

Discover Reliable



CTCI's Road to Success as
a Top 100 Global Engineering Brand

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CTCI Reaches for the World and the World Sees Taiwan

Vincent Siew, Former Vice President, Republic of China

The CTCI Group was established as an engineering company in Taiwan in 1979. Relying on its professional technology, outstanding management capabilities, and international perspective, it has completed numerous major projects, both locally and overseas, in the fields of hydrocarbon, environmental, transportation, power, etc. Even as CTCI worked to establish a solid foundation rooted in Taiwan, it ventured vigorously overseas, competing not only with firms in Taiwan, but against major, global engineering companies, making a name for itself in the international market. It grew steadily, becoming one of the top international engineering groups in Taiwan.

Taiwan is an island that depends heavily on exports for its economic development, but most of its exports consist of tangible commodities, with relatively little contribution from intangible technical services. The CTCI Group, however, has managed to forge its own way abroad, completing numerous important construction projects in regions such as the Middle East and Southeast Asia. It has taken Taiwan's strengths in technical services into the international market and shown the whole world that Taiwan is not only able to export goods including agricultural

products, hand tools, and electronic products, it is also able to provide technical services in professional engineering fields like hydrocarbon, environmental, transportation, and power.

Furthermore, in the early 1980s, many of Taiwan's urban communities had not yet built municipal waste incineration plants and were unable to manage the constantly increasing amounts of trash, resulting in the growth of "garbage mountains," and the outbreak of "garbage wars." This proved a headache for the central and local governments. During that time, CTCI stepped in with its professional technology, management, and communication skills, dispelled local concerns, and assumed the heavy burden of resolving the garbage issue. One-third of the 24 municipal waste incineration plants scattered around Taiwan today are operated by CTCI Group subsidiaries, which continues to make vital contributions to the island.

The key to CTCI's success as it expanded from Taiwan into overseas markets, and its development from a small company into an international conglomerate has been professional governance, with a leadership of professional managers, who made their way up from the basic ranks and personified the company's most important values:

- 1. A strong sense of mission:** CTCI maintains constant growth and expansion by never being satisfied with things as they are, and continuously promoting reform, innovation, and the development of new opportunities.
- 2. Selfless dedication:** CTCI executives aim to lead by example

without considering gain or loss as they strive for the company's development, and have won the trust of employees and built outstanding morale.

3. Forward-looking perspective: CTCI maintains a firm grasp of market trends and adjusts business development strategy accordingly, engaging in such fields as green engineering and photovoltaic power in order to achieve sustainable development.

4. Proactive international vision: CTCI started out much earlier than other enterprises in Taiwan, advancing into the Middle East, Southeast Asia, and other international markets in a move that required great courage and resolution.

The CTCI Group has established a benchmark for Taiwan's strength in technical services, and this achievement has won recognition at home and abroad. I have three expectations for CTCI's future: first, its powerful engineering team will serve as a tool to open new horizons for the company, and I hope it will be made even stronger by cultivating more talent; second, I'm very happy to see CTCI is exploring cooperation with more large-sized international firms in pursuing greater opportunities that will show Taiwan's competence to the whole world; and third, for CTCI to win out in the global competition, it must have abundant support from all parties and I hope that government agencies will give it their full support.

Development with Stability A Model for Taiwan's Economic Development

Wen-Yen Pan, Chairman, CTCI Foundation

Over the past 38 years, CTCI has grown from a small engineering design firm into a major conglomerate with operations in Taiwan and overseas, more than 7,000 employees, and annual revenues of NT\$70 billion. It can serve as a prime example of Taiwan's economic development.

This book records CTCI's path of growth with several points that are particularly worth noting. First, CTCI started out by building petrochemical plants and oil refineries, laying down a solid foundation of engineering capability and progressing steadily into other fields such as natural gas, power generation, environmental protection, transportation, and solar power. It has set up numerous subsidiaries, forming a multidimensional engineering group with many enterprises that have built a solid record of performance in Taiwan and then advanced into the international market. This strategy of operational diversification unquestionably provides CTCI with a limitless momentum for growth.

For many years, CTCI has progressed at a stable pace, moving forward step by step, never lacking sufficient business volume to sustain the development of the overall enterprise. This is not easy to accomplish.

The world of international engineering has no shortage of examples of rapid rise and precipitous decline. When a company wins the bid of a project, it completes the project as best it can; when it fails to win a project, it responds with a drastic downsizing. CTCI, by contrast, has never engaged in large-scale downsizing. Besides having a strong capability for business expansion and cost control, an enterprise must also view employees as its most important asset. As I well know, many of CTCI's personnel have known no other employer except CTCI, and most of the executives have risen through the ranks. If a company has the loyalty of its employees, it will be able to compete with the international majors with no fear of inferiority.

In addition, CTCI does not have the backing of a conglomerate. From the very beginning, it has been operated by outstanding professional managers, including the current Group Chairman John T. Yu; a man who, besides having an open mind, is highly rigorous and meticulous in his management of the company. Under his leadership, CTCI has held to the principles of business integrity and transparency, establishing an outstanding model for the domestic engineering sector.

“People” are the key reason for CTCI's outstanding achievement. A chapter of this book is devoted to the company's emphasis on manpower training, sharing how we take care of our employees and provide them with a stable working environment, and how we cultivate

leaders in a well-planned and systematic manner. It also explains how CTCL's competitiveness derives entirely from the competitiveness of its employees.

After building a record of outstanding achievement in the Middle East, Mainland China, and Southeast Asia, CTCL will now show its capabilities in the US market. We look forward, expectantly and optimistically, to using the strength we have accumulated in the past to create a new peak of performance in potential shale-gas opportunities.

Industry and Academe Working Together to Create a New Wave of Competence

Mau-Chung Frank Chang, President, National Chiao Tung University

Over the past few years, technological advancement has reshaped the form of industrial development. The newest industrial revolution, Industry 4.0, will strengthen the competitive advantage of enterprises and build a gap with competitors through intelligence, the Internet of Things, and other innovative technologies.

CTCI is the leader of Taiwan's engineering services industry, and it has never faltered in the pursuit of innovative R&D. In meeting the challenges of the Industry 4.0 era, CTCI has not only persevered in the struggle, but has preemptively seized the opportunity to cooperate with Chiao Tung University, which is known for its excellence in electrical engineering and information R&D, in a perfect partnership.

CTCI and Chiao Tung University signed a letter of intent for industrial-academic cooperation in July of 2016. In the future, the two partners will use cloud computing, the Internet of Things, big data analysis, robots, artificial intelligence, and other innovative technologies to

create Industry 4.0 automation and intelligentization for factories.

CTCI can use the industrial-academic cooperation platform to draw support from Chiao Tung University's R&D capabilities in establishing industry-leading innovative engineering technologies and solutions, thereby achieving smarter engineering and strengthening the CTCI Group's competitiveness in the international engineering market. Chiao Tung University will use the examples of actual practice provided by CTCI for the verification of theoretical feasibility instead of simply engaging in paper exercises. This will create a win-win situation for industry and academe alike.

Chapter 4 of this book, "Embracing the Tide of Intelligent Technology," gives us a glimpse of CTCI's vigorous engagement in innovation:

- 1. SmartPlant Enterprise (SPE):** This platform makes all of the design information concerning turn-key projects transparent, helping transdisciplinary teams to greatly strengthen horizontal integration and adaptability to change.
- 2. Concurrent design:** This allows teams in different countries and time zones to engage in borderless, real-time concurrent remote collaboration to achieve rapid progress and greater efficiency.
- 3. Smart factories:** The introduction of intellectualized elements into the implementation of projects and follow-up factory operations provides customers with customized smart-production plants, greatly upgrading their productivity.

4. 7D simulation planning and design: Industry-leading state-of-the-art R&D and use of the most advanced 7D simulation design not only helps with management during plant construction but also achieves the goals of visual data enquiry and maintenance management through the linkage of equipment maintenance and management information in a unified model following the start of plant operation.

Before CTCL and Chiao Tung University formally initiated their industrial-academic cooperation, the two partners held several meetings that left a deep impression on me. The CTCL leadership not only proved itself happy to embrace new technology and thirst after talent, but was also eager to listen to the opinions of others, exhibiting the behavior of a great enterprise.

CTCL takes “smarter engineering” as a core strategy in its rebranding plans, and is advancing toward intelligentization at a very rapid pace. As a partner in this industrial-academic cooperation, we will be happy to see CTCL use smarter engineering and innovative 7D engineering technology to provide its customers with a full range of faster, better, and more competitive services that will enable Taiwan’s engineering technology and elite manpower to shine on the international stage.

We sincerely hope that through their complementary interaction, Chiao Tung University and CTCL will be able to “act together and go far” and open up a future of sustainable development for Taiwan.

A Global Enterprise Built on 40 Years of Struggle

Paul S.C. Syu, Humanities Chair Professor, Feng Chia University;
Chairman, Taiwan Institute of Directors

If we talk about Taiwanese companies that have established a name in the international arena, I'm sure that most people would bring up Foxconn, TSMC, Giant Bicycles, or even Hiwin Technologies or Feeler. It isn't likely that they'll mention, or even know about CTCI; so to introduce this company, let's first go to the simple description used in Chapter 2 of this book. It will probably surprise a lot of people:

The global deployment of the entire CTCI Group now covers economies in Asia, the Middle East, and the Americas, with business operations in Mainland China, Thailand, Vietnam, Malaysia, the Philippines, Singapore, the United States, India, the Middle East, and Russia. Under the vision of becoming "the most reliable global engineering services provider," CTCI is continuing its vigorous advance into the future.

Not only is this vast area of business layout surprising, that a fully local Taiwanese company is able to reach this state in less than 40 years without a single year of losses makes one sigh in amazement.

The Modern Zhang Qian and Ban Chao

Compared with foreign engineering firms, in particular, CTCI lacks the backing of a large conglomerate, and does not enjoy support from a financial institution or the government. What has enabled the company to reach its present state of accomplishment is the strength it has been able to exhibit in the minds of its customers.

Descriptions of this kind of strength are provided briefly and vividly in the chapters of this book, and I will not repeat them here. The most touching part of those descriptions, however, is the depiction of how, during the process of the company's growth and development, a group of dedicated CTCI personnel forged ahead fearlessly to open up new fields of development. This is particularly striking in view of the fact that many members of this group were green hands with limited experience when they first ventured overseas. What they faced were totally different cultures and construction sites of boundless sand. And those they had to deal with there were people of different races with whom communication was difficult.

What they had was ambition, courage, and an indomitable willpower, along with hard work and constant learning. Reading about the fighting spirit that these brave souls exhibited when faced with all kinds of strange and difficult environments reminds one with profound respect of the exploits of the Han Dynasty heroes Zhang Qian and Ban Chao, who were sent on missions to the west to help open up the Silk Road.

A precious feature of this book is how it disinterestedly describes the

content and the path of development of the company's strength, and a careful reading is like perusing a canon of secrets of the engineering services industry's development. Less than 40 years was not too long a time for CTCL to hammer out such a territory and such an enterprise, nor was it too short.

People generally divide the lifecycle of an enterprise into four stages: startup, growth, maturity, and decline. When an enterprise reaches CTCL's age, it has usually entered the stage of maturity or decline. What is surprising about CTCL is that it is still filled with vibrant life and energetic optimism, as though it is still in its stage of growth.

Engineering, Engineering Services, International Engineering Services

CTCL's growth stage, however, can be further divided into several different periods. Interestingly, we find that these periods can be described in terms of three evolutionary periods in accordance with the "international engineering services" that CTCL has created: "engineering," "engineering services," and "international engineering services." The company's operating principles, models, and advantages have all evolved constantly throughout each period, each of which has its own unique characteristics.

Simply put, in its beginning period, CTCL engaged in relatively simple engineering work; it relied on quality and cost, and was not much different from other domestic engineering firms.

When the company entered the second period, however, while superficially it appeared that only the word “services” was added, the scope of its business was no longer limited to simple engineering. When it advanced from subcontracting into turnkey contracting, CTCL already possessed EPC capability, winning contracts in competition with world-class engineering firms, growing strong and self-reliant, and guaranteeing customers that it would leave them satisfied and content.

At the advent of the third period—which CTCL is in today—the company has entered the state of global operations. It not only faces a complex scope of business and engineering, but also different kinds of operating environments. With its diversified internal organization and external alliances, CTCL can respond flexibly to different conditions and mobilize resources to zero in on solutions. During this period, the company is using its accumulated experience and wisdom to reinvent itself so as to stand on its own feet among the ranks of world-class enterprises, as we had mentioned previously.

EPC Capability - The Key to Success

CTCL’s ability to move from its beginnings as a small subcontractor into the status of an EPC contractor is the major key to its outstanding position in the industry today.

A company that engages in EPC (or turnkey) contracting undertakes the full range of related activities including planning, design, procurement, manufacturing, construction, and supervision. In this kind of comprehensive contract, each activity requires a different specialized

skill, equipment, and human talent. The complexity and difficulty of planning and coordination involved far exceed those needed for a simple subcontracting job. A company serving as a subcontractor, for instance, can leave a lot of negotiations and compromises to be faced and resolved by the turnkey contractor; once a company undertakes the role of a turnkey contractor and has to supervise and make its own decisions on the international stage, however, it not only needs to deal with the governments of different countries but also to face and bear responsibility for everything from laws and regulations to financing, technology, culture, and racial issues.

Factors of Success: Talent, Organization, Culture

Looking back over CTCI's history, we see that its ability to successfully complete all kinds of difficult contracts involved countless complex factors; when we analyze all of them, however, they seem to resolve into just three major categories: talent, organization, and culture.

The first factor is talent. Looking back, it seems that in just about every step of CTCI's growth, it faced a different kind of challenge. The company has a long history in the international arena; but unlike other deeply rooted companies in the industry, in the early days it had hardly any ready-made talent to call on. What CTCI officials did was to boldly use greenhorns and trust them to grow and mature through actual experience, becoming leaders dedicated to developing new territories for the company.

The chapters of this book contain both sad and happy stories from

CTCI's history. The company should seriously consider establishing a Hall of Fame for its heroes. This kind of success at finding, developing, and making full use of talent must have been the most fundamental factor in the company's business accomplishments.

The second success factor for CTCL is organization, which represents the basic framework that enabled its effective and flexible operation. It's something that can never be described in ordinary textbooks—this kind of hierarchical model of layered control and detailed division of labor. This type of organization must be able to respond effectively to different environments, customer demands, engineering content, and cooperating partners, as well as the meticulous design demands of different countries and systems. Only when we realize this, can we fully understand why CTCL has produced so many regional units and branches under its mother company.

Chapter 2 of this book describes how, in addition to its regional branches, the CTCL Group has successively or simultaneously set up more than 10 “little CTCLs” including CTCL Smart Engineering Corporation, CTCL Resources Engineering Inc., CTCL Advanced Systems Inc., ECOVE Environment Services Corporation, CTCL Machinery Corporation, ECOVE Environment Corporation, EVOVE Wujih Energy Corporation, EVOVE Miaoli Energy Corporation, CTCL (Thailand) Co., Ltd., and CTCL Beijing Co., Ltd.. These companies can operate either independently or under centralized planning by the mother company, working in concert to achieve solutions in accordance with time, place, and circumstances.

The third factor to success, organizational culture, represents the soul of an enterprise. No enterprise, however good its personnel or its organizational design, or however advanced its technology or information systems, will be able to achieve agile coordination and seamless linkage without the functions of harmony and trust produced by culture.

CTCI's corporate culture focuses on professionalism, integrity, teamwork, and innovation. What we should emphasize here is that these cultural features are not due to top-down demands or rules, but are lifestyle characteristics that have formed naturally in the process of the company's constant expansion and growth. They are vital conditions for supporting the company's survival and development.

Outstanding Performance Depends on Leadership

I am honored to have been asked to write the "Reader's Guide" and to analyze the path to, and reasons for, CTCI's success in the development process described in other sections of this book.

Anyone who starts reading this book will be drawn in deeply by its content; in the CTCI story itself, uniquely glistening among the many other corporate stories there are. In addition, there is no standard success formula for corporate operations; each enterprise must choose its own road to success. Applying this reasoning to CTCI, and thinking back to its journey of nearly 40 years, we see that in each area—the cultivation of human resources, development of the organization, and shaping of its culture—the company has had its own unique approach.

The question we need to ask now is, what was the force of initiation, realization, and perseverance that lead CTCL to make its decisions? As Leadership Guru Warren Bennis once said, the most important key is the leader, because everything derives from his insights, convictions, and practicality.

The importance of leaders has consolidated a number of basic concepts concerning corporate operation in recent decades—such as “without leadership, there is no transformation” and “outstanding performance comes not from management but from leadership,” or the call for “the power to make things happen” or to “grasp the impossible,” or even “we need leaders, not managers.”

In this regard, we have to express our utmost respect to Group Chairman John T. Yu. He took up the presidency of CTCL in 1998 and the chairmanship three years later. Altogether, he has been leading the company for 20 years—which is more than half of the company’s lifetime, and also the period of its fastest growth and most difficult challenges.

A look at successful enterprises throughout the world, whether GE, Sony or IBM, or the great names of today such as Facebook, Google, Amazon, Apple, and Alibaba, shows that they can all be linked to a successful leader. This is the role that has been so well served by Group Chairman John T. Yu at CTCL.

These writings represent my final impressions after reading the CTCL story, and with this I bring my writings to a close.



Foreword

Constantly Evolving – CTCI Leaps Forward

Taiwan suffers from a very limited domestic market and fierce competition within industries. Taiwan enterprises therefore realize that the best strategy for survival is to internationalize. This is a strategy that many Taiwanese enterprises are not able to implement; however, the CTCI Group, a leader in the island's engineering service sector, is a master at putting down roots in Taiwan and deploying around the world.

CTCI was established in 1979, and is the only general contractor in Taiwan with project planning, engineering design, procurement, fabrication, construction, supervision, pre-commissioning and commissioning capabilities. Its business scope consists mainly of refinery and petrochemical plant construction but also spans the fields of power plants, steel mills, terminal, transportation, incineration plants, industrial plants, and environmental engineering.

After deeply cultivating its business for nearly 40 years, CTCI has firmly established itself on the list of the Top 100 international engineering contractors. It is the only engineering firm in Taiwan that is able to go head-to-head with European, American, Japanese, and Korean contractors, an engineering company that has successfully developed its business in the international market and has excelled at globalization, establishing a solid position among the leaders of the global EPC contractors.

How has CTCI, without support from the government or backing from a large conglomerate, been able to create a “Transformers-like” organizational capability and professional power that have enabled it to advance toward the vision of becoming the world's most reliable global

engineering services provider?

CTCI's Honors List

- Listed on the Dow Jones Sustainability Indices-Emerging Markets Index
- Listed among *Engineering News-Record* Top 100 International Contractors
- First place in the contractor section of the 650 service enterprises in *CommonWealth* Magazine's Top 2,000 Enterprises survey
- The Most Admired Company by *CommonWealth* Magazine in the Construction Industry
- Inclusion in the top 5% of listed companies in the corporate governance evaluation carried out by the Taiwan Stock Exchange and Taipei Exchange

1979

1990

- Expanded into overseas markets
- Established subsidiaries
- Innovative Engineering Designs

CTCI was established on Apr. 6, 1979. K.C. Wang, was the founder and served as the chairman, and it had more than 750 employees. In the beginning, the company engaged mainly in the engineering design and construction of plants for Taiwan's petroleum refining and petrochemical industries. But with the island's economic sluggishness at the time, the petrochemical industry was unstable and unable to maintain the demand to support CTCI's stable growth.

Motivated by a consciousness of crisis, CTCI determined to extend its operations into the international market, even though most Taiwanese enterprises were not thinking about overseas markets at the time, and began sending down roots simultaneously at home and overseas.

In Taiwan, the company bid for plant construction projects jointly with prominent European, American, and Japanese engineering companies, absorbing experience, building up a record of performance, and laying down a foundation for an assault on the international market.

At that time there were a number of new plants built in the Middle East. CTCI worked with Chiyoda, Japan, in Taiwan as a partner. In 1981, CTCI followed Chiyoda's steps and entered into the Saudi Arabia market and established CTCI Arabia Ltd., CTCI's first overseas subsidiary. Chiyoda and CTCI jointly and successfully completed a number of refinery and petrochemical plant projects for Saudi Aramco and SABIC.

At the same time, CTCI co-worked with JGC, Japan, and successfully completed refinery projects for the Singapore Refining Company in Singapore. CTCI Singapore Branch was thus established. Afterwards, CTCI worked with Chiyoda, Japan, and entered into Thailand, thereby successfully completing the refinery project for Thai Oil. CTCI (Thailand) Co., Ltd. was therefore established in 1987. Through execution of these overseas projects, CTCI acquired a proven track record, and built world-class quality, and environmental, safety and health management systems, as well as upgraded CTCI's capability for execution of international projects.

We must admit that CTCI acted mostly in the role of subcontractor

in these international projects, which brought limited benefits to the company, but were significant to the company in deeper ways: they allowed CTCL to gain international experience and develop a new learning curve for itself.

To diversify existing business areas and to grow the company for sustainable operations, CTCL expanded its “home rooting” strategy to an unprecedented extent, and moved from its core business for refinery and petrochemical into other business areas. In 1989, CTCL participated in the construction of Taiwan’s first MRT line; mechanical, electrical and control system for the Brown Line of the Taipei MRT, secured contracts for the power supply system, the communication system, and the supply of depot maintenance equipment. This set a precedent for the company’s diversification into other business areas. CTCL stepped up its pace of expansion and moved into the fields of power plants, pharmaceutical facilities, steel mills, incineration plants, chemical plant, waste water treatment, and high-speed rail.

Seeking to cultivate other fields of endeavor, CTCL successively established several subsidiaries in Taiwan, including CTCL Ebasco Engineering Corporation, a JV with Ebasco Corporation, USA, in 1980 providing mechanical and electrical engineering services (now renamed as CTCL Smart Engineering Corporation). CTCL Exploration Corporation was established in 1984 to conduct petroleum exploration business for CPC Corporation, and then in 1988, increased its capital to expand into the civil engineering business, and renamed as Resources Engineering Service Inc. (now renamed as CTCL Resources Engineering Inc.). In 1987, Advanced Control Systems Inc. was established to provide plant control system integration services (now renamed as

CTCI Advanced Systems Inc.).

As its development progresses at a rapid pace, it is even more important for its professional strength to advance with the times to realize its grand vision. CTCI, which has always enjoyed the advantage of its design capability, naturally increased the pace of innovation.

In the early days of the engineering industry, design drawings were all done by hand. In the initial stages of its development, CTCI began using Wang 2200T computers to keep up with the times and achieve faster, more precise, higher-standard results. This computerization of detailed design work, along with the introduction of the latest and best graphic software, upgraded the efficiency of the company's designers.

In 1986, CTCI began using Auto-CAD 2D drafting software for engineering design, and distributed large numbers of personal computers to heighten the efficiency of the human-machine interface. In 1989, the company led the domestic and international engineering sector in adopting Intergraph PDS and AVEVA PDMS (large-plant 3D design software) for the design of refinery and petrochemical plants, entering the age of 3D engineering design across the board. Various kinds of self-developed software were also introduced to upgrade design quality and efficiency so as to satisfy customers' varying demands and enable competition in the same league with major international engineering companies.

1991
2000

- First Engineering Firm IPO in the Taiwan Stock Exchange
- Landmark Projects in Taiwan
- Turnkey EPC Projects Overseas

With the arrival of the 1990s, CTCI began advancing toward the goal of becoming a world-class engineering services company.

In May of 1993, CTCI became the first engineering services company to go public in the Taiwan Stock Market. Ever since then, it has raised funds on the stock market. At the same time, its operations have been made more transparent because of the strict administrative and other demands imposed on listed companies, constantly heightening CTCI's brand awareness and its lines of credit from financial institutions. This, in turn, has given the company the strength to contract for larger projects.

During this period, the government largely increased investments for public infrastructure projects, domestic demand boosted for petroleum refining and petrochemical industries helping CTCI to a higher level after completing numerous landmark projects.

For instance, in 1995 CTCI won the contract for engineering design and construction of Taiwan's first private refinery in Mailiao for Formosa Petrochemical Corporation ("FPCC"). This was the biggest and highest investment for plant building project in Taiwan at the time; it required CTCI to complete 37 refinery process units at the same time, along with the design of more than 200 large storage tanks. The design work consumed a total of 2.4 million man-hours. This was the largest

engineering design project ever undertaken by CTCI up to that time, and it had landmark significance not only for Taiwan, but for the whole world.

In 1997, CTCI cooperated with Haldor Topsoe, Denmark, in securing a US\$70 million EPC contract for an H₂ reformer for FPCC No. 6 Naphtha Cracker, beating out such strong competitors as Heurtey, France, Born, USA, and Chiyoda, Japan. This helped the company break away from low-end work, boost its EPC bidding to a higher level, and won the bidding for numerous domestic and overseas reformer projects under authorization from Haldor Topsoe.

CTCI also built a proud record besides the field of refinery and petrochemical engineering. In 1995, it diversified its business to other areas, such as Cogeneration Plants for Tsoying Refinery and Talin refinery for CPC Corporation and its Kaohsiung Refinery Wastewater Treatment Plant Modernization Project, Kaohsiung South Regional Refuse Incineration Plant, engineering design and construction supervision for the Nantou Section of the 2nd Freeway.

CTCI also expanded into the environmental resources business; and at this stage, too, it experienced breakthrough development.

In 1992, CTCI won the contract from Environmental Protection Administration to provide project planning and engineering design consulting services for incineration plants in Keelung, Tainan, and Pingtung. Building on this foundation, CTCI vigorously developed into incineration plants EPC Projects, and further into incineration plants operation & maintenance and BOT (build-operate-transfer). This

development gave birth to several subsidiaries: ECOVE Environment Services Corporation, ECOVE Wujih Energy, ECOVE Miaoli Energy, and ECOVE Environment Corporation, and made CTCI the largest incineration plants operator in Taiwan, with eight incineration plants.

Energy-from-Waste plant meant more to CTCI than just another business. They announced the company's entry into the era of diversified operation. The company had previously concentrated on plant construction, and while it moved into other fields, it kept within the scope of engineering. When it expanded into Energy-from-Waste plant operation and BOT, however, it entered the fields of operation and development investment where it had never before ventured.

In addition to developing its domestic business at a steady pace, CTCI also set its sights on overseas markets. But the development of overseas markets is not something that can be done quickly or easily; CTCI started out by acting as subcontractor for global engineering firms with the aim of becoming an EPC (engineering, procurement, and construction) contractor itself. The threshold for entry into EPC projects is very high, requiring process, mechanical and equipment, civil and building engineering, piping, electrical, instrumentation and control, and other EPC capabilities, as well as a high degree of complex project management integration ability. If a company cannot produce a record of performance that represents its achievements, it will be very difficult to participate in international EPC bidding.

While CTCI lacked international-class EPC project experience at the time, and could not immediately undertake such projects, it took every opportunity trying enter into the field with small-sized EPC projects.

In 1992, CTCI won an EPC contract for a hydro-desulfurization (HDS) plant for Bangchak Petroleum Co., Ltd., Thailand, the first overseas EPC project. This was not a very big project, but for CTCI, it marked a firm step into the world of overseas EPC market.

During this period, Mainland China entered an era of reform and opening up, and the Chinese government vigorously pursued construction of infrastructure. The huge and enticing Chinese market attracted the eager attention of engineering firms from all over the world. CTCI, too, sensed the opportunity, and in 1993, set up a subsidiary in Beijing, Jing Ding Engineering & Construction Company, a JV with BPEC of Sinopec, and now renamed as CTCI Beijing.

Compared to European and American contractors, CTCI had an advantage in the Chinese market in addition to its outstanding technological strength: linguistic and ethnic similarities. This helped the company to win numerous EPC projects, providing an invaluable record of performance and experience on its way to becoming a world-class engineering services company.

2001
2010

- Competing with Major International E&C firms
- Pushing Organizational Reform and Exquisite Works
- Building up KM System
- Fulfilling Corporate Social Responsibility

After years of persistence and hard work, CTCI finally began to take off and soar after the year 2000. In the domestic and overseas markets, the company climbed to new heights in both scale and scope.

For overseas market, from 2001 to 2006, CTCL completed 14 EPC projects in Mainland China, creating an admirable performance that played a large part in the international recognition of the company's qualifications. CTCL entered the Thai market and set up a subsidiary in the late 80's and in 2006 it successfully secured three EPCC projects in Thailand, proclaiming its transformation into a firm that is able to compete on the same stage with world-class engineering companies.

Besides Thailand and Mainland China, CTCL returned to the market in the Middle East in an aggressive manner from 2004. In 2007, CTCL successfully completed the Ethylene Plant Phase II Expansion Cracking Furnace Project in Qatar, and in 2010, the successful completion of EO/EG Project for Saudi Kayan, with an annual production capacity of 700,000 tons, the largest EO/EG project in the world at that time.

At the same time, CTCL continued cultivating its business in Taiwan, successively completing a range of engineering projects including power plants, high-speed rail, MRT, hi-tech electronics, and biopharmaceuticals, and creating new developments in the establishment of domestic subsidiaries such as CTCL Advanced Systems Inc., known for its professionalism in the field of system integration, which listed on the over-the-counter market in 2002. The company extended its environmental resources and Energy-from-Waste plant operation businesses, in which it had already established a solid base in Taiwan, to Macau and Mainland China, and its subsidiary ECOVE Environment Corporation listed on the over-the-counter market in 2008.

CTCL's development strategy was to plant its feet in Taiwan, and after

accumulating an adequate record of performance, begin developing overseas markets. Pursuant to this strategy, the company established a foundation of power plants and MRT projects at home, and used this foundation as a springboard for advancement into overseas markets.

With the constant expansion of the group, and the increasing internationalization of its business, CTCI carried out organizational restructuring and the promotion of a culture of exquisite works that could meet the pressing needs of growth. Beginning at the end of 2003, the company built a three-level risk management system centered on the Board of Directors, corporate management, and business operations , with business operations managing risk at the project execution level, the corporate management being responsible for overall operating targets as well as accounting, legal, and cost control matters, and the Board of Directors taking final responsibility for decisions on the company's long-term development strategies and directions.

In 2004, following its reorganization, CTCI began promoting a sophisticated engineering culture by transitioning from its original design-oriented “silo culture” to a project-oriented “project team culture,” in which project teams take complete responsibility for providing services, according to contract, that satisfy customers in an all-out effort to advance toward the goals of “Winning Customer Satisfaction with Works of Exceptional Quality and Sharpening the Corporate Image for High Employee Commitment.” This effort provides a strong boost to innovation value and sustainable operation in CTCI's progress toward international development.

Because CTCI's business extends into different areas and different products, and the company must face different proprietors, cooperating partners, suppliers, and contractors, beginning in 2003, the company has used IT network technology to set up the most advanced global digital convergence systems available so that all data transmission, long-distance and international telephone calls, videoconferencing, cross-border collaborative design, and education and training within the company could be handled on this "digital information superhighway" network, breaking through the limits of time and space, reducing telecommunication costs, and greatly upgrading the speed and convenience of real-time communication. The company further installed the CTCI Corporate KM in 2006 to handle the compilation of information and management reports related to all stages of a project, including the proposal stage, execution stage, and final close-out stage. The experience accumulated in this way is used in feedback and reviews, revision of SOPs, working manuals and standards so that CTCI personnel all over the world could obtain the resources they need without regard to time or place.

At the same time, CTCI set up the CTCI Global Training System (GTS) to facilitate the sharing of accumulated information, experience, and wisdom. This developed the enterprise into a learning type of organization.

CTCI is more than one of Taiwan's top turnkey engineering firms. It is also an engineering industry leader in the field of corporate social responsibility (CRS). The company began publishing a "Corporate Social Responsibility Report" in 2008, becoming the island's first engineering services company to disclose non-financial information.

CTCI was also the first company in Taiwan whose “CSR Report” passed third-party verification.

Post
2010

- Business Blossoming Throughout the World
- A Reliable Global Brand Image
- The Hundred Billion Revenue Target

In early 2000, CTCI proposed the vision of “becoming a leading global provider of engineering services and innovative technologies” and set short-, medium-, and long-term targets for revenues of NT\$30 billion, NT\$50 billion, and NT\$100 billion, respectively. The group has already exceeded the medium-term target; and in addition to advancing toward the long-term target, in 2014, the group’s vision was revised and upgraded to becoming “the most-reliable global engineering services provider.”

The creation of such an astonishing performance is due, simply put, to the years of cultivation that have resulted in business blossoming throughout the world.

Within Taiwan, besides petrochemical projects, CTCI won its first co-generation project in 1995, and then successively won power projects at Dahtarn, Linkou, Talin, and Tunghsiao. The company’s technological level also constantly rose, from combined cycle generation technology to ultra supercritical generation technology. Beginning in 1990, CTCI contracted for sewerage system with designs and consulting work and municipal wastewater treatment plant projects. In 2016, it went further up a level and awarded Taoyuan Chungli Sewerage System BOT (Build-Operate-Transfer) Project, and Kaohsiung Fengshan Wastewater

Reclamation BTO (Build-Transfer-Operate) Project. The former was CTCI's first sewerage system BOT project, and the latter its first wastewater reclamation BTO project. Both were landmark projects for CTCI.

For overseas markets, the company continued the success in the Middle East by securing the QAPCO EP3 EPC project in Qatar in 2012, and in joint venture with CB&I, USA, a steam cracking plant with capacity of 880,000 MTA in Oman in 2015, which was the first time for CTCI to ally with an American engineering company, and its biggest overseas project to date. It marked a major victory for CTCI in the overseas engineering market.

In the Asian market, with which CTCI has long been familiar, there have also been a substantial number of successes. In the field of hydrocarbon projects, in 2008, the company won an EPC contract for a LNG receiving terminal in Kochi, India, and established CINDA Engineering & Construction PLC. In 2014, CTCI succeeded in winning PRPC RAPID Package 1 RFCC EPC Project for Petronas in Malaysia. This project, worth more than US\$1.3 billion, was an important milestone for the company.

Looking at all that it has accomplished abroad, CTCI's most impressive breakthrough during this stage was its entry into the American market. The successful extraction of shale gas in the U.S. changed the global energy and petrochemical map, putting the U.S. ahead of the countries in the Middle East as an oil producer, and making it the hottest spot for petrochemical investment. Seeing a good outlook for the ongoing performance of the U.S. market, CTCI established CTAS Corporation

in Houston in 2009 (renamed as CTCL Americas, Inc. in 2016) with a developmental strategy different from those in Europe, Japan, and Korea. It hired an American operating team that was assisted by the mother company's professional design and procurement skills, and formed strategic alliances with U.S. construction companies so as to use the combined "Taiwan + America" advantage in striving for business, and growing strong in the American market, and to continue creating new achievements in CTCL's global deployment. In this wave of opportunity, the company won detailed design contracts for LDPE Project of Formosa Plastics USA and EG2 Project for Nan Ya Plastics, both in Texas, USA. This had great significance for CTCL, being its first step into the U.S. market and the shale oil business. In the future, the U.S. might well become an important location in CTCL's overseas deployment.

Since investment in petrochemical projects is vulnerable to the impact of international oil price fluctuations, CTCL began investing in the overseas infrastructure and general industrial market very early. While this investment started later than the petrochemical projects, it has borne fruit in recent years.

A review of current achievements shows that CTCL has won three Singapore MRT projects, including third-stage track work for the Downtown Line in 2011, entering the Indian general industrial market for the first time in 2012 by contracting for the installation of China Steel's first-phase annealing and coating line, thereby helping with overseas deployment by Taiwanese enterprises, and completing power plant projects in Malaysia and Thailand. These projects helped CTCL establish its presence, in both petrochemical and non-petrochemical

fields, in markets outside of Taiwan.

After many years of cultivating within the engineering market, CTCL has come to realize that a constant heightening of corporate value will necessarily further strengthen brand image. Pursuant to this realization, the Group initiated a “brand transformation plan” and presented a brand-new CTCL global image to the world in June of 2016, establishing for itself a “most reliable” brand spirit under the slogan “Discover Reliable.” The Group uses this single and consistent brand identity and communication slogan to market itself to the outside world, forming a brand image of “the most reliable global engineering services provider.”

To further upgrade synergies and team fighting power, CTCL again carried a large-scale restructuring entailing the establishment of an Executive Committee as its highest guidance unit and the consolidation of its subsidiaries into three business groups according to their service attributes—Engineering, Intelligent Solutions, and Resource Cycling—as well as the addition of a Group Shared Services.

CTCL spares no effort in carrying out CSR, and since 2015, has continuously been chosen for inclusion in the Dow Jones Sustainability Indices (DJSI), representing international recognition. To strengthen its social participation dimension, CTCL set up an educational foundation to upgrade educational standards, cultivate outstanding talent, encourage academic research, build an environment for lifetime learning, and promote national competitiveness in the hope of developing more engineering talent for Taiwan.

Ever since its establishment, CTCL has never faltered in challenging itself in a stable and proactive manner, not only surpassing its competitors, but also widening its gap between them. Under the principle of sustainable operation, the company has held securely to its position as No. 1 in Taiwan, while climbing into the ranks of the world's Top 100 engineering firms. The Group's leader, Chairman John T. Yu, was selected by the *Harvard Business Review* as one of the 50 best-performing chief executive officers (CEOs) in Taiwan in 2016. He was also selected to receive an Outstanding Corporate Sustainability Professionals Award from the Taiwan Institute for Sustainable Energy that year. CTCL's success is not only the proud achievement of a sustainable enterprise, but provides an ideal model for other Taiwanese companies advancing into the global market.



Chapter 1

Building Reliability You Can See

The CTCL Headquarters building on Zhongshan North Road, Section 6 in Taipei soars like a tall tower into the clouds.

At 9:00 in the morning, the meeting room of the Conference Center is already filled with a babel of voices. Project teams and partner companies crowd around the meeting table in a week-long kick-off meeting. In addition to CTCL's Taiwan personnel, those carrying on discussions at the table include engineers who have come from Singapore, Thailand, India, and other countries. They express their opinions enthusiastically, hoping to come up with the best possible proposal before the owner joins the meeting.

This kind of "multinational consultation" takes place just about every day in various meeting rooms of the building. At the same time, in different corners of the world, CTCL people are getting ready to join the tough battle of the day.

Teams Campaigning Around the World

Our lens turns to an oil-refining and petrochemical complex operated by the government-owned Petronas in the Pengerang area of southern Malaysia. A heavy oil catalytic cracking project, which CTCL is carrying out, has entered its peak period of construction, and a huge waste-heat boiler assembled in Taiwan is just being installed.

The owner of the project is a state-owned enterprise, charged with the heavy responsibility of developing Malaysia's petroleum and natural gas resources, and of increasing their value. Large, internationally renowned engineering firms from Europe, America, and Asia competed

for the project. The winner, CTCL of Taiwan, has exhibited outstanding performance, running ahead of schedule, and has been repeatedly rewarded with certificates of appreciation by the project owner.

To break away from the stereotypical view of oil refineries and petrochemical plants as mere wasters of energy and polluters of the environment, when CTCL engineers are designing plant operating processes they apply their minds to how to use the end residue, and how to recover wastes and waste heat to achieve resource recycling and strike a win-win situation for both the economy and the environment.

Let's take a look at the construction site of Singapore's sixth Mass Rapid Transit (MRT) line, the Thomson Line. The construction team led by CTCL is using a gantry crane to move sections of track preassembled of rails and sleepers into the tunnel, where they are emplaced by automatic track laying machine. After the construction is complete, people will be able to travel on this line between Singapore and Johor Bahru in Malaysia, saying goodbye to the nightmares of frequent highway traffic congestions.

This is a Singapore MRT engineering project for which CTCL contracted following the Downtown Line Stage 3 Trackworks undertaken in 2011. The project owner is the Singapore Land Transportation Authority (LTA), which not only had extremely strict demands in terms of quality, but also placed heavy emphases on safety, health, and environmental controls during the construction period. In addition to completing the project on time within extremely tight time constraints, CTCL received the Zero Accidents Recognition Award and the Construction Safety

Merit Award from the LTA—the first Taiwanese company to receive such awards.

Now, let's swing our lens to the Sultanate of Oman in the Middle East. The government-owned oil-refining and petrochemical company ORPIC invested in the Liwa Plastics Industrial Complex at Sohar, a hundred kilometers north of the capital Muscat. The first 800,000-ton steam cracker and associated utilities package here, with a contract value of US\$2.8 billion, was won by CTCI and the American company CB&I as a Joint Venture.

The Liwa Plastics Industrial Complex is scheduled for completion in 2020. In addition to providing a large amount of employment opportunities, it will also stimulate the development of the downstream petrochemical industry and optimize the value of petrochemical products. CTCI shoulders the heavy responsibility of the most expensive and most important core engineering project within the Complex.

From Malaysia's Petronas, Singapore's LTA, and Oman's ORPIC; from petrochemical engineering to infrastructure construction: why are these international project owners willing to entrust such heavy responsibilities to CTCI of Taiwan?

Because CTCI represents "reliability you can see."

A Silent Driver of Taiwan's Economy

Even as CTCI is directing its forces overseas, it is playing the role of a

silent driver of the Taiwan economy.

For a long time, manufacturing was the locomotive of Taiwan's economy. Mass production requires factories; building factories is CTCI's specialty, and it builds everything from petrochemical plants and oil refineries to pharmaceutical plants, liquor plants, and technology plants. CTCI is different from most engineering firms in that its business consists of turnkey contracting that encompasses planning, design, construction, and even maintenance. This vertically integrated turnkey contracting service provides everything the customer needs with a single contract.

After a factory is built, it cannot operate without electricity: CTCI is a master at building power plants, helping Taiwan to create low-carbon, high-efficiency thermal power generation. Over the years, the company has built a solid cooperative relationship with the Taiwan Power Company (Taipower), including the turnkey project of the world's fourth-largest combined cycle power plant for Taipower at Dahtarn. CTCI currently has three Taipower turnkey projects in hand: the Linkou Power Plant, the Talin Power Plant, and the Tunghsiao Power Plant. At the same time, CTCI has followed up on its optimism about the future potential of renewal energy development by establishing the G.D. Development Corp., in a joint venture with a major solar energy player GINTECH Energy, for the development of solar power systems.

After a factory operates for a long time, it will often develop "hidden dangers." In a petrochemical plant, for example, when the temperature of a heat exchanger rises, its flow rate tends to decline, while the instruments in the control room continue to show it in the normal range.

If this kind of hidden danger is not dealt with, it might result in a crisis that snowballs out of control. The CTCI subsidiary, CTCI Advanced Systems Inc., can help factories prevent hidden dangers by collecting information, analyzing it, and making predictions from it, thus assisting to move production in the direction of smart operation.

Transportation construction is the link that provides for the flow of people, goods, and money, making it an essential part of the economic development hardware. CTCI has not been absent from this field of endeavor. It first became involved in MRT electromechanical systems; starting with the Muzha Line of Taipei MRT, it later on participated in the Banqiao-Nangang Line, Tucheng Line, Xinzhuang-Luzhou Line, and Xinyi-Songshan Line of the Taipei MRT, the Airport MRT, and the Wuri-Wenxin-Beitun Line of the Taichung MRT.

Besides MRT construction, CTCI has also won contracts for railway engineering (Hualien Stone Railway Transportation for China Steel Corporation, Taiwan High Speed Rail Taichung Station, Taiwan High Speed Rail Yanchao Main Workshop), highway construction (Second Freeway, Taipei-Yilan Freeway), and even airport engineering (automatic baggage handling systems, road and taxiway surface lighting systems), among others.

To deal with the constant stream of problems that come with economic development—garbage, sewage, air pollution—CTCI has devoted its efforts to the development and application of energy from waste technology so as to reduce the impact of industry on the natural environment.

Take the garbage problem as an example. CTCL contracts the build, operation, and maintenance of Energy-from-Waste plant; CTCL subsidiary, ECOVE Environment Services Corporation, operates a third of the 24 Energy-from-Waste plants around Taiwan, and another subsidiary, ECOVE Waste Management Corporation, handles the management and clearance of industrial waste.

Another example would be the sewage problem. CTCL began undertaking turnkey contracts for industrial waste treatment early on, and in 2016, took on BOT project of the sewage system for Taoyuan City's Chungli District as well as a waste-water reclamation BTO project for the Fengshan River Wastewater Treatment Plant in Kaohsiung City, improving river pollution and supplying reclaimed water for industrial use.

Furthermore, CTCL has been involved in the prevention of air pollution for more than 20 years, reducing flue gas emissions, lowering the impact on public health, and alleviating the risk of environmental destruction through air pollution improvement engineering at the Taichung Power Plant, the installation of a flare gas recovery system in the CPC's Talin Refinery flare gas tower, and other projects.

Highly efficient factories, an abundant supply of power, and convenient transportation are all essential conditions for economic development. CTCL contracts projects that help industry set down solid roots in Taiwan, while shouldering the burden of protecting the Earth, providing energy-conservation and environmental-protection programs for project owners and achieving the goal of sustainable operation. This, too, is creating "reliability you can see" for Taiwan.

Professionalism, Integrity, Teamwork, Innovation

CTCI is committed to being “the most reliable global engineering services provider,” and the establishment of trust is inseparable from the corporate culture of “professionalism, integrity, teamwork, and innovation.”

First and foremost, CTCI is a provider of engineering services, undertaking construction of plant, power plant, and MRT projects with huge budgets and high technology thresholds that admit of no errors. If things are not done properly at the design stage, the wrong equipment will be purchased in the procurement stage; if problems occur in the construction stage, the construction will have to be torn down and rebuilt. The result will be delays and losses instead of profits, and drastic damage to the company’s image.

Simply put, professionalism is a fundamental condition for establishing a foothold in the engineering services sector. Without professionalism, there is no room for survival.

CTCI regards its corporate goals conscientiously and is determined to work with all of its cooperating partners to serve customers, from start to finish, with the utmost professionalism. In addition to paying strict attention to detail so as to assure that a job is done right the first time, the company also respects the needs and the unique culture of each client in providing the best practical suggestions that incorporate cost competitiveness, quality assurance, and professional technology.

CTCI Group Chairman John T. Yu notes that the company has always

placed absolute importance on its professional image; this is what has enabled it to win large engineering contracts at home and abroad, and even prompted prestigious enterprises to come knocking at the door for cooperative opportunities. Internally, the company's employees feel it an honor to work for a company with such a professional image.

In addition, integrity can be said to be the foundation of trust. CTCI does not quote haphazard prices to project proprietors, and after winning a contract, it will never abandon the project or complete it carelessly whatever the difficulties or challenges. For CTCI, a commitment to a client is a mission that must be accomplished.

Former CTCI Executive Vice President Pi-Chuan Chen recalls that when an explosion occurred at the Dashe plant of the China Petrochemical Development Corp. in its early days, CTCI took on the task of carrying out repairs and, with day after day of tireless work, completed the reconstruction in just two or three months.

In order to complete the reconstruction job in due time, then EVP Chen worked until 10 pm every night, even on weekends. Worrying that the work might fall behind schedule, he would visit subcontractors to urge them on to greater efforts. Seeing this ranking executive of the general contractor coming to visit, the boss of one subcontractor, who rarely appeared at the work site, was moved to visit the site himself to oversee the work on a regular basis.

“Without any instruction from their supervisors,” Chen says, “every one of our colleagues worked with firm confidence to produce results for the client, whatsoever. I’m sure that an emphasis on the spirit of

integrity is embedded in the DNA of every CTCL employee.”

The expression of professionalism and integrity requires team cooperation. What CTCL undertakes is turnkey contracts; every project requires the integration of personnel from design, procurement, and construction departments, and even of the construction teams of partner companies and subcontractors. “We are by no means a one-man show!” John T. Yu emphasizes.

To form a combat-ready team, a company must not only cultivate outstanding leaders, but must also bring about team consensus and heighten the loyalty of its employees. Throughout the decades, CTCL has never stinted in care for and cultivation of its employees in terms of salaries, fringe benefits, learning environment, and growth opportunities, even offering such benefits as employee stock ownership trust and employee stock options to establish a sense of identity and belonging to the company among employees, from the grass roots to the highest ranks.

To provide “leadership by the heart,” CTCL uses a mentor system to inculcate the corporate spirit, and has worked hard in recent years to create a brand image so that employees will feel honored to be “CTCL people,” and to internalize team awareness.

Innovation is the weapon that CTCL uses to create differentiation and widen the gap with its competitors. John T. Yu states frankly that second-tier engineering firms are currently chasing to catch up from the rear, with first-class firms ahead of CTCL, and that innovation is essential to staying ahead of the competition.

One expression of this innovative capability is the forceful promotion of iPEC in recent years by CTCl, which has never faltered in the effort to adopt new production processes, new technologies, and new equipment. In response to the constant renewal of smart high technology and the advent of the Industry 4.0 era, CTCl integrates Industry 4.0's small-volume, large-variety smart management concepts into EPC turnkey engineering by linking together design, procurement, construction, installation, management, and acceptance checking, and even equipment suppliers and subcontractors, into a single information platform to provide a new and innovative way of EPC engineering management thinking.

In addition, CTCl will make use of the latest popular technologies including virtual reality (VR) and augmented reality (AR). VR will allow project owners to feel that they are personally on site to inspect planning, design, and construction conditions, while AR will help them to find operational and maintenance information more conveniently after the construction of their factories has been completed.

Professionalism, integrity, teamwork, and innovation: these four factors are linked with the aim of satisfying the needs of project owners and establishing CTCl's corporate image for reliability, thus securing opportunities for new plant-construction contracts with existing project proprietors and developing new clients.

Ready to Become the World's Top Ten

The Chinese character - “鼎” - in the Chinese name of CTCl signifies the ancient Chinese cooking cauldron with its characteristics of stability

and strength, and by extension support and reliability. This is the perfect symbol of CTCL's brand image for reliability.

With the setting of new record highs in revenues, contract amounts, and backlog of contract in progress, CTCL's outlook has been elevated from a "leading global provider of engineering services and innovative technologies" of the past to the "most reliable global engineering services provider." To assure the Group's sustained growth, CTCL has initiated a rebranding plan, designed to reinforce its global visibility and identity with the purpose of not only remaining No. 1 in Taiwan, but also of winning worldwide recognition. CTCL, in this way, will come to represent the "most reliable," most respected international engineering services brand.

"I can boldly say that the time for CTCL to rise to a new level has come," says John T. Yu. The company is pursuing four US\$1 billion projects that it expects to win in the near future, all of them as a result of corporations coming to knock at the door for cooperation with CTCL. In earlier times, this would have been hard to imagine. Compared with major cooperating partners of the past, such as Chiyoda and JGC, whose recent performances have been less than ideal, CTCL's continuous growth makes people sit up and take notice.

During its advancement from the design and construction of small projects to large-scale turnkey contracting, CTCL has basically been a provider of engineering services. In the future, the company hopes to use M&A to become an owner of process patents so that project proprietors wishing to use its processes will have to seek out cooperation with CTCL. This will lead to even more explosive

momentum for growth.

Surrounded by rivals in the global competitive environment, CTCI has found its own position from which to wage international business battles, and emphasize its reliability in the aspiration to enter the ranks of the world's top-ten engineering firms.

Expert's Commentary

Internationalization of Corporate Culture through “Rule by Culture”

CTCI has used its own strength to pave a road of its own, and develop into a global engineering services team. The constant growth it has maintained for many years now is truly a rare achievement.


However, there are several points on CTCI's road to internationalization that could use more work. First, the company should cultivate international talent more aggressively, not only in Taiwan but in subsidiaries in other countries, because only through the nimble use of worldwide talent can talent truly be globalized. Secondly, the corporate culture should be more internationalized and the company should advance from “rule by man” to “rule by law,” and on to “rule by culture” so that each CTCI employee, at home and abroad, will have an intangible cultural linkage. This is

the only way that CTCL can become a truly international company.

In addition, as the company grows in size, the value of the projects it contracts will also become larger. It must manage risk properly if it is to stabilize its “most reliable” brand name.

In my observation, some of Taiwan’s enterprises have their feet planted firmly on the ground but lack strong ambition, while others dare to dream but are not pragmatic enough. CTCL has both ambition and pragmatism, which many companies should learn from in this respect.

Prof. Swee-Huat Lee, College of Commerce, National Chengchi University



Chapter 2

Stable Growth through Transformation and Innovation

Ever since its establishment in 1979, CTCI has been an outlier among Taiwanese enterprises.

In one respect, CTCI is completely stable. Ninety percent of CTCI employees are engineers and the company engages in true turnkey engineering, without embellishment and keeping a low profile. Even the company's revenues climb at a stable pace; in 40 years, it has yet to suffer a single year of loss.

In another respect, CTCI is quite agile. Starting out as a purely local design and construction company, it has developed into a world-class engineering group that handles everything from design and procurement to construction and commissioning. From small to large, from a single point to an expansive area—CTCI has sought momentum for continuous growth through constant transition.

A detailed analysis shows that CTCI's journey to the present day can be encompassed in three key terms—EPC contracting, internationalization, and cross-field operation—which give an insight into how the company has grasped business model innovation to create a gilded name in the engineering world.

From Engineering Design to EPC Contracting

We cannot talk about CTCI without mentioning EPC, which means turnkey work that includes engineering, procurement, and construction. An adamant adherence to the EPC road is the main factor that has enabled CTCI to grow and wax strong.

CTCI Group Chairman John T. Yu notes that engineering firms can be divided into different types: engineering consulting companies, which mainly carry out design work for project proprietors, and construction companies, which build according to designs that have already been complete.

In Yu's view, engineering consulting companies need only to handle design, charging according to time spent, and have no responsibility to the construction work; for this reason, it is easy for them to lack an integrated approach to the design process. Construction companies, for their part, can only build according to the blueprints, so they know what they are doing but do not know why they are doing it. Each of these two types of engineering firms operates under its own constraints

Five Advantages of EPC Firms

The EPC model offers the following major advantages:

- 1. Clear delineation of responsibility:** In EPC contracting, design and construction are in the hands of the same team, meaning that there is a single responsible authority so that the feasibility of construction is taken into consideration during the design stage. Should any contradiction or conflict occur between design and construction, the EPC contractor must find an integrated solution to the problem.
- 2. Shortened schedule:** Since an EPC (or turnkey) contractor is responsible for both design and construction, the number of tenders is reduced and time is saved. The EPC contractor can start procuring materials and equipment, and preparing for construction operations

before design-stage work is completed, reducing procurement time by 30% compared with the traditional subcontract bidding model. Furthermore, with design and construction being carried out by the same team, interaction is intimate and there is less need for redesign. This can greatly reduce the total time needed for design and construction.

- 3. Guaranteed quality:** Since an EPC contractor must bear 100% responsibility for the final product, the members of its team comprise an integrated community for which the ultimate goal is creation of the highest performance and best engineering quality for the team, from design to procurement to construction. This avoids the common subcontracting problem of each subcontractor working for its own ends.
- 4. Reduced construction costs:** The EPC contracting model can inject professional construction authority into the design stage so that resource utilization and construction methods can be made even more efficient, thereby lowering construction costs.
- 5. Encouragement of R&D:** In the traditional engineering contracting model, the construction company's responsibility is simply to carry out construction according to completed blueprints. The EPC model, on the other hand, provides greater space for design and construction so that, under the precondition of conformity with the needs and functional specifications of the project owner, newer and better methods for completing the project can be developed.

For the project owner, the EPC model is superior to the separate

procurement model in terms of quality, efficiency, and cost; however, EPC contracting also tests the technological and management capabilities of the engineering company, and its threshold to entry is relatively high. It is not something that can succeed with manpower alone.

Citing the procurement stage as an example, John T. Yu states that in order to control the schedule, the ordering of equipment with a long delivery time needs to begin within three months of contract signing, and that piping, parts, and other materials need to be ordered during the detailed design stage. Otherwise, needed materials will not be available when construction begins.

Simply put, an EPC contractor needs to carry out procurement before the design stage is completed; purchasing too much will result in losses, and purchasing too little will result in a shortage of materials. Without adequate experience and professionalism, it is very difficult to calculate needs precisely.

For CTCL, EPC contracting can bring the greatest benefit to engineering. This factor, plus the high threshold that makes entry difficult for most engineering companies, prompted CTCL to position itself as an EPC contractor early on—a visionary decision.

Because of the multiple interfaces and complex number of items involved in EPC contracting, the slightest change in one part of the process can affect an entire project. Carrying out EPC projects overseas even involve the adoption of a cross-border division of labor. You can imagine how difficult this is for the average engineering

company in Taiwan.

Three Big Challenges to EPC Engineering

Mark W.H. Yang, former CTCI Group Engineering Business Deputy CEO, points out the company prides itself on another core element in its professional strength: its engineering integration capability. Proper integration must be carried out across departments, among departments, and among companies (between CTCI and its suppliers):

- 1. Horizontal integration of engineering design:** Engineering design accounts for only 5% to 8% of the cost of plant construction, but more than 70% of the data of an overall project is produced during the engineering design stage. Design, therefore, is the key to a project's success.

Engineering design can be divided, in accordance with the professional division of resources, into process design, civil design, equipment design, instrument control design, piping design, electrical design, and safety/environmental/health engineering design. Each of these divisions has its unique professional characteristics, and their effective integration through the use of information systems is extremely important (for details, see Chapter 4).

Another challenge of engineering design integration is to fully utilize resources from different parts of the world in adopting a concurrent global multi-office engineering design operating model that links together design data and products dispersed throughout various design offices to achieve a borderless distance concurrent design.

2. Vertical integration from engineering design to commissioning:

The advantage of EPC contracting is that the needs of procurement, construction, and commissioning are taken into consideration during the engineering design stage, allowing achievement of the most effective cost. Besides strengthening interchange among these four elements, after the design work is completed, CTCI sends engineers to participate in the work at the construction site, thus achieving the seamless connection of design with construction and enabling more in-depth interaction between design and construction personnel.

3. Integration of supply chain management: Since design work is affected by the timing of delivery of design documents from equipment vendors, in its contracts CTCI strictly stipulates schedules for document delivery, and penalties for delays, so as to establish relationships of mutual trust and benefit with its clients and become their long-term partner. In addition, the company has set up a “Project Service Supply Chain Management system” from which qualified suppliers can be found quickly and the approval of clients obtained timely.

Organizational Change and Breaking Away from the Silo Culture

The core of EPC contracting is integration, for without it “engineering, procurement, and construction” will be three separate activities, independent of one another, as if three or four different companies were at work, and quality will greatly suffer. How to break through departmental boundaries and effectively strengthen mutual interaction is the trial that CTCI faces in undertaking EPC contracting. CTCI Group Chief Vice Chairman John H. Lin says frankly, that as a small design and construction company in its early days, CTCI could hardly avoid a so-

called “silo culture,” in which each department acted on its own without sufficient communication and interaction. Although each department worked hard to accomplish its own tasks, the final results were less than ideal. When a company is small it can manage to keep going operating in this way, but once it grows into an international enterprise, it must change its corporate makeup.

Beginning in 2004, CTCI has committed itself to “Winning Customer Satisfaction with Works of Exceptional Quality,” carrying out reorganization toward customer orientation and tasking project teams with the full responsibility to provide services that satisfy customers.

Under this “single window” mode of operation, project managers are actually project general managers who lead ranking project executives, including project control managers, project engineering managers, project procurement managers, project construction managers, project quality managers, project safety, health, and environmental managers, and project IT managers in all-out mutually supportive and cooperative efforts to complete turnkey construction smoothly and provide services that satisfy customers. The managers of different departments are responsible for providing the needed manpower, and training related personnel in the technical and managerial skills necessary to satisfy the needs of the projects.

CTCI’s reorganization has centralized authority, clearly delineated responsibilities, and improved implementation capability, enabling the company not only to satisfy all customer demands at once, but also to respond directly to market changes.

Along with the customer orientation of its organization, CTCI has used all kinds of internal publicity to remind employees that they must put themselves in the client's shoes and think on its behalf. "We must produce what the customer thinks is satisfactory, not what we ourselves think is satisfactory, because only in this way will we have an endless stream of work," emphasizes Group Chief Vice Chairman Lin.

From its origin as a small contractor, CTCI has developed into an EPC contractor; and from small-scale EPC contracting, it has advanced into medium-scale and then large-scale EPC contracting. From its former role as a subcontractor for international engineering firms, it has developed into a company that can undertake turnkey contracting in joint ventures with large, international firms.

From Subcontractor to Joint contracting

Simply put, joint contracting is the formation of an alliance by two or more engineering companies for the purpose of joint bidding and joint project execution for mega-sized hydrocarbon projects or infrastructure projects.

Andy Sheu, the CTCI Group's second vice chairman, explains that project owners have a lot of factors to consider when they are evaluating the qualification of engineering contractor: technology, experience list (proven track record), financial capability, safety record, etc. If an engineering contractor lacks adequate technical capability for a certain stage or a certain part of a project, or if its experience list could not satisfy the requirements of the project owner, then it will seek out another engineering contractor with the needed technical capability

and experience list to participate in a joint bid. After the contractor is secured, the two companies will carry out the project together.

Since different engineering firms have different areas of technical expertise and different performance records, the use of the joint-venture method not only helps them to win bids, but also allows them to spread risk. They need not put all of their own resources into a single project; and when the project is completed, they will have accumulated a performance record that will help them bid for future work.

Joint contracting can be further divided into two types: consortium and joint venture. A consortium is a relationship established via a contract which stipulates the rights and responsibilities of the two parties, while a joint venture is a company established to carry out a project, and once the project is completed the company is dissolved.

In adopting the consortium form of operation, each engineering company has its own rights and responsibilities, and each carries out the work within its area of responsibility. Each also assumes risk. The joint venture form is designed with a division of labor, but procurement is jointly handled by the partners, and profit or loss are also assumed jointly.

Whether companies engaging in joint contracting choose to form a consortium or a joint venture is determined by how the partners want to share costs, risks, and profits, as well as by local laws and regulations. For certain projects, two engineering firms might form a joint venture and then go on to form a consortium with other engineering firms.

Whether a consortium or joint venture, or consortium plus joint venture, the project owner will be able to accept it so long as one of the companies plays the role of leader.

Andy Sheu recalls that in the 1990s, the engineering industry mostly used the consortium form of operation, while after 2000, the joint venture model became the mainstream. CTCI's early experience with joint venture operation can be traced back to 2004, when it participated in the EPCC bid for the Taichung LNG Receiving Terminal of CPC Corporation.

CTCI had the capability to perform gasification unit alone but needed a partner for the LNG tanks. After several tries, it found IHI Corporation, Japan, which had the technology and a proven track record, and both companies agreed to form a joint venture, secured the contract and successfully completed the project.

In view of successful co-working, in 2006 CTCI again co-worked with IHI and together with the Wuhuan Engineering Co., China, as a joint venture, secured an EPCC contract for the Shanghai LNG Receiving Terminal in Shanghai, China.

Each engineering company has its own organization, procedures, and systems, and the development of cooperation with other companies naturally involves a period of adjustment. For some projects, for instance, the cooperating partner is responsible for basic design while CTCI shoulders the detailed design; since the two parties may use different design operating platforms, the integration of design data from the two sides can pose a challenge. All of the material marks

established by the partner have to be converted once they get to CTCI so that the receipt, requisition, and issuance of materials at the construction site can be centrally managed.

Andy Sheu does not hesitate to say that it is difficult to avoid problems when two engineering firms enter into cooperation, and when problems arise, it is time to sit down and discuss how to solve them. Whatever the case, the top priority is to get the project completed on schedule.

Alliance with International Engineering Firms

Being able to undertake joint contracts with other world-class engineering firms means that CTCI has achieved a certain standard in terms of technology and performance. High-profile projects undertaken by the company since 2014 include, for example, a PRPC RAPID Package 1 RFCC Project (residue fluid catalytic cracking) for Malaysia's state-owned oil company, Petronas, with a contract value of more than US\$1 billion.

The Malaysia project was similar to the residue oil conversion unit EPC project that CTCI had previously carried out for the CPC Corp.'s Talin Refinery, so the company had the necessary performance record in terms of technology, but since it had never before cooperated with Petronas, it formed a joint venture with the Japanese company Chiyoda, which had experience working with the oil company, and then formed a consortium with two Malaysian contractors.

The overall development of the Malaysian refinery and petrochemical zone encompassed more than 40 projects that were contracted out to

large, internationally known engineering firms from Europe, America, and Asia. To join their ranks, CTCL had to compete not only on quality, but also on scheduling. It did not disappoint expectations; it was first to complete 90% of the 3D model review and start installation of piping and equipment at the construction site, leading the other contractors by as much as 10% in progress.

CTCL's outstanding EPC engineering integration and implementation capabilities, and its on-site safety and health management performance, were recognized by the granting of Best Contractor and Best Area awards, along with a certificate of gratitude, by the project owner in February of 2017. In March, the project team installed, on schedule, two 2,000 -ton modularized waste heat boilers, the two heaviest boilers ever to land on Malaysia's shores, after having assembled them in Taiwan. This achievement brought about another certificate of gratitude from the owner.

Following the Malaysian project, CTCL and the American company CB&I jointly submitted a successful bid for a turnkey steam cracking plant project for the Oman Oil Refineries and Petroleum Industries Company.

CTCL and CB&I organized an alliance for this project, which is being carried out in the form of a joint venture. Each of the partners is doing its part of the design work. CTCL is leading construction; the design standards, blueprints, design practices, materials control, and construction site management systems, etc. all of which have to be integrated.

To make sure that CB&I's design information flows into CTCL's

construction management system smoothly and quickly, CTCI set up a designated website, project on web (POW), as a platform for two-way exchange of information.

CTCI's winning of such a large project, with a contract value of US\$2.8 billion, is an indication not only of its entry into the Oman market, but also of its outstanding engineering record and ability to execute international engineering projects. It has become a partner that international engineering firms are eager to work with in exhibiting their competitive advantage, and in securing even bigger business opportunities.

From Local Enterprise to World-class Engineering Group

With business territory stretching across Europe, America, and Asia, and with overseas revenues accounting for nearly half of its total, CTCI is one of the few Taiwanese engineering companies that can go head-to-head with large international firms. When it was first established, the company moved to put down roots simultaneously in the domestic and overseas markets. In addition to constantly serving domestic clients such as the CPC Corp., China Steel, Taiwan Power, and Formosa Plastics, it has extended its reach to the Middle East, Southeast Asia, and other regions.

Group Chairman John T. Yu notes that Taiwan's shortage of natural resources, such as petroleum and gas, and its small market, are the main reasons why CTCI had to develop markets overseas. A company that undertakes turnkey projects overseas, however, cannot be lacking

in either technology or performance record. Even though CTCI had established a record reputation in Taiwan, this was not enough to win the approval of international project owners. When the company first ventured abroad, therefore, its business opportunities came primarily from being a subcontractor to large international firms such as Chiyoda of Japan.

In facing initial challenges as such, CTCI relied on its professional technical capabilities and diligence, whether in the Middle East, Singapore, or Thailand, to win the consistent approbation of clients and project owners, and laid down a solid foundation for overseas operations. In other respects, although its operations at the time were limited mainly to construction subcontracting, cooperation with international majors enabled the company to gain actual experience with the complexity of turnkey contracting by international companies as well as the high standards required in terms of quality, scheduling, and industrial safety. The experience and learning gained during this period was vital to CTCI's subsequent growth.

When Mainland China aroused a wave of construction after the year 2000, prominent energy companies such as BP of the UK, BASF of Germany, and Royal Dutch Shell of Holland made large petrochemical engineering investments in China. CTCI, with its advantage of language and ethnic similarities, became an ideal partner for numerous international engineering firms wishing to enter into the mainland. In 2005 alone, CTCI completed six EPC projects in Mainland China.

With this record performance, CTCI's position in the international arena greatly improved, and inaugurated a golden age in the company's

internationalization.

Following Mainland China's construction fever, investment in Middle Eastern petrochemical projects has again heated up. CTCI returned to the Middle Eastern market with the heating furnace project for Qatar's EP2 Phase II ethylene furnace expansion project, while at the same time building on its years-long deployment in Thailand by winning three international EPC projects there. This removed any doubt of CTCI's position as a world-class engineering group.

CTCI's global network now covers Asia, the Middle East, and the Americas, and its business has expanded to Mainland China, Thailand, Vietnam, Malaysia, the Philippines, Singapore, the United States, India, the Middle East, and Russia. The company is unstinting in its efforts toward the goal of becoming "the most reliable global engineering services provider."

Relying on One's Own Strength without Help

The solicitation of overseas EPC engineering projects cannot succeed without long-term deployment.

First of all, a company has to be sensitive to trends; every time it enters a new market, it should first carry out a thorough evaluation to ascertain that opportunities actually exist. The company must station its own people in the new market not only to collect information but also to build relationships with clients. "You must have someone there to aggressively approach your clients on a daily basis; this gives the clients an entirely different impression if you send someone from Taiwan to visit every month," says John Lin. Whether you're doing

business in the East or the West, showing sincerity to clients is the only way to develop business.

For example, in 2006, CTCL won a project to build an ethylene oxide/ethylene glycol petrochemical plant for Saudi Kayan, a landmark case in the company's return to the Middle East market. CTCL was vigorously bidding on other projects before this, but the bids were unsuccessful because the project owners were not familiar with CTCL. After CTCL won this Saudi Kayan project, the owner and CTCL built familiarity relationship, and the owner came to trust CTCL, and CTCL started winning projects.

Compared with Japanese and Korean engineering companies, all backed by support from the government or large enterprises, CTCL had to depend on its own resources in pushing its way overseas and carving from the brambles a road to survival.

John T. Yu points out that to win overseas EPC projects, a company must first find a chance to bid. When large Japanese companies invest overseas, they are sure to go first to their own EPC contractors. In Korea, the government even takes Samsung and other engineering companies abroad to talk about investment projects, and requires the procurement of Korean materials and equipment. With this kind of government assistance, it is naturally easier for a company to strengthen its power.

"Without help," Yu emphasizes, "we have to rely on our own strength to win the favor of clients." It is natural for a client to exercise great caution when it turns a project worth hundreds of millions, or even billions of

US dollars over to an EPC contractor. In addition to technology and performance records, the client has to carefully review the contractor's project management ability, design capability, procurement and construction capabilities, financial power, corporate image, and even the assessment of other clients. There is no shortcut to success; it has to be built up, bit by bit.

For this reason, without government support, CTCI built itself up from a small design and construction contractor, refining its basic skills to the point where it is able to stand on its own feet in the intensely competitive international market.

Nurturing “Little CTCIs” Overseas

To conquer the world, CTCI moved toward the formation of an enterprise group, setting up subsidiaries in different places. Besides being capable of wholly independent operations, these local “little CTCIs” can work in concert with the mother company to contract for large engineering projects in their areas.

The establishment of CTCI's overseas subsidiaries can be traced back to the late 1980s, a time when the number of overseas engineering projects was shrinking, while Taiwan's petrochemical and refining industries were enjoying another boom, because the government was expanding infrastructure investment. This accelerated the growth of CTCI's business at home; the contracting of numerous EPC projects left the company in need of more manpower, so it established a subsidiary in Thailand to cultivate local designers to fill the mother company's need for the outsourcing of low-level drafting personnel.

The establishment of subsidiaries is also an indication of CTCI's determination to develop overseas markets over the long term. The young CTCI adopted what was essentially a nomad strategy, migrating to where the business was, and withdrawing when the job was finished. This strategy entailed a high price in terms of costs. If a company wants to operate in a certain territory, it is not something that can be done easily in just three or four years. Three or four years is generally the time needed to complete a single project; the effort cannot end after a single project, or the networks, relationships, and professionalism built at its location will be lost.

Subsidiaries that are established overseas help to send deep roots in their local areas, and in the early stages they support the work of the mother company. Once an opportunity for a large project appears in a local area, the subsidiary in that area can become CTCI's partner in acquiring work there, providing support for local design, procurement, and construction work.

Since the 1990s, CTCI has continued replicating its successful experience in Thailand, setting up CTCI Beijing and CTCI Shanghai in China, CTCI Malaysia, and CIMAS Engineering Co. in Vietnam.

Group First Vice Chairman John H. Lin reveals that the establishment of bases overseas represents an investment of a substantial amount, making it a challenge for the company's decision-makers. At the time he suggested setting up a base in Vietnam, it was difficult to avoid dissenting voices within the company, but finally the executives convinced the others to agree to the establishment of the Vietnamese subsidiary.

To support CIMAS, John Lin sent executives from Taiwan to carry out training in Vietnam and, at the same time, arranged for Vietnamese personnel to come for training in Taiwan. He actively sought job opportunities for the overseas subsidiaries, even offering the incentive of “free for the first three months” so that the subsidiaries could contract design work from the mother firm. Such attentive support helped CTCL’s overseas subsidiaries succeed and grow.

In addition to bringing overseas talent into Taiwan, CTCL has cultivated about 2,000 outstanding local engineers overseas. The result: the Group’s resources can be integrated whenever necessary to mount a “gang fight” to further the Group’s brand image and its synergies.

Focus, then Take Root

Countries from all over the world, including Japan, Korea, Mainland China, Europe, and America, have worked vigorously to enter ASEAN and South Asia in recent years, and Taiwan’s government, too, is promoting its New Southbound Policy with the aim of boosting linkage on the economic level with ASEAN, South Asia, Australia, and New Zealand for the sharing of resources, talent, and markets. CTCL’s long-term development of overseas markets through the completion of numerous petrochemical projects and power plants—such as its 30-year cultivation of Thailand—not only helps the government implement its policy but the “CTCL experience” also provides the government with an example to follow.

The first thing to do in moving overseas, John T. Yu says, is to focus. Whatever area you want to develop, or whatever industry, you need focus. “Only with focus can you concentrate your firepower.” If you

shoot recklessly, you won't hit a thing.

The next necessity is long-term cultivation, or “tapping into the local energy.” With the exception of the Middle East, where materials and manpower costs are too high, and long-term stationing is not an option, in all other areas CTCI will set up subsidiaries for long-term cultivation so long as the local economies are strong enough to provide adequate support. That is how the company has managed to spread and prosper overseas.

Another important factor in overseas development is the formation of strategic alliances. In pursuing the plant-construction project in Oman, for instance, CTCI went into cooperation with CB&I. In its recent entry into the American market, the cooperating partner Saudi Basic Industry Corp. gave CTCI a helping hand. This is why John T. Yu feels that if Taiwan's government wants to carry out its New Southbound Policy, it should find strong strategic partners, so that the partners working together can achieve better results.

Expanding from Petrochemicals into Other Fields

Even as it has worked vigorously to expand its overseas territory, CTCI has never forgotten to keep its roots in Taiwan. “Taiwan is CTCI's homeland, and our training ground for advancement into the international arena,” emphasizes Group Vice Chairman Michael Yang.

CTCI began life with Taiwan's petrochemical industry, and its contribution is visible in facilities such as CPC Corp. refineries and Formosa Plastics petrochemical plants. Domestic refinery and

petrochemical plant engineering was necessarily limited, however, and a breakthrough had to be made to ensure the company's survival. This is why CTCI entered the EPC contracting battleground, expanding from the field of petrochemicals into other industries.

But how was this new battleground found? Michael Yang explains frankly: "Wherever there is demand in the market, that's where we looked for business." When Taipei began planning to build an MRT system in the 1980s, it presented CTCI with an opportunity. In 1989, the company won the Taipei MRT's medium-capacity Brown Line electromechanical system engineering project, contracting for the power-supply system, information system, and depot maintenance facilities. The company also participated in design and construction supervision for Freeway 2, as well as the civil and electromechanical engineering for Taiwan High Speed Rail's T250 Wuri Station, the D250 Wuri Depot, and the D290 Yanchao Main Workshop.

Michael Yang points out that a performance record is vital in the engineering business, and that without any record of previous performance in MRT construction, CTCI naturally had no chance to win related EPC projects. CTCI could only start out by acting as a consultant to the Department of Rapid Transit Systems and then doing subcontracting (for electromechanical systems engineering). Only in 2003 was it able to act as main contractor in winning an EPC project for electromechanical systems for the Taipei MRT system's Xinzhuang-Luzhou Line. For this project, CTCI was responsible for everything from system integration, power supply system, platform screen door, tracks, and depot facilities to automated fare collection system, communication system, and TETRA.

Another important battlefield for CTCL in the non-petrochemical field is power plant projects, including cogeneration plants, oil- and coal-fired power plants, natural gas-fired power plants, and nuclear power plants. The company entered this field by taking on EPC contracts for the CPC Corp.'s Zuoying and Talin cogeneration plants. After that, when the Taipower made plans for new power plants to fill the gap in electricity supply left by the retirement of old power plants, CTCL successively won EPC contracts for the rebuilding of Taipower's Linkou Power Plant, Talin Power Plant, and Tunghsiao Power plant. This is now a major source of revenue for the company.

Michael Yang, who once served as project manager for the Dah-Tarn Power Plant, feels that compared with petrochemical engineering, the main challenge with building power plants comes from major equipment suppliers. If suppliers encounter design problems, those problems spread to the EPC contractor and encumber the entire schedule. If there is a large inflation in the cost of materials, whether it's building a petrochemical plant or a power plant, the project manager can only grit his teeth and try to find a way to control his budget and avoid a loss.

CTCL is also making its place in environmental engineering operations, from waste-water treatment to the construction and operation of Energy-from-Waste plant and waste disposal. Its Energy-from-Waste business is completely successful, prompting the company to develop a Group Resource Cycling Business.

Michael Yang points out that CTCL's growth in both the hydrocarbon and non-hydrocarbon markets is closely linked to Taiwan's economic

development. Whenever the overall environment requires some kind of infrastructure construction, the company comes in at the appropriate time to play the role of promoter for major engineering projects.

After CTCL established a record in Taiwan, whether in the MRT, power plant, or Energy-from-Waste business, it looked for opportunities overseas such as EPC track work for Singapore's Downtown Line III, EPCC turnkey for a cogeneration plant in Thailand, EPCC turnkey for Malaysia's combined cycle power plant, and operation of incinerators in Macau. All of these projects replicated CTCL's successful experience in Taiwan.

From Contractor to Diversified Operator

In opening up territory for the CTCL Group, in addition to overseas subsidiaries such as CTCL Beijing, CINDA Engineering & Construction Pvt., CIMAS Engineering Co., CTCL (Thailand), and CTCL Americas under the flag of the mother company, CTCL also has more than 10 domestic subsidiaries, including CTCL Advanced Systems Inc., CTCL Resources Engineering Inc., CTCL Smart Engineering Corp., ECOVE Environment Corporation, and ECOVE Environment Services Corporation that operate under the Group Intelligent Solutions Business (GISB), Group Resource Cycling Business (GRCB), and Group Engineering Business (GEB; mainly EPC engineering), to form a solid "three-pillar" structure.

The GISB integrates the operations of CTCL Advanced Systems Inc., which provides mainly industrial intelligent services; CTCL Resources Engineering Inc., which works in civil engineering; and CTCL Smart Engineering Corp., which is involved in electromechanical engineering,

with the aim of advancing from smart plants to smart cities.

CTCI GISB CEO Hwei-Nan Yih notes that CTCI Advanced Systems was originally the Group's Instrument & Control Department, engaged mainly in plant automation systems. It was spun off as an independent subsidiary in 1987, in response to the advent of the information age, to handle manufacturing management systems for petrochemical, electronic, and semiconductor plants. The forerunner of CTCI Resources Engineering was the CTCI Exploration Corp., established in 1984 to take on the CPC Corp.'s exploration-related projects. Later on, it expanded into civil engineering, and in 1988, it switched to its present name. The CTCI Smart Engineering Corp. was set up as a joint venture with a U.S. company to build domestic power plants, concentrating especially on introducing high-quality, high-safety nuclear power plant technology.

For the GRCB, ECOVE Environment Corporation acts as a holding company, while other subsidiaries engage in investment in the handling of waste management, collection, and disposal as well as Energy-from-Waste plant investment and operation. It is the only enterprise in Taiwan's Energy-from-Waste industry with an integrated model encompassing planning and design, turnkey engineering, and operation.

The establishment of ECOVE Environment Services Corporation to operate Energy-from-Waste plants marked a major milestone for CTCI's diversified operation. GRCB CEO J.J. Liao comments that "garbage wars" erupted in Taiwan in the 1980s and trash accumulated with no place to go. To resolve the problem, the government instituted a policy

of publicly owned, privately operated Energy-from-Waste plants in urban areas. CTCL responded to this policy by establishing ECOVE Environment Services Corporation as a subsidiary in 1994, and the following year, the new company won a contract to operate New Taipei City's Xindian Refuse Incineration Plant. This was the first time in Taiwan that the operation of an Energy-from-Waste plant was turned over to the private sector, and it was the first time that CTCL expanded from the field of design, procurement, construction, and commissioning into the field of operation and maintenance (O&M).

J.J. Liao discloses that when CTCL first wanted to bid for the operation of the Xindian Refuse Incineration Plant, because it had no experience and the contractor had to take full responsibility for operational results, the company carried out a great deal of internal evaluation before taking its first step into this new field. This bold move opened up new horizons for CTCL, which established the ECOVE Wujih Energy and ECOVE Miaoli Energy to undertake BOT Energy-from-Waste projects and the ECOVE Waste Management Corporation to handle the management and disposal of industrial waste. The Group also expanded this business territory overseas, establishing the SINO GAL Waste Services Co. to undertake the operation of the Macau Refuse Incineration Plant and Hazardous Waste Treatment Plant.

Core Competitiveness and Potential Opportunities

Looking back at CTCL's journey into different fields of endeavor, John Lin comments that it is more appropriate to say that the company extended its core competitiveness into new areas than to say it diversified its operations. It used its domain knowledge to develop new

markets, and did not rashly jump into industries unrelated to its basic business.

“Our basic business is engineering, and our core competitiveness is design and integration,” John Lin emphasizes. “As for what new domain knowledge we want to integrate, we observe the trends of the times to seek out the industry with the greatest potential.” For instance, CTCL entered the Energy-from-Waste business in response to government policy back in the early days, and today, environmental protection has become a national consensus; not only is zero pollution *de rigueur*, but energy conservation, carbon reduction, and resource recycling must also be carried out. This is why CTCL used the ECOVE brand effect to move beyond the Energy-from-Waste business and develop the new areas of photovoltaics and circular economy.

In the field of photovoltaics, CTCL went into a joint venture with the major battery manufacturer Gintech Energy to establish the G.D. Development Corp. for investment and development, construction, and operation of solar power systems. G.D. Development has already completed a 10MW photovoltaic power plant in Lumberton, New Jersey, and in Taiwan it has developed power plants in more than 15 locations. The company has developed photovoltaic power plants with a total generating capacity of 28MW.

Taiwan’s new government is vigorously developing the green energy and photovoltaic industries, targeting 20GW (billion watts) of photovoltaic capacity on the island by 2025. CTCL saw the opportunity in this at an early date, and based on the rich experience it has accumulated in developing a large photovoltaic power plant in the U.S.,

as well as its cooperation in major transportation construction projects and overall development in important fields in Taiwan, the installed capacity of photovoltaic systems that the G.D. Development Corp. develops, invests in, and operates is growing continuously.

In the field of circular economy, CTCI constantly develops along new themes such as investigating the relationship chains of different Taiwan industries, seeking out circular relationships, and converting wastes into valuable materials for other industries. For example, it bought shares in the Boretech Co. for the recycling of PET bottles into chemical fiber materials and established the CTCI & HEC Water Business Corp. to engage in the Fengshan River Wastewater Treatment Plant business in Kaohsiung City. CTCI also seeks opportunities for cooperation with the leaders of Taiwan's circular economy industry for the commercialization of related facilities and, when the time is right, once again moving into the international market.

In addition to the theme of environmental protection, CTCI also focuses its attention on the changes that intelligent technology is bringing to mankind. The core skill of CTCI Advanced Systems, for example, is industrial control; besides developing smart factory management and energy management systems that help factories save energy, reduce carbon emissions, and lower operating costs, the company can work with the CTCI Smart Engineering Corp. and CTCI Resources Engineering Inc. in the direction of smart homes and smart markets or with the ECOVE Environment Services Corporation to optimize Energy-from-Waste plant operations through intelligent controls.

John Lin compares CTCI's diversified operations to an airplane:

engineering is the aircraft body, and resource cycling and intelligence are its two main wings. The integration of the three parts can lead to even stronger competitiveness and the grasping of the next wave of business opportunities.

Expert's Commentary

Scaling New Peaks with High-level Local Manpower

CTCI has undergone quite a few transformations over the past 40 years, and I feel that this can be seen as a kind of innovation. The company developed not only new ways of thinking, but also new ways of doing things. EPC contracting, for instance, involves innovative integration, internationalization requires innovative globalization, and cross-border operation brings the effect of innovative diversity. Furthermore, CTCI's strategic alliances with international engineering firms enabled it to upgrade its competitiveness through cooperation with outside entities. This, in essence, is a kind of "open innovation."

A lot of companies, when they expand into industries outside their own professions, frequently meet their Waterloo because of unfamiliarity with the new field. When CTCI crossed over into the resource cycling and intelligent operations, it naturally had a better chance of success; it was an excellent demonstration of how it succeeded by making full use of its core competence.

If CTCL wants to climb to an even higher level in the future—to become truly multinational, for instance—it will have to make good use of high-level local personnel. Furthermore, if CTCL wants to achieve brilliant results in its foray into the realm of intelligent operations it will have to introduce yet more ICT talent and adjust the pace of its operations in this new area of endeavor.

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Chapter 3

The Mission to Conquer the World

At the CTCI First Quarter 2017 Investor Conference, a lot of good news was announced.

In addition to the four projects that CTCI has won in the American market, refinery, petrochemical plant, and ethylene plant projects are also pending in Middle East countries such as Oman, Saudi Arabia, Qatar, and Abu Dhabi, as well as in emerging market countries such as Malaysia, Vietnam, Thailand, India, and Kazakhstan. More projects are open to bidding this year than last, and CTCI hopes to win many of them.

Actually, CTCI's brilliant record in the international market today did not come easily. In every market, the company started out at zero, knocking at doors repeatedly and contesting one bid after another; project followed project, accumulating experience little by little to build up the strength CTCI enjoys today and win the approbation of project owners. This allowed the company to take on larger and more difficult projects.

Westerners say "The sky's the limit." For CTCI, however big the sky, so big is the market. Conquering the world and taking a place on the international stage is the mission that each CTCI employee must strive for. To trace the route of CTCI's overseas development, we must start out in the far-away Middle East....

The Middle East: Pulling Ahead in the Tight Competition with Japan and Korea

No caravans of camels moving slowly across the desert, but Toyotas

and Chevrolets speeding along freeways; no magic lamps and flying carpets, but high voltage electric towers and factories large and small. Yes, this was the Arabian world in which CTCL employees stationed in the Middle East found themselves.

The Middle East has the world's richest production of petroleum. Especially during the oil crisis, which erupted in 1979 and pushed oil prices to high levels, Saudi Arabia and other oil-producing countries were able to earn bundles of cash by selling oil. This naturally made them targets that international oil companies had to contest for.

CTCL went to test the waters in the Middle Eastern market soon after it was established. It set up an office in Jeddah, and set out in two directions, looking for jobs at Yanbu on Saudi Arabia's west coast and Al-Khobar on the east coast.

A CTCL employee who was stationed in Al-Khobar at the time recalls the difficulties of developing a design business in Saudi Arabia. Visits to target clients such as Aramco, Petromin, SABIC, and SEC would be met with polite rebuffs, and often after they completed company registration, nothing happened. Project owners might even suggest that CTCL cooperate with their own engineering companies, or become their subcontractors.

Only in 1982 did CTCL win a construction project from the Yanbu Petrochemical Co. (YANPET). All of the company's people congregated at the Jeddah office, determined to help carry out the YANPET project. CTCL sent a large force of elite construction troops, and there was a lot of interaction between Taipei, Jeddah, and Yanbu.

At the same time as it was undertaking the YANPET project, CTCI was awarded a contract for a small seawater chlorination unit at the Jeddah Refinery. While the scale was small, this was an EPC project encompassing engineering design, procurement, and construction.

In 1984, Saudia Arabia made plans to build a refinery at Buraidah in the northwestern section of the country's central region. Aramco, which was responsible for the project's execution, was known as being a strict watchdog; if CTCI had not established good relations and a solid performance record with the company, it would have been extremely difficult to win this new bid.

CTCI Group Chairman John T. Yu was sales manager in CTCI Arabia at the time, and he knew that the threshold for attracting the attention of Aramco was high, so he aggressively promoted CTCI to this potential client. The members of his team were highly excited when they received the invitation to bid for the refinery project.

Regrettably, the project was cancelled as a result of the war between Iran and Iraq, which also cut down on business opportunities in Saudi Arabia. With this setback in the Middle East, and petrochemical plant construction projects springing up like mushrooms because of the booming petrochemical industry in Taiwan, CTCI had no time to pursue the Middle Eastern market and temporarily withdrew from it.

A Ticket to the Middle Eastern Market

After the turn of the millennium and another round of soaring oil prices, the Middle Eastern market heated up again, and work started up on one petrochemical zone after another. Of course, CTCI could not be

absent from this new surge of money and manpower. After cultivating the Mainland Chinese market for more than 10 years and completing more than 10 large projects, CTCL was incomparably more capable than what it had been 20 years before. Returning to the Middle East, however, was much easier said than done.

The huge amount of business opportunities attracted a lot of competitors in this region. In confronting Korean, Japanese, European, and American engineering companies that had been operating for a long time in the Middle East, where interpersonal relationships are everything, CTCL did not lack in technical or price competitiveness, but it did face countless difficulties in breaking into that market.

Luckily, the American company S&W, which had provided technology for the construction of an ethylene plant by the Japanese prime contractor JGC Corp., had engaged in many cooperative projects with CTCL. At the beginning of 2004 CTCL won a ticket to the Middle Eastern market in cooperation with a US company — a US\$100 million joint-venture ethylene plant expansion project undertaken by Qatar Petroleum and the French company Total.

Another challenge in the Middle East was currency inflation. With the overheated economy in the Persian Gulf area, prices of commodities, housing, steel, and cement all rose, lifting the cost of plant construction and, of course, affecting CTCL's profit. In the long run, however, a more important factor than making money was the use of the Qatar project as a Middle Eastern training ground for the engineering troops needed for the next business breakthrough in the market there.

With the base laid down with this Qatar outpost, CTCI chalked up another victory at the end of 2006 by winning a contract from Saudi Arabia's second-largest petrochemical group, Saudi Kayan, to build a US\$500 million (approximately NT\$16.5 billion) EO/EG petrochemical plant. That plant was one of the biggest EO/EG facilities in the world at the time, and it provided strong momentum for the expansion of Saudi Arabia's production of petrochemical products.

M.H. Wang, deputy CEO of CTCI's Group Engineering Business, notes that the Saudi Arabian market was once monopolized by Korean engineering companies, and that CTCI's defeat of Samsung and Hyundai of Korea and Toyo Engineering of Japan to win this project greatly upgraded his company's visibility in the Middle Eastern market.

Punctuality and Safety Win Project Owner's Praise

With such a large scale and high value, the project in Saudi Arabia naturally came with a lot of challenges. The soil in the plant area, for example, covered a salt marsh layer that made it vulnerable to surface subsidence, so all foundations and structures had to be supported by concrete piles that could bear the weight safely. Finally, the engineering team cast 1,734 piles of concrete piles on-site to reinforce the soil. In addition, shortage of Saudi Arabian technical manpower surfaced during the construction period. Fortunately, CTCI had established a firm cooperative relationship with a Mainland Chinese construction team during its previous development of the Chinese market, and the support of that team facilitated the successful completion of the project. CTCI was the first EPC contractor at that site to turn over its project to the owner.

CTCI not only came out on top in terms of on-time project completion, it also won out three times in the monthly safety, health, and environmental assessment carried out by the owner, defeating other big international EPC contractors at the site to take the Golden Flag Safety Award. Later on, the owner even invited other contractors in the complex to visit, using CTCI as a model to be emulated.

Thanks to its good reputation, in 2016, CTCI won two more contracts from the same company in the same plant complex, one debottlenecking FEED (Front-End Engineering Design) contract for an EO/EG plant, and the other an EPC contract for the expansion of ethylene production of a cracking furnace.

We can say that CTCI's performance on its return to the Middle Eastern market after an absence of 20 years was nothing short of remarkable.

Overcoming the Challenges of Ramadan and the Climate

"When in Rome, do as the Romans do." Understanding local customs and habits, and becoming familiar with how Middle Easterners think, were important issues for CTCI in its Middle Eastern operations.

M.H. Wang points out that the Middle East is a Muslim area, and that prayer is an important part in the daily lives of Muslims. Basically, Muslims are required to pray five times a day (in Saudi Arabia it is six times, with each time taking 20-30 minutes). During prayer, all companies have to stop operating temporarily and close the doors of their shops (except for hospitals and a small number of businesses).

CTCI's general affairs personnel regularly have to race with prayer

time to purchase needed goods before the shop doors are closed. Otherwise, they will be locked indoors for 30 minutes of uncomfortable waiting.

The big annual event is Ramadan. No eating is allowed before sundown every day during this month, and even water cannot be consumed. Restaurants normally do not open their doors during the day, and if you go visit a client he will offer you nothing to drink.

To avoid going hungry in the daytime during Ramadan, CTCI personnel stationed in the Middle East generally ordered simple lunches from restaurants for consumption the following day, and to avoid making their Muslim colleagues uncomfortable, they ate it quickly when no one was about.

The local Muslims at the construction site were joined by numerous Muslims from India. During Ramadan their stomachs rumbled with hunger during the day, and unavoidably affected their work performance. This, plus the five prayers a day, influenced the progress of construction to some extent.

“We had to respect the religious practices of the Muslims, and at the same time to assure that our progress did not fall behind,” recalls M.H. Wang. “The expedient thing to do was arrange to work at night.”

In addition to Ramadan slowing things down, the climate in the Middle East is blazing hot, and if the humidity is too high, working becomes difficult. In such times, the government will hang a black flag and work will have to stop. The frequency with which different governments hang

the black flag depends on the local weather; sometimes the black flag can fly for an entire month, and for CTCI to complete a project ahead of time under such conditions was difficult indeed.

Singapore: Long-term Investment and Plaudits for Petrochemical and MRT Engineering

Singapore has long been proud of its neat cityscape, law-abiding citizens, and efficient government, and it is known as the world's "garden city." It was also an importation base for CTCI's early development of overseas markets.

Former CTCI Executive Vice President Wen-Chung Liao, who was then an overseas project manager, writes in his autobiography that CTCI's first big job in Singapore was serving as subcontractor for piping engineering for the Singapore Refining Company (SRC)'s Catalytic Reformer and Visbreaker. The EPC contractor for the project was Japan's JGC Corp.

Starting out with catalytic reformer piping engineering, the CTCI team held to the spirit of delivering on commitments whatever the cost, and when the reformer was shut down for a month for annual inspection, CTCI team continued working into the wee hours every day and completed the project a month early. This set a new record in JGC's years-long Singapore refinery operations, and in recognition, the Japanese company held a celebratory banquet and presented CTCI with a bonus for the ahead-of-time completion of its project.

In the following visbreaker project, CTCI swiftly grasped the key

technologies and practices for shut-down inspection, finishing the project seven days early and establishing a reputation for professionalism in piping engineering for the Singapore refinery. For a hydro-cracker piping project in 1984, the owner designated CTCL as the company to do the work—another project that was completed smoothly.

From 1981 to 1986, CTCL also carried out an EPC and commissioning for storage tank area project in Singapore for Esso and the Singapore Public Utilities Board. The company's Singapore branch had more than 20 designers at the time, and it also took on quite a few small design jobs for engineering projects.

After 1986, the Singapore refinery offered no more large engineering projects for about 10 years. Only around 1994 was there a residual catalytic cracker (RCC) piping project and the prime contractor, JGC, came to CTCL for the installation work. During that time, Taiwanese workers had lost competitiveness because of large salary increases, so CTCL brought in a construction team from Mainland China to do the work.

Wen-Chung Liao notes that Mainland China had undertaken a program of reform and opening not long before that, and its relations with Taiwan had thawed. But no mainland construction team had ever ventured abroad; the workers were unclear about international engineering practices, and CTCL was apprehensive about taking them overseas to work.

Through a year of intensive preparation, the Chinese workers were

provided with training in technology, quality, and safety rules, but the problems of applying for Singapore working permits for them still had to be overcome. CTCL finally mobilized a Chinese construction team consisting of more than 300 people, and brought it to Singapore—the largest group of Mainland Chinese workers at any single Singaporean construction site at the time. It produced a sensation in Singapore’s construction sector, and helped CTCL to complete the RCC project within a very short period of time. The client was highly satisfied with the quality and safety of the work, and further burnished CTCL’s brand image.

In addition to developing globalized talent, CTCL’s Singapore experience laid down a foundation for the development of overseas markets and allowed the company’s young engineers to observe how a world-class engineering company operates and emulates their ways.

250,000 Accident-free Working Hours

After 2000, Singapore had practically no large engineering projects at all, and CTCL switched its main focus to large projects, worth more than US\$300 million each, in Mainland China, Thailand, and the Middle East. Operations in the Singapore market sunk into silence.

In 2011, based on its experience in building the Xinzhuang-Luzhou Line of the Taipei MRT and the Orange Line of the Kaohsiung MRT, as well as its excellent safety record, CTCL won the Stage 3 trackwork contract for the Downtown Line of the Singapore MRT. This opened a new battleground in Singapore outside the field of petrochemical engineering.

The objective of the Downtown Line, which is about 21 kilometers long, and has 16 stations, is to provide quick travel to and from downtown Singapore for workers in the eastern part of the city.

Pao-Yao Pan, deputy CEO of CTCI's Group Engineering Business, points out that petrochemical plant and structural construction engineering is generally carried out in a 3D space, while railway engineering is more like a 2D operation. Space in tunnels is limited, making it difficult to carry out two tasks at the same time. This makes planning for supporting manpower and equipment especially important, and makes it essential for the next task to begin immediately after the previous one is completed so that resources can be utilized most efficiently.

In undertaking MRT trackwork, at the front end you have the contractor's civil engineering construction, and at the back end there are contractors for power supply, signal, and other systems that enter the tunnel for their construction work one after the other. For this reason, there can be no delay in transferring the work; the construction team must turn over completed projects for the different stages of construction before expiration of the time limit, and assure that the relayed work is up to standard.

The government of Singapore places great emphasis on safety and health issues, so during the implementation of a project it demands that contractors employ licensed on-site safety and health managers. Project managers must take 30 hours of safety and health training, and then pass a test to guarantee that they understand the importance of safety and health, and will not overlook them in the push for progress. The owner promotes safety and health through all kinds of forums

before construction starts, and holds a safety and health awards ceremony every year to commend contractors with outstanding safety performance.

In Singapore, with such strict safety, health, and environmental demands, CTCL not only completed its project on time in 2016; in 2013, it won the recognition of the project owner with an achievement award for 250,000 accident-free work hours, as well as an award for excellence in safety and health management.

In 2014, CTCL won yet another engineering contract: Singapore Thomson Line Trackwork project, which is scheduled for completion in 2020.

Thailand: Surviving Economic Fluctuations with Pride in Petrochemical and Power Plant Achievements

The cover story for *Global Views Monthly* magazine's March 2017 issue was "Thailand 4.0," which gave readers an insight into Thailand's determination to rise again following political turbulence and natural disaster.

Since the military government took power in 2014 and stabilized the country, and then instituted the Thailand 4.0 program in 2016 with the aim of transforming the country into an economy driven by high-value-added and innovation, transition in Thailand has created business opportunities that many look forward to.

CTCL cemented its ties with Thailand very early, becoming involved

in the country's engineering sector back in the 1980s with a number of construction jobs. At the time, CTCL acted mostly as subcontractor for Japanese engineering firms, responsible for partial piping designs and whole-plant construction management. CTCL was optimistic about the growth potential of the refinery and petrochemical industries in Thailand, which were still emerging markets at the time, and so established the CTCL (Thailand) Co. in 1987—the company's first overseas affiliate. Just after it was established, CTCL (Thailand) used the relatively inexpensive local manpower to support the mother firm's design work in Taiwan, and was also able to provide local clients with rapid and effective services, achieving the goal of a win-win strategy.

After the 1990s, the abilities and achievements of the Thai engineers that CTCL had trained led to their rising salaries so that the original strategy of outsourcing to Thailand's low-cost manpower was challenged by the rising cost of technical personnel there. This in turn led to the transformation of CTCL (Thailand) into a company that concentrated mainly on contracting small EPC projects.

Better Engineering Quality

In 1992, CTCL won the Bangchak hydro-desulfurization (HDS) project in Thailand, marking another important milestone in its overseas development.

In his autobiography, former CTCL executive vice president Wen-Chung Liao recalls that at the time the project owner asked the Japanese company Chiyoda to negotiate a price, but Chiyoda was involved in another major project at the plant and had no time for another one, and so notified CTCL to try to bid for the Bangchak project. The Japanese

firm even provided CTCL with price-assessment materials, helping it win the project.

While the job was secured, the challenges had just started to appear. The project had to conform to ISO 9001 specifications, but CTCL had no experience in this at the time, and basically could only follow Chiyoda's model; but Chiyoda's construction methods were not the same as those planned by CTCL, and some of them erred on the side of strictness. For some methods, CTCL didn't even know how to proceed. Situations came up one after another, and the project owner pressed uncomfortably close.

At the very beginning, there were design hitches that caused delays, making it impossible to calculate prices, and CTCL could not receive its engineering fees. The only way to break through this difficulty was to seek permission from the owner to change the progress schedule. Then procurement fell behind, and the procurement progress control system had to be re-established. Finally, difficulties were encountered at the construction site itself, making it necessary to write a corrective action report, plan a fix, and submit them to the owner for review before undertaking corrective action.

Since this was its first construction project in Thailand that was large in scale and comprehensive in scope, CTCL was not familiar with local companies and subcontractors. It also lacked team solidarity. Despite these problems, it completed the mission and accomplished commissioning, operation, and handover, winning plaudits from the owner, who felt that the CTCL-built plant was even better than ones built by Chiyoda.

This project brought CTCI its first encounter with ISO 9001. Since the company was unprepared, all it could do was set up the necessary systems as it proceeded with the project. It copied what it could from the procedures manual; this saved the time needed to establish its own procedures manual, but the copying of Chiyoda's extremely strict procedures led to a lot of pain in execution. Judging from the results of that effort, however, we realize that with Thailand's relatively backward technology at the time and the language-barrier, strict procedures manual were the only way to guarantee quality. CTCI is proud that the quality of this project was even better than Chiyoda's, thanks to the strict implementation of ISO 9001.

After the baptism of the Bangchak HDS project, CTCI achieved unprecedented success with its second largest EPC project there, a pure terephthalic acid (PTA) plant for Tuntex. This project exhibited first-class standards in terms of client satisfaction, engineering quality, schedule control, and cost control, shooting CTCI to fame in the Thai market, and greatly boosting the confidence of the company's employees, making them feel that they could compete on an equal footing with international rivals in overseas markets.

Three Big EPC Projects

Being at the epicenter of the Asian financial crisis that broke out in 1997, Thailand suffered grave harm. The government and private sector greatly reduced or delayed investment projects, economic activity stagnated, and CTCI's development in Thailand was affected.

The performance of Thailand's petrochemical industry gradually turned back upwards in 2004, bringing opportunities for CTCI to contract for

engineering projects. The company won three large EPC contracts there in 2006, with budgets as high as US\$200 to US\$300 million. Those projects were carried out simultaneously, and the number of engineers that CTCL sent from Taipei to Thailand to help out with them peaked out at over 300.

These EPC projects required CTCL to deal with different clients and project management consulting firms, and to engage in secret rivalry with prominent Japanese and Korean engineering companies. The project owners even brought them all to the table for joint inspection and comparison. The competition was fierce, but it helped CTCL to reinvent itself.

In early April of 2006, CTCL won an engineering contract for the construction of a 200,000-ton phenol/cumene plant for PPCL of Thailand. The owner was a subsidiary of the state-owned PTT group, Thailand's largest petroleum enterprise. In addition to EPC engineering, it included commissioning and initial operation. The contract amount set a new record for a single CTCL project in Thailand, and gave the company an edge in its later business developments there.

After the learning derived from more than 10 EPC projects in Mainland China, CTCL's capabilities in design, procurement, and construction were no longer in question, but the overheated international engineering market caused the prices of materials to rise, and contractors, their hands full of orders, stretched out delivery times. Earning money while keeping work within budgets and stipulations, and taking care of the needs of construction at the same time, became a tough problem. Another problem was that there were too many plant-

constructions in Thailand at the time, and the pirating of personnel was going on at every construction site. Besides needing to understand the speed at which contractors could supply people, it was also necessary to use such means as salary increases and bonuses to retain workers.

In addition, PTT promoted a series of cogeneration-plant construction projects with the aim of assuring an effective supply of electricity at Rayong in Thailand, where it had a number of petrochemical plants. CTCL, which had already accumulated experience by building cogeneration plants in Taiwan, won the opportunity to build the PTTUT Center Utility Plant.

The project was divided into six stages; the first was initiated in 2004, and the sixth completed in 2010. The work for the different stages overlapped, with design, procurement, construction, and plant commissioning alternating in a tight rhythm so that each stage could be completed in time, and a record of 3 million work hours with zero accidents could be set.

From its early piping design and first overseas whole-plant EPC project to today's niches in both the hydrocarbon and non-hydrocarbon fields, CTCL's operations in the Thai market can be said to have been the best witness of its steady progress of development and transformation.

Mainland China: Riding the Wave of the “Tenth Five-Year Plan” and Competing with World-class Engineering Firms

Although CTCL had successively completed a number of EPC projects

in the Middle East, Thailand, and Singapore prior to 2000, there was still a wide gap in strength and visibility between it and world-class engineering firms. “CTCI’s real jump onto the international stage began with the Mainland Chinese market,” notes Group Engineering Business Deputy CEO Mark W.H. Yang.

The engineering market was booming in Mainland China from 2002 to 2005 under its Tenth Five-Year Plan aroused an upsurge in construction, including Shanghai SECCO Petrochemical Complex, a joint venture between BP of the U.K. and Sinopec; Nanjing BASF-YPC Petrochemical Complex, a joint venture between Germany’s BASF and Yantze Petrochemical Co. of Sinopec; and Huizhou CNOOC Shell Petrochemical Complex, a joint venture between Shell of Holland and CNOOC, operating respectively in China’s three major petrochemical bases and calling for investments totaling about US\$10 billion. Just about all of the big international engineering firms rushed in to take advantage of these huge business opportunities and CTCI was there too, establishing a presence in all three of the base areas.

The owners of the EPC projects that CTCI carried out in Mainland China were all world-class energy companies, and the methods used to contract for the projects were not completely similar. For some of them, CTCI was the main contractor, responsible for numerous subcontractors, and the projects were strictly overseen by project management consultants (PMC). Some were Engineering, Procurement, Service, Construction Management (EPsCm) contracts, but these were undertaken in the spirit of turnkey projects, with CTCI serving the role of PMC; others were on the traditional lumpsum turnkey model, carried out jointly by CTCI and the Japanese EPC firm Chiyoda, with CTCI

leading the work in China, with no PMC. Sometimes CTCI undertook EPC projects independently, where there was a PMC, but it was not deeply involved.

Mark W.H. Yang emphasizes that different projects involved different cooperating partners, different split of work structures, and different management models, but all had “offshore,” “EPC lumpsum” and “joint office” characteristics. The indispensable requirements for success in all of them were a team consensus and team goals, fully cooperative partners, exchange of ideas and communication with PMC and owners, and the establishment of mutual trust so as to form an “all in the same boat” mentality. To take the Oriental Petrochemical (Shanghai) Corp.’s PTA plant project as an example, FW of the U.K. was responsible for basic design and the procurement of critical imported equipment, while CTCI was in charge of detailed design, other procurement services, and construction management.

FW first turned basic designs (including 3D models) over to CTCI, which then started the detailed design work. Because of the huge amount of work and the tight schedule involved, the design was handled jointly by CTCI’s design team in Taipei and the design team of CTCI Beijing, a CTCI subsidiary. In the latter period, the design work was joined by senior foreign engineers, mainly from India, who helped to alleviate the urgency of piping design work. With the steady completion of the different design items, key designers came out of their offices to the construction site to carry on the work together with the construction supervisors.

Procurement work proceeded simultaneously with design, and after

the construction brigade moved into the construction site, materials and equipment were delivered. This put the overall construction work in full swing. Oftentimes, there were over 2,000 people working at the same time; during the peak period of work, the number could reach 3,000.

Challenges of Working with World-class Engineering Firms

In cooperating with a world-class engineering firm like FW, CTCI naturally accumulated a great deal of valuable experience. Connecting and coordinating with them, however, proved more challenging.

For example, while the 3D models provided by FW were fully complete, the steel structures had to be substantially revised to conform to Mainland China's regulations. Or, for instance, data of small bore piping two inches were not keyed into the 3D model that needed to be re-keyed. These, among other problems, added to the burden and the difficulty of piping designs. In addition, FW had to provide data and drawings on equipment to be procured, but it submitted some of the data too late; this made it necessary to alter the equipment design, and the company wasn't very willing to make the alterations. This problem took quite a long time to resolve.

During the construction stage, there were also quite a few difficulties of coordination with the Mainland Chinese contractors that had to be overcome. Their tools and equipment were somewhat outdated, and their mobilization of cranes was slow. The manpower was insufficient, and its quality was uneven; many personnel were farm workers, and there were too few true technicians. Furthermore, there may have been a gap between the way the Chinese contractors understood contract

contents and the general understanding of them. For instance, since the Chinese characters for the term “transport” contain a part (a radical) meaning “hand,” they felt that the term referred only to transport by hand. To them, this meant that transport by crane or other machinery should entail an additional fee. There was an endless number of disputes of this kind.

In addition, to build a plant in Mainland China, all of the relevant government agencies had to be visited for each stage, from project registration to the start of construction to completion and turnover, and it might require a small room to hold all of the resulting documentation. Certification/permitting procedures were so complicated that specialized personnel had to be assigned to handle them.

Mainland China is a market that all big companies must contest in, Mark W.H. Yang notes frankly. While CTCI enjoyed an advantage there in terms of linguistic and ethnic similarities, the overheated market led to manpower shortages, rising wages, and, in 2004, soaring raw materials prices. Project managers regularly fell into struggles between costs and schedules, and could complete their projects on time only with all team members exhausting their strength and ingenuity to break through the obstacles they faced. They paid a high price for the applause they earned.

Incidentally, when the SARS scare swept the world in 2003, CTCI was one of the victims. After returning to Taiwan, six employees who had been sent to Beijing on business were found to be infected. CTCI sent them to National Taiwan University Hospital for examination and excused them from work temporarily, disinfected the entire

headquarters building, and in coordination with the health authorities, issued home quarantine notices to all 140 colleagues who worked in the same office with them.

As soon as CTCL discovered that its employees had contracted SARS, it fulfilled its obligation to report the matter and quarantine the victims. It was the first (and only) company in Taiwan to stop the victims from going to work and quarantine them at home in line with the government's epidemic-prevention measures. This crisis management added quite a bit of luster to CTCL's corporate image.

India: Putting Down Local Roots and Seeking Infrastructure Opportunities

Jim O'Neil, then chief economist at Goldman Sachs, an American investment bank, coined the term "BRICs" in 2001, listing Brazil, Russia, India, and China as being at the center of global economic change.

Today the four BRICs are in four different situations. With the slowdown in Mainland China's economic growth rate, especially, India has seen a resurgence. With economic growth exceeding 7% year after year, a huge market and cheap manpower, and a "demographic dividend" provided by a population, 65% of which is under 35 years old, the foreign direct investment (FDI) influx in 2015 topped China to make India No. 1 in the world.

India's domestic market is a new battleground for CTCL. When the company advanced into India into 2008, its first project was an EPC liquefied natural gas (LNG) plant in Kochi. The project was undertaken

jointly by the CTCI Overseas Corp. and CINDA Engineering & Construction, CTCI's Indian subsidiary, with the former handling front-end engineering design and offshore procurement, and the latter taking care of detailed design, local procurement, construction, and commissioning.

Alleviating the Impact of Union Strikes

The Kochi industrial area is located in central Kerala State, the southernmost part of the Indian subcontinent. It is a special tariff zone where companies can enjoy tariff-free treatment, but has a tropical monsoon climate with a rainy season, lasting from May to October, bringing heavy, long-lasting rains that add to the difficulty of on-site operations.

According to the construction schedule, the piling was to start in the fifth month of the project, and be completed in the 13th month. Unusually torrential rains, however, delayed the earliest piling by about six months and the driving work was completed only in the 20th month. After that, a large amount of manpower had to be mobilized to make up for the delays caused by the weather.

Another challenge was the local labor-union culture. Kerala has powerful unions able to demand that contractors wishing to hire workers must hire union members at a ratio of one to one. If a union declared a strike, its workers dared not go to work; and during strikes, the roads were blocked off, so that non-union workers and CTCI's own employees were unable to enter the construction site. Strikes also delayed the delivery of materials, naturally affecting the progress of construction.

CTCI used countermeasures to alleviate the impact of union strikes. Upon learning that a strike would happen the next day, the generator supplier would be asked to prepare fuel and water trucks. Food would be purchased, and drinking water replenished. Construction workers would arrive at the construction site early to await orders or would rush into the site when the strike was relaxed, and those who could not get to the site would turn on their computers and work from the dormitory. If a strike occurred on a regular work day, the work would be switched to Sunday to keep the work going.

Even with these countermeasures, it was difficult to keep construction from falling behind, because the technical standards of their workers and their ability to mobilize the three major local contractors were unable to match CTCI's catch-up plans. John H. Lin, who was vice chairman of CTCI at the time, ordered the mobilization of a large number of Taiwanese electrical/instrument foremen to travel to India and provide support at the LNG site, to help the electrical/instrument work to catch up. At its peak, almost 40 Taiwanese foremen were stationed at the site, and they worked hard toward one goal: to finish the electrical/instrument work on time—including approximately 800,000 meters of wiring work and the installation of more than 3,000 lights.

CTCI's outstanding performance as EPC contractor for the Kochi LNG plant helped it win another contract from the same owner in 2016: an EPC project for expansion of an LNG plant at Dahej. This helped give CTCI a firm foothold in India.

CTCI's development in India included supplying the domestic-demand

market by helping China Steel build an electrical steel coil plant with an annual capacity of 200 tons there, and carrying out first-stage engineering for the Chinese Steel Corporation India's first-phase annealing and coating line. This was CTCL's first involvement in India's general industrial market, and the hope is that it will lead to further involvement in India's infrastructure engineering.

The new policies proposed by Indian Prime Minister Narendra Modi include transportation construction, an industrial corridor, and smart cities, all of which involve public construction. The planned investment in these areas will reach several tens of billions, or even a trillion, US dollars; the business opportunities this will bring are huge, promising lucrative deals for the public construction sector.

It must be said, however, that most of these public construction projects belong to industries that are local in nature, and unless they call for a high level of technology, or are linked to government aid programs, foreign companies will generally have a hard time competing for them. But long as it is clear about its own position and forms strategic-alliance teams with local upstream and downstream companies, though, CTCL will have a good opportunity to win public construction projects in India.

The United States: Striking Shale Gas Opportunities at the Right Time

In times past, the United States occupied relatively little space on CTCL's global campaign map. The Group's Second Vice Chairman Andy Sheu explains frankly that the U.S. economy was in the doldrums for a

long time; with no plant-construction plans, there was no point of entry. Furthermore, it is difficult for foreigners to set foot in the American market. All CTCL could do was watch and wait.

Shale gas, which is classed as non-traditional natural gas, is trapped in shale formations and difficult to extract. Unlike traditional natural gas, which only needs a hole to spray naturally from the surface. After the 2000s, however, American companies developed horizontal drilling, hydraulic fracturing (fracking), and other technologies to release the natural gas from the shale, and usher in commercial production. By 2008, the production of non-traditional natural gas, including shale gas, had exceeded 50% of America's total natural gas production, and pushed the U.S. ahead of Russia to become the world's top producer.

This “shale gas revolution” changed the world's energy and petrochemical map, and pushed the U.S. ahead of the Middle East and other oil-producing areas to become the most vibrant area for petrochemical-plant investment. CTCL, of course, was paying close attention.

Andy Sheu reveals that CTCL sniffed the aroma of shale-gas opportunity in 2010, first setting up a business development & procurement office in Houston, where energy companies are concentrated, and manned it with Taiwanese personnel. Besides being used to expedite procurement, this office could also look for opportunities to contract engineering projects.

Learning that the Formosa Plastics Group was going to expand its Texas plant to seize shale-gas opportunities, CTCL began maneuvering

actively in the American market.

First, with the company's agreement, Andy Sheu recruited American consultants and used their experience and contacts in the U.S. energy industry to develop CTCI's market there. Next, Sheu set the tone for CTCI's American company; with the exception of himself as chairman and CEO, the rest of the team, including the president, were U.S. citizens. The American company was responsible mainly for construction and project management, while design and procurement were directed from Taiwan.

CTCI has gained quite a lot in the U.S. market by taking advantage of the trends of the time, winning design and EPC contracts for Formosa Plastics' American plant, as well as front-end engineering design work for a petrochemical project jointly invested by Exxon Mobile and the Saudi Basic Industry Corp. (SABIC). The U.S. looks set to become an important market for CTCI.

Expert's Commentary

The Continuous Quest for Cooperation with High-End Project Owners

There are several reasons why CTCI has been able to conquer overseas markets, with brilliant performances in the Middle East, Mainland China, ASEAN, and other areas: 1. Clear positioning, with

a focus on whole-plant EPC contracting for the petrochemical and refinery industries, plus outstanding project management and cost control, which are the company's strong points; 2. Engineering performance records and contacts built over many years; and 3. A strong corps of engineers, which coupled with its knowledge management system, will help the company develop its "combat capabilities" to the utmost.

Regarding the future development of CTCI's overseas business, I feel, first of all, that Mainland China's "One Belt, One Road" policy and the economic development of the ASEAN countries will stimulate a lot of infrastructure construction, giving CTCI great points of entry. As for its core petrochemical and refinery plant construction business, the company needs to constantly pursue opportunities for cooperation with high-end project owners, and advance toward the acquisition of even more advanced technological capabilities. In addition, the company should work to create even greater business opportunities by continuously transplanting its power plant, infrastructure, and Energy-from-Waste plant experiences in overseas markets.

Ruey-Shan Andy Guo, Dean, College of Management, National Taiwan University

The background of the page is a solid gray color. Overlaid on this are several geometric patterns. A large white hexagon is centered on the page. Surrounding this hexagon are four sets of parallel lines that create a 3D effect, as if they are the edges of a cube or a series of planes receding into the distance. These lines are in various shades of gray and are oriented at different angles, some parallel to the hexagon's sides and others at 45-degree angles.

Chapter 4

Embracing the Tide of Intelligent Technology

CTCI held its annual Chinese New Year gala for 2017 on Jan. 18 in Exhibition Hall 3 of the Taipei World Trade Center.

One of the highlights of the event was the appearance of Robot K1 from the United States. Silver in color and 270cm tall, K1 was not only able to swing its hips, but could also do a high five with CTCI Group Chairman John T. Yu, delighting the crowd.

Unlike the robot, which was just a gimmick to add a touch of excitement, in the address he delivered at the party, Chairman Yu emphasized that CTCI was in the midst of a program to promote intelligent EPC (iEPC), and that virtual reality, robots, and unmanned aerial vehicles were all destined to appear at CTCI workplaces, helping to provide clients with faster, better, and more competitive services.

Intelligent Design, Robot Builders, Unmanned Inspection

Just imagine it. In the not-too-distant future, CTCI's operating model might look like this: starting with the design stage, engineers won't find it absolutely necessary to make drawings themselves, all they'll have to do is set the relevant parameters, and the computer draws the plant designs automatically. All the engineers need to do is examine and confirm the contents of the designs, and assess the possibility of whether there are better design methods.

After the design drawings are completed, VR devices allow engineers to confirm each design detail in a more concrete manner and the client is able, as though he or she were physically there, to see what the

plant will be like when it is finished.

As for procurement, information linkage along the entire supply chain provides real-time knowledge of the status of production of the equipment and parts, and any change in design can be accommodated quickly.

During construction, with the exception of specialized welding, which still has to be done manually, everything is handled by robots: piping prefabrication, sandblasting, painting, assembly, inspection, transport, steel structure safety, and other operations. This will greatly reduce manpower at the site. Whereas in the past, engineers had to climb up scaffolding to carry out inspections, in the future, this will be done by unmanned aerial vehicles.

CTCI has always been proud of its EPC contracting capability. With the advent of Industry 4.0, the company is working hard to introduce intelligent technology that will upgrade engineering integration and project management capability, improve the precision and speed of project implementation, and establish an unassailable advantage in the fiercely competitive international EPC contracting market.

This is the “secret weapon” with which CTCI will meet the tide of intelligent operations: iEPC.

Innovation: A Powerful Tool for Differentiating CTCI from the Competition

The equal position that innovation holds with professionalism, integrity,

and teamwork in CTCI's corporate culture indicates how importantly the company regards innovation.

Over the years, CTCI has held steadfastly to three major keys to growth. The adoption of new business models, development of overseas markets, and expansion of cross-field capabilities all depend on the endless flow of momentum that innovation brings. "Innovation," Group Chairman John T. Yu emphasizes, "is the powerful tool that CTCI uses to differentiate itself from the competition."

Corporate innovation is the result not of a miracle or sudden inspiration, but of the effort to maximize corporate value. For CTCI, a company engaged in engineering services, innovation has two main objectives; one is value up, the other to cost down. Besides providing clients with services of greater value, this also brings greater efficiency in terms of cost, time, and manpower utilization during project implementation, providing the company with the means of sustainable existence. Looking over the path of CTCI's innovation development, we see that it is intimately tied in with the evolution of computers and information technology.

CTCI started life with design work, and most of its earliest innovation began with the design stage. The older generation of CTCI personnel still remembers that in the early years, design was basically done on paper, with engineers wielding square rulers and drawing designs by hand. This process was not only vulnerable to error, but its efficiency was also comparatively low. With the arrival of large-scale computers on the scene, the company procured Wang 2200T computers to satisfy the demands of clients by boosting speed and precision.

Detailed design work was computerized first; after that the computer systems were constantly updated and high-end graphics software was purchased, and drawing work was transferred to computers.

CTCI brought in a full set of Auto-CAD 2D drafting software in 1986, and distributed a large number of personal computers to upgrade the efficiency of the human-machine interface. The company formally entered the age of 3D engineering design in 1989, with the introduction of the PDS graphics system, enabling it to engage in synchronous operation with major global engineering companies.

KM – An Arsenal that Roams the World

The rise of the Internet after the year 2000 changed the way that people store and exchange information and knowledge. It also expedited CTCI's global knowledge management (KM) system, enabling company employees to stand on the foundation of their predecessors' experience and bringing more innovative possibilities.

CTCI's former executive vice president, Wen-Chung Liao, was a strong advocate of KM. The design, technical, and company documents that have to be turned over to a client after an engineering project is completed, number in the hundreds of volumes, Liao points out, not to mention that even more are required for reference during the process of construction. While employees all recognize the need to preserve data, the demand for all kinds of reference documents by the engineering services industry can be satisfied only by a company's establishment of a database.

In the early days, everything was on paper, and it was not easy to carry around. It was very difficult for personnel stationed abroad to take all the documents they needed to the overseas construction site ahead of time. In the 1990s, therefore, CTCL began digitizing its paper documents, scanning them into PDF files and then establishing a database with them. With the continuous accumulation of data, however, the retrieval of documents required browsing them one by one, and personnel stationed abroad were unable to easily find the documents they wanted, even by connecting with the database online.

In early 2005, when Wen-Chung Liao held a meeting with his colleagues at a Philippine construction site, one of them was suddenly inspired to say, “Sir, we’re fighting a battle overseas without weapons at hand. How are we going to win the battle?” This shocked Liao into the realization that “CTCL needed an arsenal that could be moved all over the world.” Upon returning to Taiwan, he immediately discussed the matter with information department heads. They rebuilt the company’s KM system, not only reinforcing its search capability but also establishing a Q&A mechanism that enabled the sharing of professional knowledge and the handing down of discussion results.

For CTCL, with its global operations, KM created an even greater competitive advantage. Wen-Chung Liao uses the example of a project in Saudi Arabia. During the construction process, stainless steel pipes became brittle and caused water leakage. The method that the personnel there used to solve the problem was transmitted back to Taiwan, and later on, when the company was bidding on the construction of a petrochemical plant on the island, the knowledge of this solution helped to win extra engineering fees in the amount of

NT\$60 million.

The company revised its KM once again beginning in 2011, not only extending its existing function, but also strengthening interactive linkage, knowledge community, and other functions. In addition to internal use, some of the content was made accessible to clients, business partners, and up- and downstream contractors so that all could learn and grow together.

The Networking of EPC Operations

CTCI's progress toward EPC contracting and globalization was accompanied by a multitude of challenges, including demands by clients that construction time be shortened even more, even greater alteration of specifications, ever more expensive materials, increasing shortage of experienced manpower, increasing internationalization of the CTCI team, and growing constraints on profits. These impacts had to be dealt with; and in the area of technological innovation, that meant the networking of EPC operations.

Mark W.H. Yang, former deputy CEO of CTCI's Group Engineering Business, points out that EPC engineering can be divided into four main stages: engineering design, procurement, construction, and commissioning. The whole EPC period contains five main workflows, from the owner, licensors, EPC contractor, equipment vendors, and subcontractors. The EPC contractor has to link together all of these five main workflows and their related information, and play the role of an engineering value integrator that turns over all plant-construction information.

To make sure that all of the work in the split of work framework proceeds smoothly, and that the fruits of split of work and cooperation are achieved, CTCI uses the SmartPlant Enterprise (SPE) operating platform with the relevant software divided into different systems for eight categories of information, including 3D model, schedule control, equipment and material management, and document management.

SP3D: Global Collaboration with Zero Time Difference

The accuracy of 3D data during the design stage has a direct impact on the progress and quality of construction. SmartPlant 3D (SP3D) serves not only as a platform for the storage and delivery of data, but can also provide data sharing and design information transparency functions. In addition, SmartPlant 3D includes object-relation, design rule, and other inspection mechanisms that greatly enhance the overall precision of design.

To take design rules as an example, certain data or rules must be observed during design work. In using SP3D, these data or rules can be set up to provide a reminder function, so that when any of the data or rules are violated during the design process, the system will immediately light up warning lights of various colors to alert the designer. This elevates the quality of the design.

In addition, the SP3D system can facilitate global work-sharing. Offices in different areas or even difference countries can simultaneously share work on the same engineering design. This provides for year-round 24-hour collaboration.

SPM: Close Integration of Design and Procurement Information

SmartPlant Materials is an equipment and material information management platform that spans the design, procurement, and construction stages. Compared with the previous way of operating, with the provision of information on the maintenance of individual units, this single platform greatly enhances the timeliness, accuracy, and integration of equipment and material information. Since it is an online system, anyone can log onto it from any office or construction site, whether in Taiwan or overseas, and make an enquiry or retrieve maintenance information at any time.

Mark W.H. Yang points out that CTCL has applied the SPM system in successive large-scale EPC engineering tasks. The close integration of design and procurement information not only lowers the cost of project implementation by reducing the insufficient or excessive purchase of equipment, but also gives project equipment management personnel a single platform for enquiry about equipment and material conditions. The system provides information on the actual progress and budgeting of a project for reference, and reinforces schedule control. In addition, construction workers at the site can retrieve information about equipment design and procurement, and revise the construction plan as necessary to avoid having materials but no workers, or workers but no materials.

SPF: Transparency of Information

Every project generates a lot of documents. In the past, document control was a multi-system operation; the same document may have been given a document number in System A, while the actual document was stored in System B. With the SmartPlant Foundation's

single platform, a document can be given a serial number and uploaded directly. In addition, all reports can be generated from the system's centralized database.

There are quite a few advantages to using the SPF platform for document control. For one, documents can be classified and stored in the database automatically according to type, avoiding the man-made inconsistency that causes document management problems later on. The system also has an electronic job flow control function that helps users manage jobs. Another function can call for reports, helping project personnel to trace the current status of all documents.

It is worth noting, that once a document is uploaded into the system, all design engineers can use a document number, serial number, or equipment number to find the document that they need quickly, thereby achieving the goal of aiding engineering design. All document edition, issuance, and delivery records are stored in the SPF system, where engineers can trace the historical records of a design, providing information transparency that enables the more rapid execution of design work.

EIC: Immediate Transfer of Engineering Information and Control Reports

The SPF platform also provides engineering information control (EIC), using the single platform's function of integrating project engineering information to provide design engineers, project lead engineers, project engineering managers, and other personnel at various levels with real-time engineering information and control reports that help them focus on the key points of implementation.

Traditionally, engineering information flows from top to bottom, being concentrated first with project engineering manager and then disseminated to the different project lead engineers, and finally to all the design personnel. With EIC, when an information document is uploaded, it is transmitted immediately via the networks that are linked to the system. All project engineering managers and lead engineers need to do is play a monitoring and review role in the information transmission process.

Use of the EIC system for a project can do more than shorten the work flow and reduce manpower. Also, since users receive only the latest version of documents, they will not do work that has to be undone because old documents were used. Furthermore, EIC provides a complete record of all documents transmitted, which can be used for analysis after a project is completed.

Manifesting the Spirit of Accountability

In sum, not only are the work flows and information that appear in the traditional EPC contracting process made transparent on the SPE platform, but every little change leaves its traces of passage. This facilitates follow-up review and manifests the spirit of accountability.

For this reason, when members of the team are carrying out their work, they must consider not only their own “points,” but must extend their thinking to the upper-level “line” and even to the whole “area” so that all those participating in the project can carry out their various tasks at a consistent pace.

It is said that “all technology comes from human nature.” CTCI’s innovation on the SPE program does not end with the establishment of the requisite platforms and systems. After a system is established, the participation of the relevant personnel and human-system adjustment has to be worked out to heighten performance indicators and create benefits before it can be considered successful.

The foundation built by CTCI’s accumulation of technology has enabled the company to stride forward and create iEPC: Intelligent EPC.

Welcoming the Industry 4.0 Era

A description of the advancement from EPC to iEPC must include Industry 4.0.

What is Industry 4.0? Simply put, it is the large-scale use of automated robots, the sensor-equipped Internet of Things (IoT), supply chain internets, big data analysis of marketing and production, and human-robot collaboration to upgrade the productivity and quality of the manufacturing value chain in the era of ageing society and declining fertility rates.

The Industry 4.0 concept was raised at the Hanover Fair back in 2011, and was widely adapted in Europe, America, Mainland China, and other areas, gradually becoming a major trend that drew the attention of governments and industries.

From discussions related to Industry 4.0, it is not difficult to discover that its essence is the use of intelligence in linking the different

elements of manufacturing together to carry out optimization so as to improve corporate competitiveness and profitability.

Different industries have different linkages and optimization objectives. What machine processing links are sensors, machine tools, data analysis software, and manufacturing execution systems, and its objective is to optimize the results of improved yield and lengthened machine life. Product manufacturers are more concerned with the linkage of customer network ordering information, business management systems, materials supply, production scheduling, and factory production lines; for them, the objective of optimization is the production of customized products with the shortest possible delivery schedule.

Introduction of Intelligent Elements

CTCI introduced elements of intelligent operation into its project execution and following plant operation processes, building an intelligent EPC turnkey plant construction system by linking the independent individual engineering design, procurement, construction, and commissioning systems together. This not only regularized the results of design and automatic design inspection, but also allowed immediate and automatic updating when changes were made during the different stages of engineering. This optimized engineering performance.

During the engineering design (E) stage, design, calculation, analysis, and model-making work was automated through the implementation of design automation and intelligentization, advancing the company

steadily toward intelligentized development of such areas as intelligent piping layout and automatic power distribution lines. In addition, design quality was optimized and improved through industrial-academic cooperation or internal R&D, thereby continuously upgrading the company's core professional competences.

For the procurement (P) stage, CTCI established a “data exchange platform for vendors” and “CTCI Alliance Partner (CAP) Mechanism” to provide instantaneous communication and information exchange internally and with equipment vendors. This allowed the company to understand a vendor's production progress and status of manufacturing after placing an order, reinforcing the Group's internal procurement supply chain management and providing seamless liaison with other companies.

For the construction (C) stage, the company implemented electronic and mobile management, extending the use of mobile devices to important construction sites and introducing industrial robots to carry out welding, assembly, painting, transport, and inspection work on the sites. This enhanced working efficiency, upgraded installation performance and quality, reduced industrial safety incidents, and advanced construction sites toward intelligent modular manufacturing and intelligent installation.

Three Major Innovations of iEPC

CTCI Group Vice Chairman, Michael Yang, reports that in the process of implementing iEPC, innovations being carried out include the following:

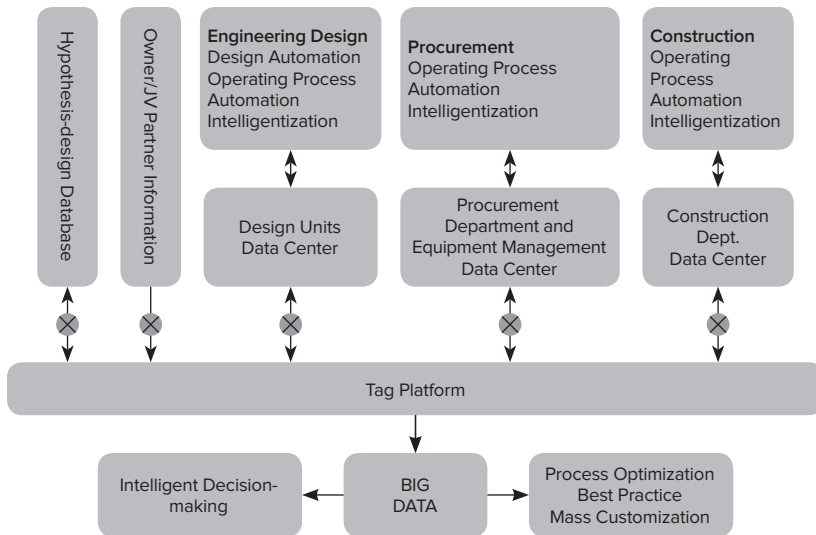
A Common Tag Platform for Optimization of EPC Management

In the process of EPC execution, things such as equipment, pipes, instruments, and structure foundations are all given serial numbers. But different kinds of numbering systems and structures are not identical, so CTCI developed an innovative common tag platform to link and tag all data.

Using this platform, all one needs to do is searching a single equipment number, and then, through the tag stream, he or she gains access to the full range of graphics, materials, and work execution. Contents of the tag platform can be printed out as reports or signboards, so that those responsible can have a clear view of construction progress. In addition to facilitating integrated project control, this cuts the time needed to collect data and reduces the difficulty of data matching and review. It produces a greater influence on automated interdisciplinary operations, allowing the early implementation of design changes and lowering the cost of late-stage changes. This visualizes management platform and strengthens construction productivity.

Establishment of the common tag platform was completed in 2016. It is one of the core iEPC mechanisms, bringing together all engineering and project client information, business partner information, hypothesis-design information, and information on all engineering design, procurement, and construction departments. The different departments can recover information directly from the platform according to their mission needs, saving them the time of sending information to each other. The information on the tag platform can also be formed into big data, and used to achieve the objectives of process optimization, best practice, and mass customization.

Common Tag Platform Data Streaming



Development of Engineering Models and Strengthening of Design Capability

Design is normally the result formed by following a series of rules. If overall spatial considerations are used to determine the width of plant corridors, the length of pipes, and other details, for example, all of the details have rules to follow. If design is automated so that computers can make design drawings, then the design experience of engineers has to be transformed into rules that are incorporated into information systems so that quantitative methods can be used to upgrade engineering design productivity and improve design quality. In this way, professional engineering knowledge becomes a company asset—the so-called rule-based engineering. From 2011 to 2016, CTCI developed

150 rules. In the future, computers will not only carry out design in accordance with those rules, but will be able to learn from them how to resolve questionable issues. The rule-based model that is constantly being developed at the present time will establish a foundation for the artificial intelligence (AI) design of the future.

VR/AR: Upgrading the Quality of Plant Construction

Virtual reality (VR) and augmented reality (AR), which are seen as the next killer products of technology, will be used in iEPC to establish virtual plants that can be inspected visually before construction begins to provide an insight into the needs of actual practice.

VR devices not only allow users to see 3D images of how a plant will look after it is finished, but can also display the size, material, and other data—even the direction of flow—for piping at any point in the image. VR can also simulate a fire and allow users to review the distribution of water sprinkled to put out the fire, and it can show simulations of how equipment is being hoisted for mounting, so that the most suitable hoisting pathway can be assured.

In developing VR applications, CTCI worked with a team led by Prof. Jen-Chung Shih of the Institute of Multimedia Engineering, under National Chiao Tung University's Department of Computer Science, in an industrial-academic cooperative effort to develop technology for the application of VR to 3D model review. The results of this effort are expected to appear by the end of 2017.

AR technology can be used in the process of construction. For example, it enables engineers to compare simulated 3D piping with

the actual status of piping at the site and assure accurate fitting before proceeding with installation. After a plant is turned over to the owner, the owner can access the AR interface through the QR code on a mobile device to find engineering graphics, equipment specifications, maintenance manuals, maintenance records, and other information needed for preventive maintenance and real-time monitoring. This brings the owner even more added value.

Integrated Virtual-Real Life Cycle Services

At a time when the use of 3D and 4D simulation design is still common in the industry, CTCI is promoting the development of multidimensional XD applications (which include more dimensions than 4D). This will not only help with construction management during the plant-construction phase, but after a plant has started operating, will include equipment maintenance and management information in the same model to allow the retrieval of visual data and facilitate repair and maintenance management.

The iEPC built up by CTCI permits the integration of real and virtual life cycle engineering services, from basic EPC whole-plant construction to the period of operation and maintenance by the owner. This not only widens the gap with competitors but also, through customization, gives owners the feeling that CTCI is an outstanding, reliable EPC contractor with advanced technology. This, in turn, brings the whole world to recognize that CTCI represents reliability and embodies the deep-level content of “happy employees and satisfied customers.”

Expert's Commentary

More Recruitment of Information Personnel

The cooperation with CTCI and the Department of Computer Science team from National Chiao Tung University focused mainly on the use of VR. VR is a hot topic now, but it actually existed back 20 years ago. The problem then was that its hardware and software was too expensive, with a single VR headset costing maybe one million NT dollars. The entry threshold was also high, and there were not many general industrial applications. VR then was used mainly in medicine and pilot training. After the prices of VR hardware and software became more affordable, more and more industries began using the technology. The biggest user of VR technology in Taiwan today is the video game industry. Among other industries, CTCI is quite advanced in this area, perhaps because its engineering background makes it boldly receptive to new technologies.

CTCI began using 3D drafting very early, and this established a good foundation for its entry into VR applications. But for a technology to become truly mature, it almost unavoidably has to go through a period of growing pains, and this needs the full support of a company's high-level management. If CTCI can only recruit more information personnel, I'm confident that it will progress along this road of innovation even more rapidly.

Prof. Jen-Chung Shih, Institute of Multimedia Engineering, Department of
Computer Science, National Chiao Tung University



Chapter 5

Elite Engineering Serving the World Over

When dawn starts to break and the sky begins to brighten, he has already arisen and freshened up.

The call to morning prayers wafts over from the mosque outside his window, reminding him that this is not Taiwan, but the exotic Middle East.

Before the sun rises, he starts out for the Industrial Zone, about an hour away, to wait for the construction workers to come to work.

After the long day is over, work ends, and he starts to prepare to return to his dormitory, night is already falling.

Far away from home and family, living in toil night and day, despite his longing for his homeland, he still tells himself now and then that completing his assigned task on time is his mission as a CTCL employee.

Nearly 40 years of effort have transformed CTCL from a local company with just 800 employees, into a world-class engineering enterprise with business operations that span the domestic and overseas markets, and a work force that tops 7,000. This achievement results from the arduous work expended by each CTCL employee.

Engineers make up the majority of the big CTCL team; whether sitting in a Taiwan office drafting designs, taking care of procurement for the Singapore company, preparing meeting materials on a flight to the Middle East, or coordinating the allocation of personnel at a Malaysian construction site, their colorful array of work will surely break down

the stereotypical image that most people have of the dull and rigid engineering profession.

This group of engineering vanguards charges into action all over the world, vying without fear with top engineers from Europe, America, Japan, and Korea, completing large project after large project with outstanding quality and within amazing time periods. How does CTCL train these commanding engineering elites, one after another?

Unmatched Talent Development

Engineers gain experience with design, procurement, construction, and other departments, undergo severe tests by the marketing & sales department and learn how to develop markets, are stationed overseas where they acquire an insight into the Western spirit and attitude of “seeking truth through facts,” and use access to all of the learning resources provided by the company to cultivate their decision-making and the vision that leaders need. This is the unmatched method that CTCL uses to develop talent.

Let us take CTCL Group Chairman John T. Yu as an example. Joining the company after completing military service as a second lieutenant, he originally worked in the Electrical Engineering Department. Three years later, when China Steel lacked supervisors for plant construction and asked CTCL to second needed personnel, Yu went to China Steel with a group of colleagues to work at the construction site of a steel mill plant. With his engineering and construction experience, he was later transferred to procurement. This began his overseas career.

In the beginning, CTCI needed someone to go to Singapore and handle procurement for the desalination system EPC project at Indonesia's Cilacap refinery. His superiors saw that Yu could speak English and should be able to communicate with foreigners, so they sent him to do the job. After returning to work at company headquarters two months later, he was sent to the United States as procurement representative. Being his first trip to the U.S., he was not very confident of his ability to do the job. In the spirit of accepting a mission that must be accomplished, he started preparing to go abroad without a second thought.

The first three months in the U.S., Yu recalls, his English listening comprehension was not very good. Whenever he talked with a company on the telephone he trembled nervously, and whenever the person on the other end finished talking, he repeated the message to make sure that he had made no mistake about the procurement items. If he were still not sure, he would ask the person on the other end to send him a telegraph so that he could check it up in a dictionary, word by word.

In the 1980s, the Middle East was one of CTCI's key overseas "battlegrounds," and Yu was sent to Saudi Arabia to serve as sales manager. He recounts the experience: "We worked 10 hours a day, six days a week, encouraging and cheering each other on. Although we were very busy, our morale was high, but sometimes it was hard not to feel homesick. Late at night, we would listen to popular music tapes mailed to us by our families, and tears would flow."

A decline in its business there prompted a CTCI decision to withdraw

from the market in the Middle East temporarily. John Yu was transferred to Thailand to serve as Managing Director of CTCI (Thailand) Co., Ltd., charged with establishing an engineering design foundation and supporting construction work. As head of business development during his previous stint in the Middle East, all he had to do was to concentrate on his work. In Thailand, however, he began dealing with the company regulations, financial statements, corporate organization, management practices, and the like. His outlook had to change so that he could consider the company's operational growth from a broader perspective.

After the conclusion of his experience in Thailand, Yu returned to Taipei headquarters to take up the position as the general manager of the Sales Dept., in charge of global business development. Later on, CTCI arranged for him to take a short-term advanced course at Harvard University. "With preparation for three cases a day, group discussions, and teaching sessions, along with extracurricular reading and lectures by distinguished experts, I couldn't get to bed before midnight!" Yu jokingly describes his Harvard studies. "I was like Granny Liu in the Grand View Gardens." (A reference to a character in the classic Chinese novel *Dream of the Red Chamber*, to describe someone who is overwhelmed by new surroundings)

His harvest from this "journey to the Grand View Garden," however, was a rich one. "Under the guidance of our professors," he comments, "we were able to analyze the causes of each company's rise and fall, very logically, and to understand how correct decisions led strategists to succeed, or erroneous judgments caused them to fail." Besides analyzing what CTCI could learn from these cases of success and

failure, he also tried to think from the standpoint of those decision-makers and determine what kind of decision he would have made in their shoes at that time.

John T. Yu succeeded to the presidency in 1998, and took on the heavy burden of the chairmanship three years later, becoming the helmsman of this great ship that is CTCI.

Well-rounded, Multidimensional Talent

Because CTCI engages in the provision of EPC engineering services, and because it serves clients both in Taiwan and overseas, it needs personnel that are well-rounded and have multidimensional capabilities. These personnel must have an understanding of engineering and the ability to talk business with clients before they will be able to establish a foothold in overseas markets.

John H. Lin, who is currently CTCI's group chief vice chairman, started out with the company as a piping design engineer. After doing design work for almost a year, he felt that he needed actual construction-site experience. As fortune would have it, CTCI just then contracted for the construction of a Kaohsiung caprolactam plant (the forerunner of today's China Petrochemical Development Corp.), and Lin volunteered to join the lifting work at the construction site. This lifted the curtain on construction-site work that lasted as long as 25 years.

Compared with his former job sitting in an office, work at the construction site seemed like serving in the army. Lin's living quarters were a large open-bay barracks. His colleagues worked with him during the day, and they all lived together at night. Working in such

close intimacy with the construction site gave him a chance to gain in-depth learning and understanding of such on-site practices as lifting eye design and the calculation of lifting gradient and center of gravity. This gave Lin a great feeling of accomplishment.

John Lin discloses that time management is extraordinarily important when working at the construction site, because only good control of progress can leave the client with a good impression of CTCL. His strategy for achieving this is to strive to get ahead of schedule in the early stage of project execution. This not only makes the client feel at ease, but also provides extra time to solve problems that might pop up later on. "I insist on never being overtaken by the schedule."

The first half of his career with CTCL was occupied with construction and building work, but in 1999, Lin was directed by his superiors to switch paths, and take charge of project development and implementation outside of Taiwan and Mainland China. This was a tough test for Lin, who had never had any contact with business development. From his former home at the construction site, he became a "frequent flyer," traveling abroad 200 or 300 days a year throughout the Middle East, Southeast Asia, the United States, Japan, and Europe—and collecting more than 600 business cards.

He doesn't hesitate to say that in his work of developing businesses overseas at the time, a lot of clients considered CTCL a mere subcontractor for Japanese companies and the global investment environment was sluggish, piling difficulty after difficulty onto business development. However, Lin was able to think of ways to complete his mission.

He raises the example of an Iranian project. Iran's economy was weak at the time, and his superiors demanded that the client first open a letter of credit. This violated normal contract-signing procedures. But Lin did his best to communicate with the client, and after a number of intense sessions of wrangling and negotiation he won the contract.

After chalking up a number of victories for CTCI, Lin took on the post of president in 2002. Under his leadership, the company has achieved breakthrough growth in its business performance.

Well Prepared to Meet New Challenges

From subcontractor to EPC contractor, from Taiwan to the international market, from its core business for hydrocarbon to non-hydrocarbon business, CTCI has always entered new fields of battle. With new battlefields come new missions. There is no such term as “unchangeable” in CTCI's work; every day, company employees must face, in wary trepidation, the new missions that can come at any time.

The Group's Second Vice Chairman Andy Sheu is used to new challenges. Joining the company shortly after establishment as a “CTCI first-period piping” greenhorn, even before his two months of training were completed, he was assigned to Piping Section as Supervisor for Second Nuclear Power Plant of Taiwan Power Company. After a year there, he was transferred back to the Piping Design Office. The traditional training process for engineers is to start out with design before gaining practical experience at construction sites. Sheu's training reversed this process.

When Sheu returned to headquarters without even having completed his first piping layout drawing, he was assigned to the Procurement Department. Then, after a little over than a year, he was assigned to Singapore Branch as procurement representative there. “I didn’t have much experience at procurement at the time,” he concedes, “and I hadn’t been overseas before. So I couldn’t help feeling some doubt and resistance.” After talks with his superior, however, he decided, with an open attitude, to accept the assignment.

Andy Sheu, who had a background in power mechanical engineering, felt a need to augment his know-how in the field of procurement. He read all kinds of foreign-language books and magazines on international trade, and took advanced courses at Center for Public and Business Administration Education of National Chengchi University, Chinese Management Development, and the Taiwan External Trade Development Council. His two years of practical experience in Singapore gave him an opportunity to verify the theories he learned from books.

Later on, Sheu was again assigned to head overseas sales, and again, he faced an interdisciplinary challenge. He admits that the crossover from purchasing to sales was highly difficult, but his earlier experience in purchasing allowed him to approach sales from the standpoint of the owner. He knew how to satisfy the owner’s demands while assuring the greatest profit for CTCL. Furthermore, because of his principle of “treating others with integrity,” he was generally able to win the owner’s agreement when conducting business.

His “daring to engage in battle” attitude was not lost on his superiors,

and Sheu was successively assigned as special assistant to the president and managing director of CTCL (Thailand). Upon his return to Taiwan, he was assigned to head a newly established Corporate Business Development Dept. before being promoted to the position of president. Today he is the group's second vice chairman, in charge of business development in the Americas.

For CTCL, challenge is a daily occurrence, and a member of the CTCL team cannot hope that the company will complete his training before sending him into the field. "We have to be prepared to go into battle at any time," Sheu emphasizes. "Adapting ourselves to any new challenge is the best way for us to face new missions."

Training in Every Corner of the World

"Looking back over CTCL's cultivation of talent in the past," comments Associate Professor Wen-Jeng Lin of the Graduate Institute of Human Resource Management at National Central University, "we see that experience and testing, whether from posting overseas or in cross-field areas, have been done more in line with business development than in any systematic and planned way."

John T. Yu also states that when CTCL was working vigorously to expand its business territory in early years, people were sent wherever someone was needed. There was nothing like strategic talent development; employees followed directions according to the arrangements made by senior officials. Company development was the prime guiding principle.

With the steady increase in CTCL's scale and reach, however, plus the growing assertiveness of young people about their career development, the company had to begin cultivating its talent in a planned and strategic way.

With the company progressing toward its target of NT\$100 billion in revenue, manpower quality and quantity was a key factor in achieving this milestone.

"Our industry has a high dependence on talent," stresses John T. Yu. CTCL's professional manpower encompasses a wide range of skills, including mechanical, electrical, chemical, civil engineering, and international trade, and the company's recruitment strategy is not to poach talent from others, but to cultivate new engineering-department graduates through a full range of training courses.

Mark W.H. Yang, former DCEO of CTCL's Group Engineering Business, explains that in addition to irregular classroom courses, the company's Global Training System (GTS) has set up an online training platform that allows employees to receive "training in every corner of the World" with no limits to time or location. This learning platform enables personnel to confirm the status of their learning at any time, and officials to ascertain the training status of their subordinates.

To encourage employees to better themselves, CTCL offers them opportunities for free advanced training, especially through EMBA and other management programs, both at home and overseas. A common characteristic of engineers is that they stick tightly to their own professional fields, and lack flexibility. Besides strengthening

their management skills, an EMBA education helps them to establish external relationships so that they can bring greater competitiveness to CTCL in its business development.

Improving English and Overseas Service Abilities, and Developing Transnational Personnel

In recent years, CTCL's human resources development plan has emphasized internationalization. That is, the cultivation of so-called transnational talent. To this end, language ability and global vision are indispensable parts of the plan, in addition to engineering skills and management capabilities.

To take the upgrading of language ability as an example, starting in the year 2000, CTCL has used TOEIC scores as a factor in promotion and concrete figures as targets for English-language improvement. In addition, the company has brought in an online English-learning system, and established an English study club that practices English listening, speaking, and discussion once a week, and also holds irregular "English improvement" lectures.

To mold a language-learning environment, ranking CTCL executives took the lead in using English emails for internal communication. This precedent has been extended to the sole use of English—listening, speaking, reading, writing—by project teams holding meetings or working with overseas owners, in recruiting foreign white-collar professionals, or in receiving personnel that overseas affiliates have stationed in Taiwan. This immerses CTCL personnel in a seemingly international work environment, providing a boost to their English

ability.

In addition, CTCI sends hundreds of its people overseas every year—an overseas posting, in fact, is an essential step on the CTCI ladder of advancement. The company uses progressive steps to prepare its people for overseas postings, starting with appointment to large domestic projects to train them in establishing interpersonal contacts and in preventing and solving problems. Then they are assigned to world-class projects to train them in negotiation, integration, and adaptation with teams having different cultures and to help them learn to complete tasks smoothly under pressure from the owner's harsh demands and the constraints of the project schedule. After passing these two stages of trials, an employee generally has the skills he or she needs to engage in foreign-language communication, establish partner relationships, resist pressure, and adapt to other cultures, and thus to successfully undertake overseas missions.

Before sending an employee overseas, CTCI will issue a manual for living in the area of assignment, with information on everything from visas and Taiwan's government offices overseas to language, politics, security, climate, religion, transportation, food, sanitation, clothing, shopping, and more. Before leaving Taiwan, the employee can read the manual to learn all about where he or she will be living, thereby minimizing the risk of inability to adapt.

If an employee is assigned to an executive position overseas, before taking up the new post, he or she will attend classes on such subjects as international etiquette and the customs, laws, and regulations of the place of posting. This assures that after arriving in the foreign country,

the employee's behavior will not violate local mores and that he or she will win the respect of the local workers, clients, and companies.

Cementing Loyalty and Retaining Outstanding Employees

Precisely because it is not easy to train employees, once they are trained, it is also necessary to retain them.

Retention requires the building of loyalty to the company. "The main elements in loyalty include the wages, fringe benefits, learning environment, and growth opportunities, which are directly related to the employee's benefit, along with things that are indirectly related, such as company image, culture, and reputation," John T. Yu points out. Only by providing both direct and indirect elements can a company retain its outstanding talent.

Ming-Cheng Hsiao, CEO of Group Shared Services, notes that CTCI has always emphasized a system of fair and reasonable wages and benefits. In addition to a commitment to paying wages that are higher than the local minimum wage, the company strives for internal, external, and individual fairness.

To achieve external fairness, professional consultants are used to investigating wages and benefits, gaining an understanding of market conditions, and then analyzing the job environment to provide a base for the design of the company's wage structure. Internally, competence and job duties are assessed in designing the wage structure. The resulting pay standards are applied to every employee, with no

difference between genders. To achieve individual fairness, the company carries out wage reviews and adjusts salaries in accordance with market salary surveys and individual performance.

CTCI also uses two other methods to keep its employees. One is to offer an employee stock ownership trust, in which employees can invest a fixed ratio of their basic salary and year-end bonus, with the company itself adding 50% to that amount as an additional bonus. This additional bonus, however, does not count in calculating retirement or severance pay.

The second method is to offer company shares to employees at a special price, in accordance with the Regulations Governing the Issuance of Stock Options to Employees, with option ratios and targeted buyers being determined by type of job, performance, amount of contribution, special merit, or other factors. The president and department heads can also distribute stock options, in accordance with a set ratio to total issued shares, to encourage those making a direct contribution to the company or having exceptional performance.

In other companies, stock options often benefit only executives, but at CTCI, basically every employee is covered. The only difference is the number of options offered. “How many they get is one thing,” stresses John T. Yu, “but what we want to show is that ‘the company cares about you.’ We hope the company will be like a family, with all members living in harmony and solidarity.”

A Regimental Commander System with Diverse Promotion Channels

Loyalty is an important consideration in the design of many CTCL systems, and letting the employees see their own future is a key to inspiring loyalty.

Every CTCL employee has an individual development plan, or IDP. Besides giving the employee an understanding of his or her abilities and inclinations, this helps managers make the best work arrangements for them. New employees are assigned a mentor during their training stage, and after going to work, they have a coach to help resolve whatever problems that might crop up during their “greenhorn” period.

When employees accumulate sufficient experience in their original jobs, they can apply to rotate to another department. Someone from an engineering division, for instance, might be assigned to a procurement division, and someone from a procurement division might be transferred to sales & marketing. There is also a cross-training system, in which department heads train personnel from other departments. The objective of both job rotation and cross-training is to help employees build up cross-field abilities, and be better prepared to meet the demands of job advancement.

To build a diverse range of channels for promotion, CTCL early on implemented a “regimental commander system” with managerial jobs divided into managers with subordinates and managers without. One with subordinates is a “regimental commander,” but a specialist

manager without subordinates can be promoted to the same managerial level, so that opportunities for promotion are not limited by number of channels. CTCL has a succession plan for ranking executives, with all key positions under monitoring; three candidate successors are chosen for each position and trained, starting two years in advance, so that one of them can be selected to take over when the time comes.

Another key to the establishment of loyalty is to use corporate image, culture, and reputation to encourage employees to feel a sense of identity, belonging, and honor in regard to the company. CTCL has worked hard to create a global brand in recent years, brightening the company's visibility at home and striving to make employees proud to be part of their company.

Hard and Soft Power Bring Projects to Smooth Completion

Manpower development is not something that can be accomplished in a day or two. In the engineering sector, training someone to be a competent project manager takes 20 years or so.

Michael Yang, currently Group Vice Chairman and CEO of the Group Engineering Business, became one of CTCL's top "combat generals" after 30 years of cultivation.

A graduate of the Department of Mechanical Engineering at National Taiwan University with an advanced degree, Yang, who was born in the early 1960s, started out at CTCL with worksite construction supervision before switching paths to sales. Then he took up the position of

project manager for the Dahtarn Power Plant, where his outstanding performance boosted him from the company's youngest senior manager to a ranking executive position.

Yang recalls that the first day he went to work, the company told him to go back home, buy a ticket and be ready to get going. The next day, he reported to the Fifth Naphtha Cracking Plant construction site. Following his "tests in the battlegrounds" at domestic worksites, the company arranged for him to continue his struggles at Rayong in eastern Thailand, supervising the progress of construction and managing more than 100 workers. He even learned Thai so that he could communicate better with the local people.

After he spent two years in Thailand, the company officials felt that Yang, being both "obedient and willing to work," should be transferred back to Taipei to engage in sales, and over the ensuing four or five years he became a sharp and capable sales expert. In 2003 the company turned the Taiwan Power Co.'s Dahtarn Combined Cycle Power Plant project over to him. With a price tag of NT\$20 billion, we can imagine how much pressure this project imposed on him. "But since the company dared give the project to me," Yang says, laughing, "what was there for me to be afraid of?" In the attitude that "only success was acceptable, never failure," he boldly took the burden of the Dahtarn project on his shoulders.

The timing was unfortunate, and the year 2005 brought a tide of soaring raw materials prices. The price of stainless steel, for example, doubled. High costs naturally had an impact on company profits, so Yang racked his mind for ways to save on costs and keep his company

from suffering losses. Finally, thanks to concerted efforts by his team, the crisis was successfully overcome and three generating units were completed within three years. This laid the foundation for Yang's future advancement.

Talking of CTCI's greatest challenge, Michael Yang confesses that he actually altered his so-called "engineer personality," and learned to be softer and more receptive to the opinions of others.

He feels that the "hard power" of engineers is not a problem, but when overseeing work, engineers should superintend the workers, when engaging in sales they should face the client, and when acting as project manager they should integrate their teams so that projects can proceed according to schedule, and the support of the owners can be assured. Without this "soft power," it is difficult to complete a project smoothly.

He read massive amounts of materials and worked hard to cultivate his own "soft power." This was one of the keys to his distinguishing himself at CTCI.

Yang feels that besides all the engineering projects that CTCI has completed in Taiwan and overseas, the company has also served as a cradle for Taiwan's engineering talent. One of the company's goals for the future is to continue cultivating engineering talent that is even more outstanding, as it struggles hand in hand with others to upgrade Taiwan's engineering industry.

Expert's Commentary

Building a Transnational Talent Platform

World-class enterprises place great importance on the development of transnational talent. In its early years CTCL had to dispatch people overseas frequently for the purpose of business development. While originally, this was not done to cultivate talent, it was the actual consequence.

Like a lot of foreign companies, CTCL today develops transnational talent in a systematic and planned way. Stationing them abroad or sending them overseas for advanced training, naturally, is the most direct way to do this.

I suggest that in addition to these two methods, CTCL should consider following the example of numerous foreign benchmark enterprises by setting up a transnational talent platform that uses short-term seminars to bring employees that the company has earmarked for development into contact with managers who have been posted overseas. Later on, they can maintain interaction over the community platform. The company might also organize internal English study groups and hold discussions on current international affairs. This will help cultivate an international perspective and lay the foundation for participants to become transnational personnel.

Associate Prof. Wen-Jeng Lin, Graduate Institute of Human Resource
Management, National Central University



Chapter 6

Sustainability through Professionalism

Is it impossible to have both economic development and environmental protection at the same time? Actually, it isn't.

The use of energy-saving technology can reduce energy use and cut carbon dioxide emissions for refinery and petrochemical plants; the use of energy-saving electrical equipment can lower the consumption of electricity; the implementation of pollution prevention can reduce air pollution; the adoption of wastewater treatment can make waste water recyclable; and the application of green building methods can greatly facilitate the recycling of heat, the lowering of electricity consumption, the reduction of materials usage, and the reduced use and recycling of water.

This kind of “green engineering” technology has always been one of CTCI's competitive advantages. At the end of 2013, for example, the company won a contract for exhaust gas recirculation system engineer FGRS (Flare Gas Recovery System) Project at the CPC Corp.'s Talin refinery plant. This project provides a perfect demonstration of CTCI's green engineering.

The Talin refinery plant covers about 300 hectares on the south side of the Second Harbor Entrance at the Port of Kaohsiung. Being situated between the Kaohsiung Refinery and the Linyuan Petrochemical Plant, it is a major supply station and transport hub for fuel used by the two plants. It also serves as a major base for oil terminal, as well as for petroleum refining for all of Taiwan. CTCI was responsible for the detailed design and construction of the exhaust gas recirculation system for the refinery's Flare Gas Recovery System. To instill the concept of energy conservation and carbon reduction, and pursue

ways to lower emissions that pollute the air, the company exerted its utmost effort to achieve the most effective recovery and recycling of the refinery's waste gases. For materials that could not be recovered and recycled, appropriate means of disposition were carried out to assure that pollution of and damage to the environment was reduced to a minimum.

Since the FGRS was an environmental project in an industrial zone, away from homes or intensive residential areas, the construction did not create trouble with neighboring residents. Although there were some concerns in the initial period, these were resolved by on-site personnel who explained to residents that the purpose of the construction was to dispose of waste gases and protect the environment. Once the residents understood this, they basically took a positive and encouraging stance, and expressed the hope that the engineering team would complete the project quickly.

The emphasis on environmental sustainability inherent in the “green construction” principle provided an important entry point for the CTCL Group's corporate social responsibility (CSR).

A Pioneer of CSR in Taiwan

CSR has become a crucial topic among enterprises in recent years.

According to the Chinese book *Corporate Social Responsibility: A Multi-Perspective*, the CSR concept germinated back in the 1920s and had formed a theoretical framework by the 1960s, focusing mainly on the definition and scope of CSR. In the 1980s, the book reviews

the manifestation and weighing of CSR from the perspective of management. After 1990, CSR began forming into a global groundswell, and from 2000, it became an issue that no major enterprise could afford to ignore.

In Taiwan, CTCL was an early adopter of CSR, giving it an important position sooner than other domestic companies. This was the result of CTCL's rapid pace of internationalization. The company wanted to link up with the world and compete with international enterprises, so it could not but exert itself in the field of CSR.

CTCL also wanted to show clients its care for stakeholders and establish its corporate credibility, so it set up a CSR Committee in 2008 to carry out CSR planning, implementation, data collation, and progress review. That same year, it issued its first "Corporate Social Responsibility Report," which it turned over to the British Standards Institution (BSI) for independent verification. Every bit of information in the report was backed by evidence, and there was no deliberate embellishment at all.

Taiwanese companies had just started implementing CSR at the time, and they generally understood "social responsibility" as meaning "social welfare." Being born as an engineering firm, CTCL approached the implementation of CSR from the standpoint of its own core competence, placing its focus on green engineering with the aim of producing a win-win situation for all parties including itself, its partners, its stakeholders, and the environment. This effort showed the spirit of industrial sustainability.

In 2009, CTCL approved its "CSR Promotion and Report Publication

Regulations,” firmly establishing principles for the organizational framework, authority, and implementation of the CSR Committee with the aim of enhancing its corporate image, assuring client loyalty, and building harmonious partner relations. In 2010, the hierarchical level of the CSR reporting was upgraded to the Board of Directors, which became responsible for reviewing and supervising all CSR-related matters.

CTCI also set up medium- and long-term Key Performance Indicator (KPI) sustainability targets to the year 2020, in the hope of making CSR part of the company’s competitiveness through the regular examination of implementation results.

Ever Victorious in the CSR Race

CTCI adopted a more vigorous method of CSR implementation in 2013. To strengthen emphasis on and contribution to environmental protection, the company restructured the Committee, expanding the functions of the Supply Chain Relations working group, and changing its name to Environmental Protection working group. It was put under the supervision of the Innovation R&D Center and charged with integrating the various measures used by the company to carry out environmental protection, with group meetings being convened on a regular basis to follow up on the results of implementation.

Three subcommittees were organized to operate under the CSR working group—Operation and Governance, Environmental Protection, and Social Participation—and their work was included within the KPIs of the different business groups with the aim of fulfilling corporate

social responsibility. In November 2013, the CTCI Board of Directors approved the CTCI Rules for Corporate Social Responsibility to guide implementation.

Ever since implementing CSR, CTCI has been an “ever victorious army,” a winner in many competitions. CTCI was a winner, for example, when the Taiwan Institute for Sustainable Energy first held the Taiwan Corporate Sustainability Awards in 2008, using evaluation of the corporate social responsibility reports of major business groups and enterprises, and has been on the list of winners every year since.

Furthermore, since 2015, CTCI was included in the Dow Jones Sustainability Index (DJSI) for two years in a row. The DJSI, compiled jointly by RobecoSAM and S&P Dow Jones, is the world’s first index that tracks the CSR of top enterprises, and is one of the corporate sustainability rating tools with the highest international credibility. CTCI is the first enterprise in Taiwan, and the only one in the Engineering & Construction industry in Taiwan, to be included in the DJSI, which is used as an important reference by investment institutions all over the world.

CTCI won seven major TCSA Taiwan Corporate Sustainability Awards in 2016. Group Chairman John T. Yu also received an Award for Outstanding Corporate Sustainability Professionals (see attached chart).

“For CTCI,” states Chairman Yu, “CSR is more than just donating money and doing charity. Our company makes CSR part of its core competitiveness, and we strive to make it part of our DNA.”

CTCI CSR Honor Roll

- 2015 Emerging Index Membership with Excellent Performance
- TCSA Award for Outstanding Corporate Sustainability Professionals
- TCSA Taiwan Corporate Sustainability Award in the service industry large-company category, Transparency and Integrity Award, Growth through Innovation Award
- *CommonWealth* Magazine Excellence in Corporate Social Responsibility Award
- British Standards Institution (BSI) Sustainability Excellence Award

Governance through Transparency, Professionalism, and Improvement

CTCI is not a family business, but is an enterprise guided by professional managers in three major directions: transparency, professionalism, and improvement.

From the time of its establishment up to today, CTCI has continuously promoted a corporate governance culture of stable growth and sustainable development. Three functional committees under the Board of Directors have steadily improved the internal controls system and information security and risk management mechanisms, while achieving integrity in governance through the strategies of “strengthening the supervisory function of the Board of Directors,” “improving the

company's management system," "reinforcing information security management," "implementing risk management," "fulfilling information disclosure," and "establishing corporate self-discipline standards."

To strengthen the supervisory function of the Board of Directors, the company has set up Business Ethical Behavior Guidelines for Directors and Managers, stipulating that directors and managers must follow the highest ethical principles. The Board of Directors has also established a Corporate Governance Committee, Audit Committee, and Remuneration Committee to make operations more nimble, and upgrade decision-making quality and performance.

To improve the company's management system, a basic framework has been set up, operational and financial information are disclosed on a regular basis, and operating risk is controlled in accordance with the rules stipulated by the Financial Supervisory Commission in order to upgrade the company's operating performance and efficiency, assure asset safety, and protect shareholders' rights.

To reinforce information security management, beginning in 2014, CTCL set up a project organization, introduced international ISO 27001 standards, established an information security management system, and passed British Standards Institution (BSI) certification. To implement risk management, starting in 2006, the company introduced a risk management system, formed an interdepartmental Risk Management Committee, and formulated Risk Management Standards that set risk management operating procedures for different departments and projects.

In addition, CTIC has always been a “model student” in the disclosure of corporate information, never sparing any effort to fulfill information transparency. In the information disclosure assessment carried out jointly by the Taiwan Stock Exchange and Taipei Exchange, CTIC has won an A++ rating—the highest possible—for information disclosure by listed companies year after year, as well as recognition as among the top 5% of listed companies. The issuance of its corporate CSR report is another manifestation of the company’s information disclosure practices.

To establish corporate self-discipline standards, CTIC has set up separate basic codes of conduct to be followed by directors, managers, employees in general, and purchasing personnel. To protect fair trade and prevent graft and bribery, in addition to formulating rules to follow, the company has also set up an investigation committee and complaint hotline. Illegal acts will be met with punishment.

Pi-Chuan Chen, former executive vice president of CTIC, feels that CSR is like an annual checkup and that “The issuance of the CSR report every year not only allows us to spot where the company is falling short, but also helps us find the direction of CTIC’s future development.”

Strong Green Engineering Power

If we say that CTIC’s implementation of operational governance is for the purpose of laying a foundation for corporate sustainability, and that it strives for environmental protection to realize the vision of green engineering, we should understand that these measures also strengthen the company’s green competitiveness and help fulfill its

responsibility as a citizen of the world.

In times past, most of Taiwan's engineering bids were decided by the lowest bidder; more recently, however, there has been a tendency toward choosing the most advantageous tender, which considers the technology, quality, function, commercial terms and conditions, and price, evaluating all of these factors in choosing the best bidder. For CTCL, which places equal importance on green engineering and competitiveness, this provides a great boost. It means that in the bidding process, CTCL can bring up professional suggestions from a stance that includes both environmental protection and budget, to help the owner devote its efforts to protection of the environment, whether during the process of plant construction or in future operations.

In addition, CTCL would pinpoint large landmark projects and disclose the energy conservation and carbon reduction services that were provided to the owner during the construction process, and the energy conservation and carbon reduction or environmental protection engineering techniques that had been used, with the aim of working together with the owner to accomplish CSR while complying with the spirit of the contract.

Using statistics on green engineering projects carried out by CTCL from 2013 to 2016, and calculating on the future life cycles of 30 years for petrochemical plants and 40 years for power plants, the total saving of electricity use resulting from those projects equals 14.8 days of generation by all of Taiwan's fossil power plants. The reduction of carbon dioxide emissions equals the amount of carbon that would be absorbed in a year by 166,063 Da'an Forest Parks. The

water saved is equal to all the water used by Taipei City in 151 days. This green engineering power is one of the marketing tools that CTCL uses to differentiate itself from its rivals when striving for business opportunities.

A Model Student for Petrochemical Plants

How does CTCL manage to carry out its environment protection and energy conservation plans in the process of plant construction? A prime example of this is manifested in the company's contracting for the CPC Corp.'s Sixth Naphtha Cracker project.

The background of the Sixth Naphtha Cracker project goes back to the ageing of hardware and software facilities in the Third Naphtha Cracker, after it had been in service for a long time. The plant's production capacity was no longer competitive, and it was vulnerable to unnecessary energy consumption and pollution. CPC's Third Naphtha Cracker renewal and expansion project not only upgraded Taiwan's self-sufficiency in petrochemical raw materials but also, it was hoped, would achieve energy conservation and carbon reduction standards in the production process. After CTCL won this project, it took a double-barreled approach to it: production process renewal and pollution prevention.

To renew production processes, CTCL adopted the Lummus process from the United States. This is a production process that has accounted for a relatively high share of the global naphtha cracker market over the past 10 years; it offers high production efficiency and reduced energy consumption, and even the electrical piping it uses complies

with international energy conservation and carbon reduction standards. In addition to the constant development of the high-performance production processes and equipment that meets international standards for energy conservation and carbon reduction for CTCL adoption, engineers take advantage of their participation in trade fairs to seek out the latest energy-saving technologies and equipment. This helps the company to offer its clients services and products that provide benefits in both cost and environmental protection. CTCL approaches the prevention of pollution from three directions: air, water, and noise. In addition to adopting an emission reduction design for flare towers, for example, the company also installs safety interlock trip systems to reduce waste gas emissions, and it designs oil/water separation equipment so that all of the plant's waste water can be collected, and after separation, discharged to the water treatment plant. Besides preventing pollution, this allows some of the waste water to be recycled for industrial use and some for ordinary use in the plant.

The prevention of noise pollution is another prickly issue. For the Sixth Naphtha Cracker, CTCL built a compressor room to block sound, and installed a barrier wall to reduce noise around the plant's perimeter. The results were excellent; for some time after the plant construction and trial operation were completed, local residents would come and ask, "Is this plant operating, or not?"

After CPC's Sixth Naphtha Plant was completed, it evidenced outstanding performance in production capacity and pollution prevention, winning first place in the public construction category of the Public Construction Golden Quality Awards organized by the Ministry of Economic Affairs. CTCL, we might say, is a "model student" in

petrochemical plant construction.

CTCI has an exclusive secret weapon that it uses in its fight for environmental protection: the Group Resource Cycling Business. The operations of this group extend through Energy-from-Waste plant design, construction, commissioning, operation, and maintenance, as well as waste disposal, providing integrated upstream-to-downstream waste treatment services. The group has appropriate monitoring and testing mechanisms for the air, waste water, bottom ash, and fly ash produced in the incineration process, as well as measures to prevent pollution. In addition, besides converting the heat produced by the incineration of garbage into energy, the company also provides recycling services for solid wastes, waste gas, waste water, and secondary pollutants.

People in general often have a stereotypical image of Energy-from-Waste plant; but actually, process improvement, pollution reduction, and the development of new technology that continuously cuts emissions, plus the upgrading of equipment function and enhancement of energy recycling efficiency, can turn incinerators into resource recycling plants that recover energy and convert it into electricity. In the Energy-from-Waste plant operated and managed, CTCI holds various kinds of good-neighbor activities to propagate environmental education among local residents and work with them to create low-carbon communities.

The Energy-from-Waste plants that CTCI operates are “outstanding” in all kinds of environmental assessments, receiving various awards including an Energy Conservation and Carbon Reduction Action Label from the Environmental Protection Administration, and an Outstanding

Environmental Protection Unit award from the Southern Taiwan Science Park. These honors reflect the trust and recognition that CTCI enjoys.

Loving the Earth Daily

In addition to developing new techniques for energy conservation and carbon reduction in the field of engineering, CTCI also carries out all kinds of energy conservation and carbon reduction measures at its headquarters. This allows the company's people to practice caring for the Earth, protection of the environment, and conservation of energy in their daily affairs.

Environmental protection work in the headquarters building focuses on management of the consumption of three key resources: electricity, water, and paper. In the management of electricity use, notices and reminders encourage employees to develop the habit of energy conservation, while hardware such as inverter air conditioners and energy-saving lighting like T5 and LED lamps are used. In addition, an electricity-saving system has been installed to monitor the building's power consumption model, and related electricity-conservation measures have been formulated.

Water management is carried out with the aim of reducing the consumption of water by controlling the volume and time of water use, as well as by installing water-saving faucets on a large scale. To manage the use of paper, the company promotes the use of emails instead of paper to transfer data, and printouts to use both sides of the paper. The use of recycled paper is also encouraged.

Creating a Safe and Healthy Work Environment

In its progress toward the vision of becoming “the world’s most reliable global engineering services provider,” CTCL has never forgotten that the efforts of all its employees, the backing of owners and suppliers, and the support of all sectors of society have been a vital facilitating force for the company’s growth over the years. This is why all of CTCL’s social participation activities are undertaken out of a sense of gratitude.

Because employees are CTCL’s most important asset, the company devotes efforts not only to human resources development (see Chapter 5), but also to the creation of a healthy and friendly work environment with gender equality. It has established a health center to provide treatment by professional doctors and registered nurse consultations, designed a variety of health-promotion activities, and publicized correct health knowledge to its employees. In addition, the company vigorously develops social-group activities so that employees can pursue their interests and relief pressure outside of working hours. It has more than 20 clubs, including sports and non-sports related ones, which promote employee bonding and company loyalty. All of these benefits create a learning-friendly, sharing, healthy, and happy work environment.

In regard to external owners, suppliers, and workers, CTCL uses the two major factors of quality and reliability to create friendly and harmonious partnership relations.

The provision of outstanding engineering quality has always been CTCL’s basic commitment to its clients. It has built a set of quality

management procedures in accordance with international ISO 9001 standards to assure that all stages of a project, from project management, design, procurement, construction, production, and commissioning to all other links in the project chain, comply with contract provisions, laws, and the company's own self-demands. These management systems were validated in 1996, and their practical operation is assured using the plan-do-check-act (PDCA) model.

Since project quality must be built on the foundation of a safe work environment, CTCL has established an Occupational Safety and Health Management System in accordance with ISO 14001 and OHSAS 18001 standards, and an environmental, safety, and health policy statement was issued by the corporate president in 2005. The environmental, safety, and health policy was revised in 2009 and again in 2013. The revisions were signed by the company president and heads of business operation units, declaring to clients CTCL's determination to place the utmost importance on environment, safety, and health. Implementation is carried out through daily reviews of construction quality; the strict management of environmental, safety, and health systems; the promotion of environment, safety, and health; and the development of environmental, safety, and health management techniques and other methods needed to create a safe work environment. This provides a foundation for the establishment of reliability.

Establishing an Education Foundation

As a member of society, and having a desire to "give back to society what has been taken from society," CTCL involves itself into all kinds of social welfare activities by participating in councils and associations,

leading community promotion, and supporting disadvantaged groups.

CTCI's social welfare behavior is based on its own special characteristics and advantages. Since the company has a background of professional engineering know-how, for example, it participates actively in engineering-related societies and associations, with the aim of working with peers to upgrade industry standards. Since CTCI's headquarters is located in the Shilin District of Taipei City, the company cooperates with the Zhishan Cultural and Ecological Garden, a local NGO, in organizing the Glory of Zhishan – Shilin Cultural Festival, a major annual event for the local area. In addition, CTCI needs a large number of computers to assist with design, and when upgrading its equipment, it donates its used computers to disadvantaged groups. Besides lightening the burden on the environment, this also exhibits the company's concern for society.

The CTCI Education Foundation was established in 2016, declaring formally that the CTCI Group would work more actively and in an organized manner in the education and promotion of talent.

Ming-Cheng Hsiao, CEO of the CTCI Education Foundation and Group Shared Services, reveals that in its early days, the Foundation focused on four core areas: development of outstanding talent, provision of incentives for academic research, building of a lifetime education environment, and encouragement of employees to participate in corporate volunteer services. In addition to its past provision of scholarship grants and participation in societies and associations, the Foundation wished to cooperate with colleges and universities in organizing such activities as engineering education courses, visits,

and camps to help the academic sector cultivate engineering talent. To provide incentives for academic research, it would promote green education forums and organize sustainable alliances, and proactively promote environmental protection, energy conservation technology and green engineering together with supply chain companies and other engineering firms.

In line with the principle of sustainable engineering, the Foundation will invite engineering experts and scholars to work together in planning and publishing books on sustainable engineering education. Each of these books will focus on one of five major fields: goals of sustainable development, principles of sustainable engineering, assessment of sustainable engineering, case studies of sustainable engineering, and opportunities and challenges. They will explain the concept of sustainable engineering, design, and case studies with the aim of contributing to the establishment of a resource-conserving, environmentally friendly sustainable society.

The CTCI Education Foundation and the Taiwan Institute for Sustainable Energy jointly organized the Taiwan in My Eyes event in April 2017, inviting 48 students from universities across Taiwan and 23 other countries to form 12 groups, and carry out visits and in-depth observation of life, enterprises, buildings, ecology, and culture in Taiwan. This activity, it was hoped, would help the participants develop into a new younger generation with pluralistic viewpoints for understanding other countries, macro-thinking habits, and communication abilities, one that would make themselves heard on international community websites, and share what they have learned about a Taiwan that is advancing toward sustainable development.

The CTCI Education Foundation also held a Youth Sustainability Leadership Program, for which 36 outstanding students from 20 domestic colleges and universities were selected for in-depth exploration and analysis focusing on the United Nations 2030 Agenda for Sustainable Development and the Sustainable Development Goals through classes taught by university professors and corporate executives. This diversified learning opportunity was designed to help the participants expand their international perspective and vision. The Camp also selected 20 young sustainability leadership role models for an opportunity to attend the United Nations Framework Convention on Climate Change conference in Bonn, Germany, so that they could make practical use of their influence in the common drive for global welfare and sustainable development.

Sustainability as a Core Pursuit

In observing CTCI's principles and behavior in the execution of CSR, it is not difficult to see that the common core value of the three main factors of "operation and governance," "environmental protection," and "social participation" is nothing other than "sustainability."

In fact, the definitions of CSR include not only "corporate social responsibility" but also "corporate sustainable report." We can say that the CSR promoted by CTCI contains characteristics of both these definitions, manifesting the results of CSR implementation and, at the same time, displaying CTCI's determination in the pursuit of sustainable development.

"The plants that CTCI builds and the products that we make must all

last for a long time,” stresses CEO Ming-Cheng Hsiao. “In carrying out CSR, we must, of course, also target the long term.” Hsiao quips that an enterprise has to exist for a long time before it can make lasting contributions to society; sustainability of the enterprise itself to the environment to talent, this is how CTCL’s pursuit of sustainability has enabled it to become “the world’s most reliable global engineering services provider.”

Expert’s Commentary

Let Its Influence of Professionalism Spread Far and Wide

The development of CSR over the past 10 years or so has linked it with future corporate development strategy. CTCL began publishing its CSR report way back in 2008, emphasizing green engineering, echoing industry trends, and developing a comprehensive implementation structure. This is something we should applaud.

In addition to pursuing information transparency in its corporate governance, CTCL very early on, started to implement measures to care for its employees, and in more recent years has begun building its brand, boosting employees’ sense of pride and loyalty. This is another big plus for the company.

Because it is a leader in Taiwan’s engineering sector, we hope that CTCL can do even more and strive even harder to disseminate

its professional influence. In green engineering, for example, the company can extend its influence not only to clients but to other targets as well, helping to give the public an even better understanding of CTCL's power on environmental engineering. This will enhance CTCL's visibility in the field of CSR.

Lien-Ti Bei, Distinguished Professor, Department of Business Administration,
National Chengchi University; Director, Sinyi School, College of Commerce, National
Chengzhi University

1979 ►

CTCI

Chronology of Major Events



1979

- CTCI Corporation established by first Chairman and CEO, Kuo-Chi Wang.
- Contracted for the Chenggung Brewery Plant 2 expansion project, entering the field of brewery engineering for the first time.
- Inaugural issue of *CTCI Monthly* published.

1980

- CTCI Smart Engineering Corp. established.
- Aramco refinery construction completed, marking CTCI's entry into the Middle Eastern Saudi Arabian market.

1981 ►

1981

- CTCI's first overseas subsidiary, CTCI Arabia Ltd., established in cooperation with Xenel of Saudi Arabia.
- CTCI Corp. Singapore Branch established.

1983

- CTCI Engineering & Construction Sdn. Bhd. established in Malaysia.

1984

- Headquarters operations moved into Floors 13, 14, 21, and 22 of the CTCI Building on Dunhua S. Rd. in Taipei.
- CTCI Exploration Corp. established.
- Contracted for Taiwan's first major LNG receiving terminal project – the CPC Corp.'s LNG terminal and pipeline facilities.

1985

- Appointment of Director Ya-Moh Tung to serve concurrently as President approved by the Board of Directors.

1985 ►



CTCI Building on Dunhua South Road in Taipei



LNG terminal and pipeline engineering for the CPC Corp.

1986 ▶

1986

- Auto-CAD 2D engineering design and drafting software introduced, and all engineering drawing shifted from manual to computer operation.

1987

- CTCI (Thailand) Co., Ltd. established.
- CTCI Advanced Systems Inc. established.

1988

- Name of the affiliated company, CTCI Exploration Corp., changed to CTCI Resources Engineering Inc.

1989

- Intergraph PDX and AVEVA PDMS large-plant design software successfully introduced, ushering CTCI into the age of 3D engineering design.
- Contracted for Taiwan's first MRT line the medium-capacity Brown (Muzha) Line of Taipei MRT – moving CTCI into the field of MRT electromechanical systems.

1992 ▶

1992

- Contracted to provide design consulting services for the Environmental Protection Administration's Keelung, Tainan, and Pingtung resource recycling centers, successfully entering the market for garbage incineration and power generation.
- Secured EPC hydro-desulfurization engineering contract from Bangchak Petroleum Co., Ltd. of Thailand, entering the overseas EPC engineering market for the first time



EPC hydro-desulfurization engineering at Bangchak refinery in Thailand

1993 ▶

1993

- CTCI Beijing Co., Ltd. established.
- Permission granted for CTCI shares to list on the stock market as Category A stock, making CTCI the first Taiwan engineering company to gain stock-market listing.
- CTCI Overseas Co., Ltd. established.

1994

- ECOVE Environment Services Corporation established.
- Promotion of Vice President Rih-tung Lin to the position of president approved by the Board of Directors.

1995

- Contracted for design and construction of Formosa Plastics' Sixth Naphtha Cracker. This was the largest and most expensive private petrochemical project in Taiwan at the time.
- *CTCI Monthly* switched to publication in the periodical magazine format.

1995 ▶



Refinery design and construction of Formosa Plastics' Sixth Naphtha Cracker complex



1995 ►



Cogeneration plant EPC engineering at the CPC's Talin Refinery

1995

- Contracted for the CPC Corp.'s Talin cogeneration plant EPC project, entering the field of EPC cogeneration for the first time.
- Won contract for the first incinerator operation services outsourced to the private sector in Taiwan – the Xindian Incinerator in Taipei County.

1998 ►

- Secured contract for preliminary detailed design and construction supervision for the Nantou section of the second freeway, participating for the first time in freeway planning.
- Secured contract for building of wastewater treatment plant and wastewater monitoring system at the CPC Corp.'s Kaohsiung refinery, entering for the first time the field of large-scale refinery/petrochemical wastewater treatment EPC engineering.

1996

- Passed international ISO 9001 quality management system certification.

1997

- CTCI Overseas (BVI) Corp. established as offshore holding company.

1998

- Director Li Chen-Hai selected by the Board of Directors to the post of chairman.
- Vice President John T. Yu approved for promotion to president by the Board of Directors.

1999 ►

1999

- CTCL Chemicals Corp. established.
- Innovest Investment Corp. established.
- CTCL Development Corp. established.
- ECOVE Environment Corp. established.
- Chlor-alkali industry strategic alliance signed with ICI.

2000

- Contracted with Xianglu Petrochemicals (Xiamen) for purified terephthalic acid (PTA) plant construction, propelling the company into the field of large-scale petrochemical EPC project in Mainland China.
- Contracted for BOT garbage recycling plant construction and operation project in Wuri, Taichung County, and established the ECOVE Wujih Energy Corporation to handle plant construction and operation in the area. This was Taiwan's first large municipal garbage recycling project to use the build-operate-transfer (BOT) model.

2000 ►



Purified terephthalic acid (PTA) plant engineering for Xianglu Petrochemicals (Xiamen)



Wuri Refuse Incineration Plant BOT project in Taichung

2000 ►



Taiyen collagen biomedical materials plant construction



Kuokuang combined cycle power plant IPP Project

2000

- Contracted with Taiyen Biotech for technology transfer and whole-plant procurement for a collagen biomedical materials plant, moving the company into the biotechnology field.

2001

- Promotion of President John T. Yu to the position of chairman approved by the Board of Directors.

- Promotion of Executive Vice President Mu-Chuan Liu to the position of president approved by the Board of Directors.
- CTCI invested in and contracted for Kuokuang combined cycle power plant IPP Project. This was the company's first participation in such a project, as both investor and contractor.
- Contracted for selective catalytic reduction (SCR) engineering for Hua Yang Electric's Houshi Power Plant in Zhangzhou, entering Mainland China's coal-fired supercritical power plant SCR market for the first time.

2001 ►

- ECOVE Waste Management Corporation established to provide waste management, disposition planning, and removal services.
- Contracted for BOO project for Tainan Science Industrial Park waste treatment center, successfully entering the field of domestic industrial waste management BOO project.
- CIMAS Engineering Co., Ltd. established.

2002

- The affiliated CTCI Advanced Systems Inc. listed on the over-the-counter market.
- Promotion of Vice President John H. Lin to the position of president approved by the Board of Directors.
- Contracted for the BASF-YPC Co.'s low-density polyethylene (LDPE) EPC engineering project in mainland China, defeating international rivals from Korea and other European and Asian countries to achieve a position as an EPC contractor in the international engineering market.

2002 ►



Contract signing with BASF-YPC Co. of Mainland China for low-density polyethylene (LDPE) EPC project

- CTCI Arabia Ltd. established.
- Won the right to build and manage the Miaoli County incinerator on a BOT basis, and established the ECOVE Miaoli Energy Corporation.
- Cooperated with Babcock & Wilcox of the U.S. in contracting for the 265MW coal-fired unit's selective catalytic reduction (SCR) engineering at the Dan E. Karn Power Station in Michigan, marking the company's first entry into the American coal-fired plant SCR engineering market.

2003 ►



2003

- Passed employee stock ownership trust regulations, opening membership in the stock ownership association to employees.
- CTCI Shanghai Co., Ltd. established.
- Contracted for civil and electromechanical engineering at the Taiwan High Speed Rail's Wuri Station, Wuri Depot, and Yanchao Main Workshop, gaining entry into the field of high speed rail construction.
- Won EPC contract for main power generation equipment at the Taiwan Power Co.'s Dahtarn power plant project, participating for the first time in EPC project for a large-scale combined cycle power plant.
- Contracted for ECU/LCI EPC project for the CNOOC Shell Petrochemicals Co., successfully developing the non-petrochemicals market in mainland China.



EPC contract for main generating equipment at the Taiwan Power Co.'s Dahtarn Power Plant

- CTCI suffered the impact of the SARS epidemic, and immediately established an emergency response committee. All employees fully recovered, and the company received a citation of appreciation from the head of the National Health Administration. Taipei Mayor Ma Ying-jeou visited personally to show his concern and support.
- Established a “digital information superhighway” network to integrate the company's domestic and overseas web systems and create a no-borders, zero time difference digital convergence platform.
- Issued overseas European convertible bonds (ECBs) for the first time.



Taipei Mayor Ma Ying-jeou visits CTCI to ask about the impact of SARS

2004

- CTCI Corporation Abu Dhabi established.
- CTCI Corporation Qatar established.
- Incinerator strategic alliance signed with B&W Volund.

2004 ►

2004

- Contracted with Qatar Petrochemical Co., Ltd. (QAPCO) for ethylene plant expansion, marking a milestone in the company's return to the Middle Eastern petrochemical engineering market.

2005

- Contracted for stages 1~6 cogeneration plant EPC engineering for PTTUT Central Utility Project No. 1 in Thailand, marking CTCL's first success in the field of power plant EPC engineering overseas.

2006

- Morgan Stanley Private Equity Asia purchased 19.9% of CTCL shares.
- Contracted with the Bangchak Corp. of Thailand for product quality improvement EPC, creating a record high contract amount for an overseas EPC project.



Groundbreaking ceremony for Saudi Kayan EO/EG project



Phenol/cumene plant construction for the Thai company PPCL

- Contracted with Saudi Kayan's 537 KTA Ethylene Oxide / Ethylene Glycol Plant Project for the world's largest EO/EG petrochemical plant at the time, creating record highs for project size and contract amount for an EPC project in the overseas market, as well as a landmark in the company's return to the Middle Eastern market as prime contractor.

2006 ▶

- Contracted with PPCL for construction of a 200,000-ton phenol/cumene plant, creating a new record high contract amount for in engineering project in Thailand.
- Contract signed with Shihlin Electric & Engineering Corp. for purchase of CTCL headquarters building on Mar. 28. The groundbreaking ceremony for the new building was held on Oct. 3, and the beam-raising ceremony took place on Oct. 17, 2007.
- Passed ISO 14001 environmental management system and OHSAS 18001 occupational safety and health system certification.
- The CTCL corporate knowledge management system began operation.



Groundbreaking ceremony for the CTCL Group's new headquarters building

2008 ▶

2007

- Issued domestic unsecured convertible bonds for the first time.
- Stock options issued to employees for the first time by CTCL and CTCL ASI.
- Kaohsiung Fabrication Shop reorganized as an independent CTCL affiliate, CTCL Machinery Corp.

2008

- Contracted with Petronet LNG of India for Kochi LNG terminal EPC project, marking successful entry into the Indian market.



Kochi LNG Receiving Terminal EPC project for Petronet in India

2008

- CINDA Engineering & Construction Pvt. Ltd. established.
- Contracted with the CPC Corp. to provide EPC service for the residue fluid catalytic cracking (RFCC) plant at the Talin Refinery, setting a new record high amount for a single contract.
- The affiliated ECOVE Environment Corporation listed on the over-the-counter stock market, the first investment holding company in Taiwan to do so.
- CTCI listed No. 63 in ENR magazine's Top 100 International Design Firms.
- Issued corporate social responsibility (CSR) report; became first company in Taiwan to win British Standards Institution (BSI) certification.

2009

- Promotion of President John H. Lin to the position of Vice Chairman, and of Executive Vice President Andy Sheu to President, approved by the Board of Directors.
- Opening ceremony held on Mar. 15 for the CTCI Group Headquarters Building, built with the full efforts of the



CTCI Headquarters Building

CTCI project team with 17 floors above ground and three basements featuring high safety, high comfort, and high functionality. The new headquarters building, which marked the beginning of a new era in the company's sustainable development, won the First Prize in the 2010 National Golden Awards for Architecture.

2009 ►

- CTCl Americas, Inc. established.
- CTCl Corporation Italy established.
- Passed TOSHMS:2007 occupational safety and health certification.

2010

- Contracted for Dragon Steel's No. 2 Sinter Plant Project. This plant was a model of green energy and environmental protection for sinter plants all over the world, with the most advanced selective catalytic dioxin/nitrate reduction and waste heat recycling systems.

2011

- G.D. Development Corp. established.
- Contracted to provide EPC engineering for Taiwan Power Co.'s Linkou coal-fired power plant, entering the field of ultra supercritical power generation for the first time.
- Ten percent of CTCl equity acquired by Chiyoda of Japan, facilitating cooperation in the development of the non-hydrocarbon market.

2011 ►



Photovoltaic power plant in New Jersey, USA



EPC contract for Taiwan Power's Linkou coal-fired power plant

2011 ►

2011

- Contracted to provide EPC engineering for a combined cycle power plant in Kimanis, Malaysia, establishing CTCI's visibility in the international combined cycle power plant EPC market.
- CTCI Singapore Pte. Ltd. established.
- Contracted EPC trackwork project for the Downtown Line of the Singapore MRT (DTL Stage 3), successfully entering the international rail transit field.

2012

- Contracted with QAPCO to provide (EPC) engineering services for an ethylene cracking furnace and ethylene tank. This was CTCI's first EPC project as prime contractor in Qatar.
- Contracted with the China Steel Corporation India to provide engineering services for a first-stage annealing and coating line, successfully entering the general industry market in India.

2013 ►



EPC contract for Taiwan Power's 2,600MW combined cycle power plant

2013

- Contracted with the Taiwan Power Co. to provide EPC engineering for the 2,600MW Tunghsiao combined cycle power plant, entering the field of EPC project for large-scale combined cycle power generation for the first time.

2014 ▶

2014

- Contracted with Petronas of Malaysia to provide EPC project services for a refinery residue fluid catalytic cracking (RFCC) unit, creating a new record for a single contract with an amount in excess of US\$1 billion.
- Contracted for with Saudi Methacrylates Co. (SAMAC) to provide EPC services for a methyl methacrylate (MMA) and polymethyl methacrylate (PMMA) plant. The production volume of this MMA/PMMA plant is among the largest in the world.



Project teams from Taiwan and Malaysia gather for a group photo following a ceremony welcoming the arrival of the first set of heavy equipment and presenting commendations for a Petronas EPC project

2015 ▶

2015

- Jointly contracted with CB&I to provide EPC services for a steam cracking unit for the Oman Oil Refineries and Petroleum Industries Company (ORPIC) at the Liwa Plastics Industrial Complex. This was the company's first foray into the Omani market, and it set a record amount for a single CTCL overseas project.
- Contracted to provide detailed engineering design services for Formosa Plastics' EG2 plant expansion project in the United States. This is one of the world's largest ethylene glycol plants.
- Entered into the Dow Jones Sustainability Index (DJSI), the first Taiwanese company to be listed in the DJSI in the Engineering & Construction industry.
- Passed ISO 27001:2013 information security management system certification.

2016 ▶



Announcement of the CTCI global brand

2016

- CTCI global brand announced, with the aim of forming a brand image of “the most reliable global engineering services provider.”
- Contracted Fengshan Shi Wastewater Reclamation Plant BTO project in Kaohsiung City, creating a new milestone for water recycling in Taiwan.
- Contracted to provide engineering services for the Chungli Sewerage System BOT project in Taoyuan County, marking the company’s

first sewerage system BOT project following its provision of sewerage system design consultation work and urban wastewater treatment plant EPC



Contract signing for Fengshan Shi Wastewater Reclamation Plant BTO project in Kaohsiung City

2017 ►



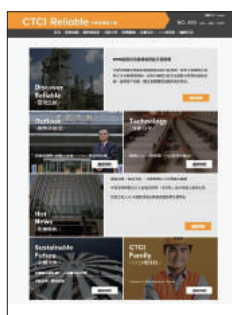
CTCI Education Foundation established to pursue the development of engineering talent

contract.

- CTCI Education Foundation established to upgrade educational standards, cultivate outstanding talent, provide incentives for academic research, build a lifelong education environment, and promote national competitiveness.

2017

- *CTCI Monthly* publication switched to CTCI Group e-newsletter.
- Taiwan Sustainability Guild Hall established jointly by CTCI and the Taiwan Institute for Sustainable Energy.
- A PTA Strategic Alliance formed with Invista for the purpose of laying out a global petrochemical industry.



國家圖書館出版品預行編目(CIP)資料

Discover Reliable: CTCI's Road to success as a Top
100 Global Engineering Brand / written by Chi Jun
Hsieh

ISBN 978-986-95718-0-7(精裝)

Discover Reliable

CTCI's Road to Success as a Top 100 Global Engineering Brand

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Translated by **Earl Wieman**

Editor: **Jessica Lee, Phoebe Chan** and **Alex Lee**

Art Design: **Lorne Tsai**

Published by **Commonwealth Publishing Co., Ltd., Harvard Business Review**

Chairman: **Charles H.C. Kao**

Publisher: **Cora Wang**

Editor-in-Chief: **Ma Li Yang**

Address: **#1, Lane 93, Sung-Chiang Rd., Taipei, Taiwan 104, R.O.C.**

TEL: **886-2-2662-0012**

FAX: **886-2-2662-0007 ; 886-2-2662-0009**


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Publication Date: **2017/12**

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Complex Chinese Edition

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ISBN: 978-986-95718-0-7



In addition to taking root in Taiwan, CTCI has advanced vigorously into overseas arenas, contesting not only the “Asia Cup” but the “World Cup,” as well to become one of Taiwan’s few international engineering conglomerates that can compete with world-class engineering firms.

————— **Vincent Siew**, Former Vice President, Republic of China

As the CTCI Group marks its 38th year, it has grown from a small-scale engineering design company into today’s large enterprise, with a business territory that extends throughout Taiwan and the world, over 7,000 employees, and earns annual revenues that reach NT\$70 billion. We can honestly say that CTCI has set an ideal example for the economic development of Taiwan.

————— **Wen-Yen Pan**, Chairman, CTCI Foundation

As one of its partners in industrial-academic cooperation, I am happy to see how CTCI uses intelligentized and innovative plant-construction engineering technologies to provide its customers with faster, better, and more competitive multidimensional services. This is an achievement that gives Taiwan’s outstanding engineering technology and personnel a chance to shine on the international stage.

————— **Mau-Chung Frank Chang**, President,
National Chiao Tung University