D

#### (1) Plan and engage in technology R&D research projects

By coordinating the discussions of the scholars and experts of each project field, CAC also planed important R&D research projects to engage in technology research. These research topics are proposed in respond to the needs of construction industry at present which, during execution, shall be jointly complied in operation by engineering construction sectors of government with scholars from academia. In this way, the research result can be effectively transferred and implemented to the industry.

#### (2) Set up construction automation index

In order to evaluate the performance of construction automation technology, CAC, through questionnaire and practical work interview in collecting basic data, has set up automation indices in bridge engineering and tunnel engineering.

a. Bridge automation index :

The content of bridge automation index includes construction methods such as cast-in box girder, incremental launching method (ILM), advanced shoring method (ASM), and precast segment method. Taking the comparison between cast-in box girder, which was popular in the 1980's, and ILM and ASM, which are two popular construction methods at present (as shown in Table 1), we could see that the construction rate of bridge superstructure has great improvement at present.

b. Tunneling automation index:

In the aspect of developing tunneling automation index and its applications, the average monthly excavation speeds (AMES) of 284 tunnels constructed in Taiwan between 60's to 80's have been collected and analyzed using statistic methods. The AMES statistics of each centennial period are shown in Figure 4. As shown in the figure, most of the tunnels constructed between 70's and 80's are road tunnels with smaller excavation sections, therefore the AMES is as high as 68.25m/month. In

the last decade, although the AMES of tunnels have dropped to 40~60m/month, yet they were tunnels with large excavation sections. Tunneling automation promotion efforts made by the local engineers did show some improvement in both techniques and equipments. However, when compared with advanced regions in the world such as Europe, Japan and North America whose AMES can go as high as 80~100m/month, there is still much improvement space in Taiwan's tunneling automation.

(3) Publishing technical book

CAC engages in editing and publishing technical brochures conforming to requirement of engineering practice to promote construction automation techniques. At present, it has already published eleven technical brochures with subjects ranging from incremental launching method, advanced shoring method, cast-in cantilever method for bridge engineering; all-purpose working crew, automated inspection system for tunneling; automated production of ready mixed concrete, etc.

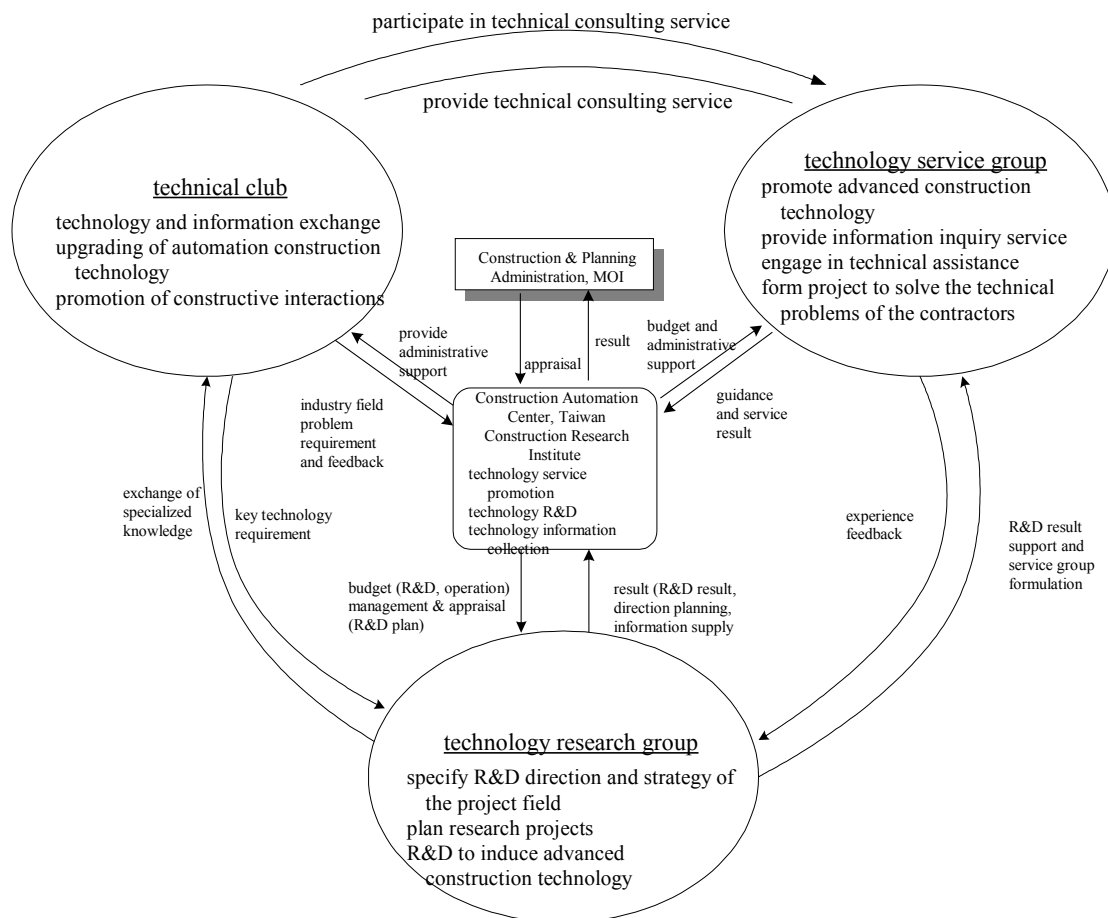


Figure 2 Operation connections of technology research group, service group and technical club

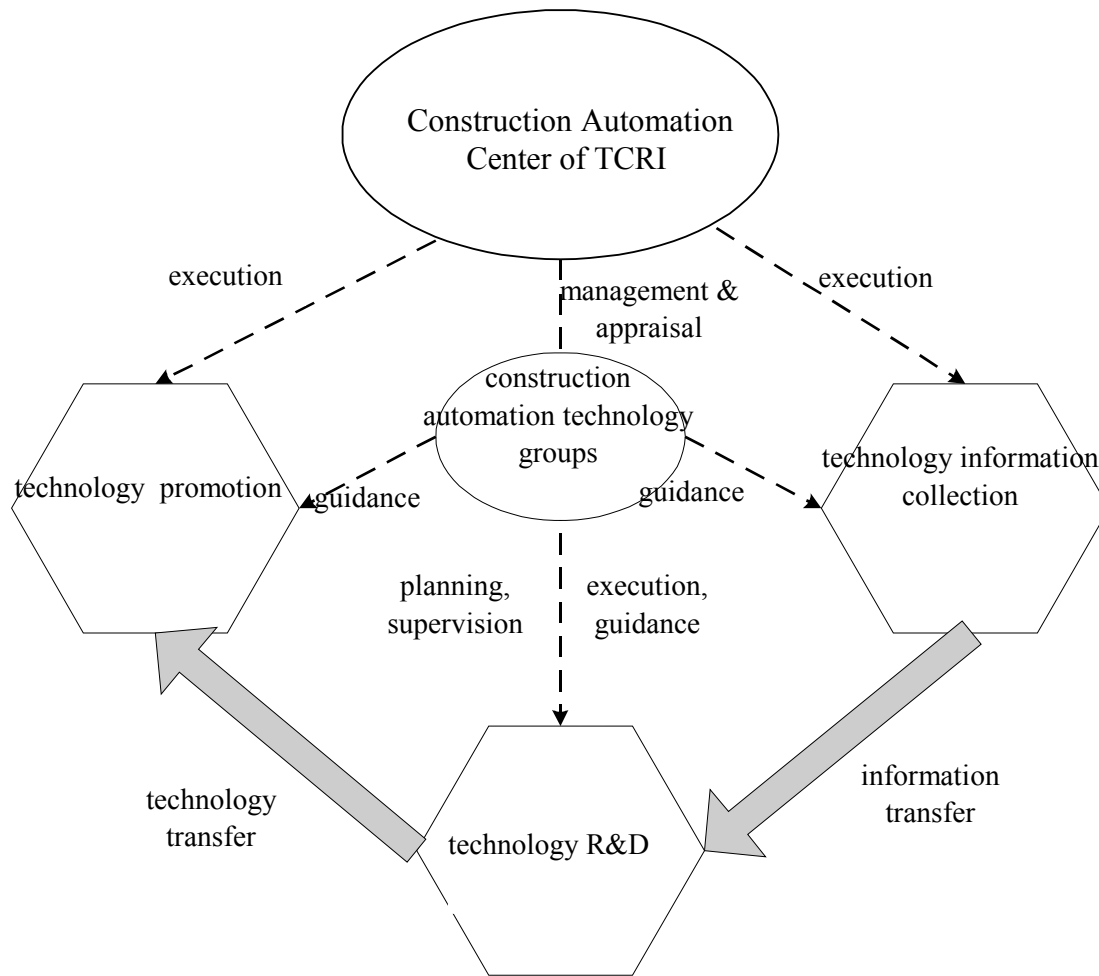


Figure 3 Flow of technology information collection, technology R&D and technology promot

Table 1 Construction rate of bridge superstructure

Construction method of superstructure	Construction rate (meter/day/construction equipment)
Cast-in Box Girder (in 1980's)	1.3
Incremental Launching Method (at present)	2.8
Advanced Shoring Method (at present)	3.59



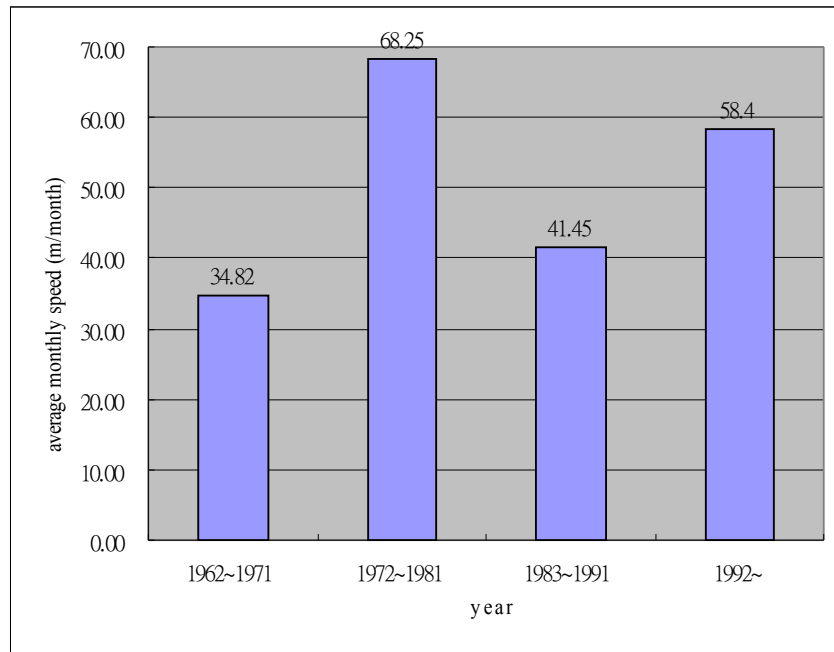


Figure 4 Statistic chart of the average monthly excavation speed of tunnels in Taiwan during 1960's~1990's

### 3. Technology promotion

#### (1) Promote construction automation technical club

At present, there are more than 2000 members consist of representatives from sectors in engineering planning, design, construction, material supply, machinery, etc., to exchange experiences, set up a proper and effective technology and information channel by regular technical tours and symposia in four technical clubs.

#### (2) Hold symposia and seminars

Symposia and seminars are one of the best approaches to continuously provide advanced

technology to the industry. CAC periodically invites domestic/overseas specialists to hold symposia and seminars on various subjects, to provide the engineering industry of Taiwan chances of absorbing new ideas and knowledge.

#### (3) Provide technical service

In order to transfer the R&D result, CAC provides three levels of technical services. Level one provides technical information inquire service. By gathering members of the technology service group, level two offer on-site investigation and consulting. For technically challenging problems, Level three service will organize specialists and scholars in the project

fields to engage in a project to solve the problem.

(4) Combine the aspects of government to promote technology exchange

In order to incorporate the administrative force of the government, to expand level and contact of participation, to promote construction automation through various administrative sectors of the government, CAC has organized several seminars with major engineering sectors of the government, including Taiwan Area National Expressway Engineering Bureau, Taiwan Area National Freeway Bureau, Taiwan Highway Bureau, etc.

(5) Set up and maintain website to provide construction related information

CAC continuously engages in maintaining a web site, and provides the most updated information of automation technology in bridge engineering, tunneling, precast construction and concrete applications, etc. and provide information and data on technical brochures, new construction techniques database, activities of technical clubs, seminars and symposia on automation, etc.

In addition, the web site will link to the domestic/overseas construction related web sites to effectively provide the important domestic/overseas construction industry information, and facilitate the domestic construction industry to engage in exchange interactions with the related overseas sectors.

(6) Sponsor the outstanding construction automation awards for construction work and engineering professionals

In order to encourage engineering professionals and companies to implement automation techniques, CAC sponsor the outstanding construction automation awards for construction work and engineering professionals each year.

#### 4. Conclusion

Under the operation framework and through mutual support and compliance of technology research group, service group and technical club

with mutual reinforcement, CAC has set up the mechanism for technology promotion, R&D, and information collection of automation technology. It also shows, through this kind of mechanism, the forces of various fields can then be effectively integrated, to concentrate consensus, expand participation levels, and accelerate the implementation of automation techniques.

The work of transferring construction automation technology cannot be realized in a short period, though with the primary achievement of the promotion in initial phase, yet it shall rely on continued promotion on a long term by collaborate efforts of industry, academia and government. Most of all, only through active participation and compliance with response from various engineering fields, can the competitiveness of overall construction industry be truly strengthened. In the future, CAC will, in compliance with the progress of domestic engineering construction works, continuously and actively plan to hold various automation activities conforming to the industry's demand in practice. It is also hoped all engineering fields can, based on keen participation in various automation activities in the past, continuously provide support and instruction, to jointly contribute effort for upgrading and development of domestic construction industry.

#### Reference

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