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# THE CHANGING MARITIME INDUSTRY: THE IMPACT OF MEGAPROJECTS ON THE WORKFORCE


## ABSTRACT

Over the course of the last 40 years the face of dredging has changed dramatically, with coastal engineering projects completed in much shorter time frames. It is widely recognised that the technological changes in maritime construction and the ever-increasing magnitude of projects, so-called megaprojects, have resulted in increased demands on personnel, crew members, engineers and others in the dredging industry. This article addresses these demands and how they have impacted the education and professional requirements of the workforce.


## INTRODUCTION

In recent years so-called megaprojects in coastal engineering have increasingly been in the spotlight. It is not clear at all, however, which criteria place any project in that category. Is it the impact on the economy or the environment? Is it the area covered by the project, the volume of material handled, the turnover or the profit associated with the execution? These questions seem rather academic since almost everybody in the coastal engineering community considers projects like Tuas reclamation and other projects in Singapore, Chek Lap Kok airport in Hong Kong, the reclamation projects in the Gulf region (Dubai and Qatar), and most recently the extension of Maasvlakte in Rotterdam to belong to this category. Surprisingly, hardly any mention is made of similar sized projects in the past: construction of the Suez Canal and Panama Canal, the closure of Lake IJssel and the subsequent reclamation of 165,000 ha of land, the Delta Project in the Netherlands, including the storm-surge barriers in the Eastern Scheldt and the Rotterdam Waterway.

## WHAT CONSTITUTES A MEGAPROJECT?

### From large to extra-extra large

A critical analysis of similarities and differences between the older megaprojects and the more recent ones demonstrates that these older projects should not be excluded from the category megaproject. The most important distinction between the older projects such as the Suez and Panama Canals or the Lake IJssel Reclamation and Delta Project in the Netherlands (Figure 1) and the projects today such as in Dubai (Figure 2) is the construction time. Where the projects of the past took decades to be completed, the recent ones are completed in a few years. For a more elaborate analysis, see Table I, Figures 1 and 2, and K. D'Angremond, "Scale effects of megaprojects", *Shore & Beach*, (Vol. 76, No. 4, Fall 2008). More interesting than a discussion about which projects qualify for the mega-size category is the analysis of the faster execution of these projects: What are the causes and what are the effects of the faster execution? One cannot limit this discussion to the world of the contractors only, but one should incorporate designers and owners as well.

Above: One of the first megaprojects was the work done in Hong Kong, including the construction of the new Hong Kong airport, Chek Lap Kok.

## BACKGROUND OF THE FASTER EXECUTION

The faster execution of mega-dredging projects has several reasons including economic and social motivations. But of course neither of these would matter nor be possible if technology had not kept pace.

### Rate of return

One of the major reasons why faster execution of large projects is attractive is certainly the wish to enhance the rate of return on investment. More and more projects are scrutinised by economists on

**Table I. Megaprojects Present and Past**

| Project name | Country | Year of Completion | Construction Time (Years) |
|---|---|---|---|
| Suez Canal | Egypt | 1869 | 11 |
| Panama Canal | Panama | 1914 | 22 |
| Lake IJssel Reclamation | The Netherlands | 1968 | 48 |
| Delta Project | The Netherlands | 1986 | 30 |
| Palm Jumeirah | UAE | 2005 | 3 |


Figure 1. Lake IJssel reclamation in the Netherlands.

the basis of a calculation of the net present value (NPV). Interest payments on the capital investment during construction reduce the NPV and earlier revenues increase the NPV. All good reasons to attempt a reduction of the construction time. An additional reason might be the fear that competitors "borrow" the ideas and run away with potential customers.

Whatever the economic drivers to reduce construction time, from a technical perspective this acceleration was only possible because of a tremendous increase in the capacity of the construction equipment.

As the focus here is on coastal engineering projects, this means mainly the capacity of the dredging equipment.

The increased production capacity is partly the result of increased understanding of the physical processes involved, like mixture formation, pumping sand water mixtures and deposition of granular material. In fact, one may conclude that the co-ordinated research efforts that started in the late 1960s now fully contribute to the output.

### Supply and demand

A second aspect is a mutual influence between supply and demand in the market. Technological innovations facilitate the construction of ever larger equipment, the larger equipment facilitates larger projects and the larger projects in their turn create a demand for larger equipment. This effect can best be explained by comparison of some older and more recent dredgers.

An interesting comparison is of two vessels, both named *W.D. Fairway*. The older one was constructed in the 1960s, the newer one in 1996 and extended in 2002. This coincidence became to light at the National Dredging Museum, when during a search for a picture of the new vessel, a picture of the older one came to light. Although the newer vessel was lost after a collision in 2007, it remains unusual to find two vessels with the same name which are so extremely different (see Figures 3 and 4 and Table II). The remarkable point is that, roughly speaking, although the strength of the crew on both vessels is equal, productivity is not: Despite the tremendously increased hopper capacity on the newer vessel, the filling time for both hoppers remained almost the same. This once again demonstrates that supply and demand and technological innovation have gone hand in hand.

### Effects of faster execution

Whatever the background of the faster execution, contemplating the consequences is interesting and crucial. Obviously, the faster execution and the shorter duration of the projects must have a large impact on organisations and individuals involved, whether the owner of the works, the designers, the contractors or the supervisors.

Starting on the purely technical side, the time available to run in on a project is less. Small deviations of the work plan will have immediate and large consequences. There is less time to re-consider and optimise working methods. Preparations, therefore, have to be more elaborate, but also the project management must be more alert than ever to notice differences between the anticipated work method and the actual course of events. There is very little time to allow for a learning curve on the project.

The same applies to the representatives of the employer. If the works cause unforeseen and unwanted side effects (technically, environmentally or even socially or politically), in the past time was ample to reconsider and adapt the original set-up. This is not merely a hypothetical remark; many such adaptations took place during the execution of the Lake IJssel reclamation and the Delta Project in the Netherlands where time to rethink a

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graduated as a civil engineer from Delft University of Technology, the Netherlands in 1963. He then worked with Delft Hydraulics, Volker Stevin Dredging and the Port of Amsterdam. In 1989, he was appointed professor of coastal engineering at Delft University. Since his retirement from TU Delft in 2001, he remains active as an arbitrator and consultant. He is member of various professional organisations and is currently Secretary of the Foundation Friends of the National Dredging Museum, Sliedrecht, the Netherlands.

problem allowed engineers to fine-tune working methods. Some clear examples are the decisions not to reclaim the Markerwaard area and to construct the storm-surge barrier in the Eastern Scheldt instead of closing the estuary. Today, with shorter time spans for executing work, making such adaptations is more difficult.

The effects are not restricted, however, to the technical side of the projects. A shorter project duration also means compaction of all financial and administrative procedures. This starts with financing, intermediate surveys, issuing of payment certificates, and so on. It ends with reduced times for contractual notifications and formulation of claims, to name a few aspects.

The overall picture is clear: Faster execution leads to a need for increased alertness, shorter lines of communication and a better understanding of all processes during execution. The staff on site must consist of well-trained observers who can distinguish and interpret even the slightest signals that indicate deviations from the anticipated plans.
It means that they must be able to observe and to reflect quickly on the meaning and background of what they have observed.

Where communication between designer, owner and contractor is involved, one of the solutions is a change in the contractual relations. Design and Build contracts or even Design, Build and Maintain contracts solve part of the problem for the owner,


Figure 2. Reclamation projects in Dubai were completed in a few years.

**Table II. Comparison of main characteristics of the old and new TSHD "*W.D. Fairway*"**

| Feature | Unit | *W.D. Fairway* (old) | *W.D. Fairway* (new) |
|---|---|---|---|
| Length | m | 69.19 | 232.35 |
| Width | m | 11.85 | 32.00 |
| Loaded draught | m | 5.47 | 13.68 |
| Sailing speed (fully laden) | knots | 10 | 15 |
| Hopper capacity (sand) | $m^3$ | 1,236 | 33,800 |
| Cargo capacity | tons | 1,605 | 56,800 |
| Suction tubes | - | 1 | 2 |
| Suction tube diameter | mm | 850 | 1200 |
| Max. dredging depth | m | 18.29 | 55/120 |
| Total installed power | kW | 1,660 | 27,500 |

but increase the exposure of the contractor. The introduction of the Alliance Contract has provided a way for contractor and client to share responsibilities and risks and find solutions together, but this too requires elaborate planning and teamwork.

At the end of the day, people on the work floor have to cope with the more complicated conditions. When the scene on the work floor changes, making changes to the workforce must be considered as well. Successfully completing a large project remains the work of people, in spite of the power of our tools. The conclusion is that the changes in the scale of present-day projects will have a major impact on the quality and quantity of the human resources we engage.

## THE EFFECTS ON INDIVIDUALS

When attempting to formulate what effect these changes have for the staff on dredging

Figure 3. The original TSHD *W.D. Fairway* (1960s).

Figure 4. The second TSHD *W.D. Fairway* (built in 1996 and lengthened in 2002).

projects, the conclusion in the first place must be that all involved have a much larger responsibility than in the past. And larger responsibility leads to more stress. Society expects a larger span of control from its engineers, a vision of the consequences of the project, a rapid and adequate response if something unwanted or unexpected occurs. These skills are important, and somewhat new, but we can prepare engineers by education and training, and by putting an adequate human resources selection process in place.

Employees are subject to changes in the social field as well. In the past, the duration of the projects was such that it often paid to take the family along for several years. The companies were used to providing housing, schooling and medical facilities for large groups of staff. Since many of the projects of the past took place in remote areas, the project manager was not only manager of the project proper, but also director of the project school and the project hospital.

With the shorter execution times, taking the family along is usually not reasonable, which adds to the personal stress. Fortunately, part of these effects is mitigated by the modern means of communication and the improved living conditions on board of the dredgers. At the same time, the world is shrinking and remote areas are few and far between. In cities like Hong Kong, Singapore and Dubai, setting up a company school or a company hospital is no longer necessary. International schools and adequate health care services already exist independently of, though sometimes supported by, the companies. Still, in spite of this, this new class of mega-projects demands an increased flexibility not only from the staff, but certainly also from their families.

## CHALLENGES IN A BROADER PERSPECTIVE

All these changes take place in an environment where coastal engineers are facing broader challenges in general. There is a growing need for fresh water as a result of a growing world population. Moreover, the effects of climate change and sea level rise present threats for a large (and growing) part of the world population that lives in low-lying coastal areas. Any solutions that are proposed must not only meet technical specifications, but must be sustainable as well.

The coastal engineering community can only cope with these challenges if it is able to apply innovations to the profession. That is easier said than done. Looking at coastal engineering in general, it means that the industry has to consider more elements than just the coastal stability; it must incorporate considerations about climate change in a realistic way; it must introduce elements from the biosciences and ecology; it must consider spatial planning and zoning and pay more and more attention to the latest macro-economic insights. Last but not least, as engineers, the dredging industry will have to convince the broader public about the justification of these ideas.

The same applies to dredging as the toolkit for the coastal engineer. Over the last decades, the knowledge of the dredging process has so much improved that it is difficult to optimise further in this direction. Innovations have to be introduced from different disciplines like electronics, materials science, remote sensing and logistic planning. Here, dredgers will have to demonstrate that dredging can improve the environment and does not destroy it.

Considering these options for innovation, it becomes clear that most opportunities are opening up at the interface between disciplines, disciplines that are sometimes far away from the traditional fields of interest of today's coastal engineer. The prospective interfaces, however, are not only present in the scientific subjects; they are also found in the relation between (competing) companies, between employer, consultant and contractor and between nations and even cultures.

If one recognises the need for such open innovations beyond the traditional borders to integrate the best ideas into feasible new concepts, the need for new business models becomes obvious as well. Such new models must combine a borderless strategy and a very dynamic business concept.

This is quite a challenge for an industry that used to shield its own knowledge from the outside world to such extent that even the application for a patent was considered to be a breach of confidentiality.

For this reason the industry must expect joint ventures that are not only aimed at the execution of a single project, but also that address more general issues.

Partners in such joint ventures can be commercial companies, non-profit organisations, government agencies and research institutes.

## THE NEW GLOBAL COASTAL ENGINEER

The changes in the work environment of the "new" coastal engineer must have an effect on their education as well. To operate successfully, today's coastal engineer must have specific skills to work in a global environment.

- They must still master the traditional technical abilities
- They must master more than one language
- They must have a broad cultural awareness
- They must be innovative and creative
- They must have entrepreneurial skills
- They must be flexible
- They (and their families) must be mobile

The easiest solution is to say that it is the task of universities and colleges to develop these skills. There is no doubt that during the education process more emphasis should be placed on the independence and individual responsibility of the students in relation to the required skills

However, adding more and more aspects to the curriculum cannot go on indefinitely. There are limits in time, but there are also limits by the nature of the academic environment. In order to prepare the students for their new role, an open exchange with the professional field is necessary to establish a clear link between the abstract scientific background and the actual behaviour of water, sediments, machines and human beings. This exchange can have different shapes: traineeships by students and lecturers, internships at large dredging companies and consultancies, but also lectures by professionals, embedded in the curriculum.

This exchange is not a panacea; the professional world must realise that education is continuing and should obtain the shape of "lifelong learning". To a certain extent, this attitude has been taken up by the large companies that have trainee programmes for inflowing students (Figure 5). In general, however, the aspect of lifelong learning has hardly found a place in the civil engineering society. This is surprising since, for instance, the medical and the legal professions have accepted "continuing education" as part of their professional accreditation. More recently some changes in this atittude seem to be on the horizon.

## ANSWERING THE CRY IN THE WILDERNESS

Some of the ideas presented here have been voiced by several colleagues and presented a few years ago at conferences and in articles. At the time a few years ago, it felt like "a cry in the wilderness". Today however, it is amazing to see that many of these ideas are being implemented rapidly and are starting to show some first results.

In the USA, recognition of the need for specialty certifications programmes in engineering, such as exist for doctors and other professionals, has recently led the American Society of Civil Engineers to start a new academy, known as the Academy of Coastal, Ocean, Port & Navigation Engineers (ACOPNE) (www.acopne.org). ACOPNE was created to offer a voluntary, post-license credential that provides professional engineers an opportunity to gain further recognition in the field of coastal engineering and related disciplines. The goal of ACOPNE is to improve the practice, elevate the standards and advance the COPNE profession and provides recognition to those individuals who have excelled in the sub-disciplines embraced by COPRI (Coastal, Ocean, Port and River Institute).

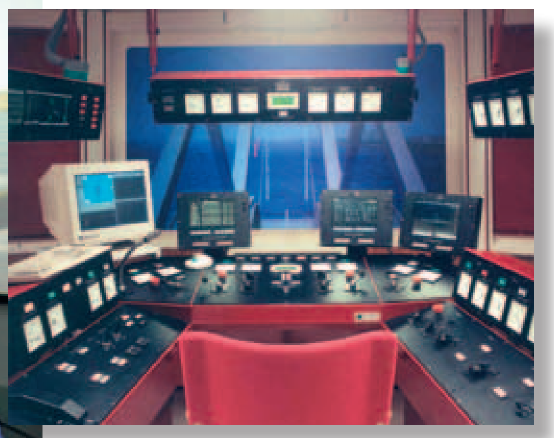

Figure 5. Two views of cutter suction dredger simulator: Simulators are part of in-house training to prepare personnel before they take over the tasks onboard.

Figure 6. When the scene on the work floor changes, making changes to the workforce must be considered as well. Efforts to train younger employees to transition into management have resulted in Young Management Days in many organisations.

In the field of education joint MSc programmes are being established, such as a new initiative by Delft University of Technology (TU Delft, the Netherlands) and the National University of Singapore (NUS). There is also a new programme under the umbrella of the EU: CoMEM. The Erasmus Mundus Master in Coastal and Marine Engineering and Management is a two-year, English-language international Master's programme, in which five highly rated European universities participate. Students will familiarise themselves with key issues involved in providing sustainable, environmentally friendly, legally and economically acceptable solutions to various problems in the CoMEM field.

During the programme, students study at universities in three different countries. Students spend the first semester in Trondheim, Norway, the second semester in Delft, the Netherlands; during the third semester in the second year, students choose a specialization in Barcelona (Spain), London (UK) or Southampton (UK). Semester 4 is devoted to doing the MSc thesis at one of the three universities previously visited.

In the Netherlands, the Vereniging van Waterbouwers (the Association of Hydraulic Engineers, formerly VBKO), an organization of contractors in coastal engineering, has started a programme to intensify the ties between the industry and the educational institutes. This initiative is still being expanded. In spite of the economic downturn, the industry has pledged to maintain the opportunities for students to complete their thesis work during an internship. The industry has further entered into formal financial and professional support to the Faculty of Civil Engineering of TU Delft. Although the main reason for this support was a regrettable shortfall in the budget of the faculty, the agreement between the industry and the University opens new and unprecedented options for exchange.

Furthermore, the research programme "Building with Nature" of EcoShape, based on the research by Ronald Waterman and his book of the same name, has made a start and constitutes a cooperation between employers, contractors, consultants and research institutes. The programme is not restricted to Dutch participants, but constitutes an international framework.

The main employers of recently graduated professionals all have their own trainee programmes. Some of them have received special recognition for their excellence as the best trainee programmes in their respective country. As a follow-up, they try to boost the mutual exchange between the young professionals by creating chapters within their organisations. In this way, "Young PIANC" and "Young Rijkswaterstaat" as well as "Young Management Days" of IADC are becoming increasingly active (Figure 6). The professional associations attempt a move in the same direction. CEDA (Central Dredging Association) has taken a similar initiative.

In an international context, it is reassuring that the continued existence of COPEDEC is safeguarded now under the umbrella of PIANC, and that after the successful conference in Dubai, a new one is planned in India (2012).

## CONCLUSIONS

Clearly, despite the economic downturn of the last few years, progress is being made towards a contemporary coastal engineering industry that welcomes open innovation and spends keen attention to the need to modernise the education of young professionals.

These innovative changes are required for both organisations and individuals, and this change will find expression in its impact on education. The exposure to real life engineering experiences during the academic study period is crucial to bridging the gap between science and practical application. Traineeships and internships give young professionals the opportunity to combine academic knowledge and field observation into more abstract experience and understanding.

Hopefully these young professionals will profit from this attention and will have the opportunity during their further careers to keep reflecting on the interaction between theory and practice, between model and prototype.

## REFERENCES

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