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Through their regional branches or through representatives, members of IADC operate directly at all locations worldwide.
CONCEPTUAL MODEL FOR PARTNERING IN THE DREDGING INDUSTRY

STEHPHANIE JANSSEN
Partnering can be a tool for increasing co-operation and sustainability during high-risk maritime construction and dredging projects. A model helps to determine when and if applying partnering is appropriate.

LONG-TERM COASTAL DEFENCE AND MANAGEMENT AT PEVENSEY BAY, UK: A PUBLIC PRIVATE PARTNERSHIP

MARCO TANIS AND TACO VERGEER
Storms have always caused erosion along the coastline of Pevensey Bay (UK), but rising sea levels have made the situation critical. A Public-Private Partnership is creating a long-term, cost-efficient strategy to improve the situation.

USING SUBSURFACE 3D MODELLING FOR PLANNING WATERFRONT CONSTRUCTION IN ARCHAEOLOGICALLY SENSITIVE AREAS

ANDREW S. THOMAS
By showing existing historic conditions with utmost clarity, comprehensible to all stakeholders and parties, subsurface 3D modelling leads to the collaborative communication necessary for beneficial project planning.

BOOKS/PERIODICALS REVIEWED

Coastal Management, the Proceedings of ICE’s Conference and the photographic essay, A Resistable Force, give two views, one scientific, the other visual, of our coastal areas.

SEMINARS/CONFERENCES/EVENTS

Short courses in Texas and Environmental seminars in Delft as well as Call for Papers for CEDA, WEDA and PIANC-COPRI conferences are part of the 2009 agenda.
Sustainability has several definitions: According to the United Nations’ Brundtland Commission, sustainability is about “meeting the needs of the present without compromising the needs of future generations to meet their own needs”. It is also defined as incorporating environmental and social considerations into a company’s governance structure or as creating a management system in which contractor and client share responsibilities and risks in order to deliver the best possible product. But sustainability is not only about responsibilities and risks. It is also about optimal use of strengths and opportunities. The strengths of one party must be recognised and respected by the other parties, so that opportunities are created which maximise the expertise of each.

The concept of sustainability is gradually becoming a more accepted manner for defining how we would like the world to look in the future and how we can strive to realise this. In the dredging and maritime construction industry this concept has had direct consequences on how we work, how we do business, how we plan projects and how we implement those plans.

Specifically, in the dredging sector where projects are growing more and more complex – be it enormous container terminals and extensive ports, complicated offshore pipelines or massive land reclamations – a greater level of understanding amongst the stakeholders, client and contractor is a necessity. As much as possible transparency and connectivity, as well as collaboration and flexibility, must be encouraged. Not all design challenges can be seen from the start, but early consultations and preparations can prevent misunderstandings and result in a more efficient working relationship.

The implications of a global economy and of climate change and rising sea levels also emphasise the far-reaching impacts that dredging projects can have on our quality of life. The goal of all parties should be to achieve projects which will have long-term positive results. To do this requires working in a way that promotes mutual trust and co-operation so that decisions not only reflect self-interest but also the best interests of the customers, the community and the environment.

In the dredging industry, this element of collaboration has found expression in the move toward partnering, Public-Private Partnerships (PPPs) and alliance contracts. These tools have steadily been gaining momentum and can be viewed as part of an effort to find sustainable solutions. These types of contract send a message to the client and stakeholders that the contractor is committed to the project for the long haul. In this issue of Terra et Aqua the IADC Award winning paper written by a young author examines the pros and cons of partnering and identifies the factors involved in partnering projects. A second article presents a good case study of the way in which a twenty-five year alliance contract at Pevensey Bay in the UK can and does work to the satisfaction of all parties. And lastly the brochure Facts About Alliance Contracts, the newest addition to the IADC series, explains the intricacies and appropriateness of alliance contracts.

At this time of worldwide financial uncertainty, the only realistic position is to keep a dialogue going, to keep seeking the best possible solutions for building sustainable projects. Professionals in the private dredging industry know that infrastructure projects, which protect our coastal areas and create new land for ports and commerce, for residences and recreation, can be enduring contributions to sustainability. All the more reason to look at partnering as a means of communicating, collaborating and re-building, not only beaches, but also confidence and trust.

Koos van Oord
President, IADC
CONCEPTUAL MODEL FOR PARTNERING IN THE DREDGING INDUSTRY

ABSTRACT

Partnering can be an instrument for increasing sustainability in the decision-making process of dredging projects. This article argues that sustainability in the decision-making process can be influenced by optimising the interaction between the public decision-making process and the technical design and construction process. These processes are strongly interrelated, although in practice the project-related responsibilities of involved parties are often allocated to either one of these processes, and stakeholders often have different interests in relation to the project. This can lead to sub-optimal interaction, resulting in adversarial relationships amongst partners and lose-lose situations.

Partnering on the other hand is a form of co-operation between contractor and client. Literature on partnering is diverse and plentiful, but remains unstructured and shows strong focus on success stories. Although this helps to gain insight into the potential of partnering, it does not allow parties to critically reflect on the threats and promises of partnering in their specific projects. Such reflection requires a conceptual model that identifies and structures the main factors in partnering projects.

A recently published theoretical model for partnering, published in construction literature, is extended and modified here based on further literature review and two case studies of partnering in dredging projects. These projects are an infrastructure development project for a part of the Betuveroute and a spatial development project Wieringerrandmeer, both located in the Netherlands. The research results in a revised conceptual model for partnering can be used as an instrument for deciding on applying partnering, and, subsequently, to provide a checklist that aids the design of a partnering process and its continuous monitoring.

The author would like to thank Leon Hermans, Assistant Professor at the Faculty of Technology, Policy and Management of Delft University of Technology, for his contributions to this article, Dieuwertje Klazinga who supervised the process of the research and Royal Boskalis Westminster NV for its support for the research. The article was presented at CEDA Dredging Days 2008 in Antwerp, Belgium and is reprinted here in a revised version with permission.

INTRODUCTION

The topic of the relationship and co-operation between Client and Contractor has been addressed repeatedly in papers, at congresses and during meetings in the construction industry in general and in dredging industry specifically. For instance, the report of a recent workshop on contract management in dredging mentions that: “neither the client, nor the consultant, nor the contractor is individually sufficiently knowledgeable about the environmental consequences of a project. All the parties together, however, can muster a collective expertise that will be of benefit to the entire operation”. “…Existing knowledge must be better harnessed and utilised through more open sharing of expertise amongst clients, consultants and contractors” and: “In the end, prevention is far preferable over any form of dispute settlement and so using all
means in the pre-tender phase to reduce potential conflicts is advisable” [23].

Secretary General of the International Association of Dredging Companies (IADC), Constantijn Dolmans, mentions that the IADC tries to encourage ports to get the dredging companies involved at an early stage in the long-term planning for the development of the ports [14]. He claims that innovations have been derived from collaborations between Contractors and Clients: “Increasingly clients understand that when contractors are given more space, it also benefits them” [13] (Figure 1).

The topic of co-operation gained attention because of the increasing complexity and size of projects and the changing contracts and responsibilities of the parties in the dredging market. With large and complex project, the design questions cannot all be answered at the start. The danger arises of parties maximising their individual profit instead of optimising project results. This happens because of a lack of clarity on the project, the lack of a long-term relationship between the partners and the low profit made on the project [28].

In this article attention will be paid to a form of co-operation between client and contractor called “Partnering”. Partnering is believed to have several positive effects on projects and to overcome problems with traditional approaches in construction industry, such as time and cost overruns and litigation within projects.

The questions of when and how a partnering approach can be usefully applied in dredging projects are addressed. Based on a survey of recent literature, a conceptual model for partnering is adapted and extended that increases the understanding of partnering and can be used to decide whether partnering is suitable for the project. This conceptual model is then compared with empirical data from two case studies in the Netherlands resulting in further modifications, as well as some specific insights into the dynamics and conditions that affect the success or failure of partnering projects in practice.

SUSTAINABILITY, DECISION MAKING AND THE DESIGN OF DREDGING PROJECTS

How does co-operation between client and contractor contribute to the sustainability of a dredging project? Although sustainability in dredging projects is sometimes reduced to issues of ecology and nature conservation, the general concept of sustainability is broader. It covers economic, social as well as environmental dimensions. Moreover, ever since the UN’s Brundtland Commission defined sustainability in 1987, sustainability has been characterised by its focus on future generations and its concern for the long-term effects of current actions [9-20].

This means that for dredging projects, sustainability refers not only to an appropriate treatment of environmental interests, but also for instance to the long-term use of the resulting project by a client and the long-term market position of a contractor. These aspects of dredging projects all contribute to sustainability, even if they may conflict with each other. Why then in dredging projects is optimisation not always self-evident?

In realising a construction project three different phases can be distinguished:
- the design of the project,
- the construction or implementation of the project, and
- the finished project, ready for operations [24].

This article leaves the operations of the finished project outside the discussion and focuses on the construction and preparations of the project. Large and complex dredging projects in the dredging industry are rapidly becoming the norm rather than the exception. These complex projects can be regarded as shaping and changing larger “socio-technical systems”, that is, systems that are characterised by the interaction between society’s institutional structures, technical infrastructures and human behaviour.

In relation to socio-technical systems one can identify three different types of design:
- a systems design,
- a decision process design, and
- an institutional design [6].

These three types of design differ highly from each other, although they have a clear relationship with designing a socio-technical system. Descriptions of the three types of design can be found in Table I. The table shows that the technical system design should lead to an artefact to be realised, while the process design should result in a decision, and the institutional design produces a set of rules.
An IADC Best Paper Award was presented at CEDA Dredging Days 2008 to Stephanie Janssen who graduated from Delft University of Technology in September 2007 at the section policy analysis of the Faculty Technology, Policy Analysis and Management. Her research on “partnering” was part of her thesis project for the Masters “System Engineering, Policy Analysis and Management” (SEPAM) at Delft University of Technology. This research was conducted for Royal Boskalis Westminster NV. She currently works as a junior researcher and advisor on integrated spatial development projects at the unit for scenarios and policy analysis for Deltares, a Dutch institute for delta technology.

Each year at selected conferences, the International Association of Dredging Companies grants awards for the best papers written by younger authors. In each case the Conference Paper Committee is asked to recommend a prizewinner whose paper makes a significant contribution to the literature on dredging and related fields. The purpose of the IADC Award is “to stimulate the promotion of new ideas and encourage younger men and women in the dredging industry”. The winner of an IADC Award receives €1000 and a certificate of recognition and the paper may then be published in Terra et Aqua.

Table I. Design (Technical, Decision process and Institutional) according to Bots.

<table>
<thead>
<tr>
<th>Technical design</th>
<th>Decision process design</th>
<th>Institutional design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design consists of technical specifications, drawings and models (tangible artefact)</td>
<td>Design consists of a set of rules that the actors should observe during the course of the decision-making process (intangible artefact)</td>
<td>Design consists of a set of rules (intangible artefact)</td>
</tr>
<tr>
<td>Product: an artefact to be realised</td>
<td>Product: a decision</td>
<td>Product: internalisation of the rules in society, thereby changing human behaviour</td>
</tr>
<tr>
<td>Based on assumptions on the environment and the artefact</td>
<td>Based on assumptions on actor behaviour in response to the rules</td>
<td>Based on assumptions on behavioural and cultural aspects of collective actions</td>
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</table>

An example of the development and extension of a harbour shows how these three designs are all needed. In the case of a harbour, the technical design describes the piece of land to be reclaimed from the sea; it contains quays, sufficient deep waterways, breakwaters and so on.

The institutional design is used to make arrangements so that the reclaimed land becomes part of the harbour. It consists of a set of agreements on the use of the harbour; determining ownership, the rights and obligations of users, applicable legislation and so on.

The decision process design is a design applied to both the technical design and the institutional design. For example, the owner of the harbour is the one who had the idea to extend it, but as an extension of a harbour affects not only the owner but also the people living around the harbour, the economy, the environment, the government and other things, the owner needs to discuss and agree with different parties to reach decisions.

This demonstrates that all the three designs are necessary to develop large and complex projects, in this case, a harbour. It also shows the interaction between the different designs, that they are interrelated and cannot be regarded separately (see Bots [6]). The interrelations between the different phases in developing a project are schematised in Figure 2.

The design, according to Bots is a result of the interaction between the designer, the client and the realiser of the design. In traditional construction or dredging projects the contractor is responsible for the construction of the system. Within design

Figure 2. The three phases in realising a project: The scheme shows that all activities in realising a dredging project are interrelated.
and construct contracts the contractor has a responsibility for the technical design. The initiator of the project, for example the owner of the harbour may take responsibility for the process design and the institutional design. The responsibilities for the different activities in the scheme rest with different parties. An optimal and sustainable project result therefore requires interaction and co-operation of the responsible parties.

Co-operation contributes to an integrated design, in which the interests of the process design, the technical design and the institutional design are covered and lead to an optimal and sustainable project result. Partnering is a form of co-operation between client and contractor in a project, which is the central focus in the remainder of this article.

**PARTNERING**

What is partnering?

Partnering was first reported in the late 1980s in United States construction industry, where the US Army Corps of Engineers applied the partnering method [26] as a response to traditional projects leading to cost-overruns, late completion and litigation. In the early 1990s partnering was applied in the UK oil and gas industry. As a result of successes in the oil industry, the UK construction industry adopted the approach in the mid-90s. The report of Sir Michael Latham “Constructing the Team report”, was of major influence in the development of partnering [29].

One of the most cited definitions on partnering is the one used by the Construction Industry Institute (CII) [10]: “A long-term commitment between two or more organisations for the purpose of achieving specific business objectives by maximising the effectiveness of each participant resources. This requires changing traditional relationships to a shared culture without regard to organisational boundaries. The relationship is based on trust, dedication to common goals and an understanding of each other’s individual expectations and values”.

Another definition commonly used is the definition put forward by Bennet and Jayes [4]. They describe partnering as a “set of strategic actions” that deliver vast improvements in construction performance, “driven by a clear understanding of mutual objectives and co-operative decision making by a number of firms which all focus on using feedback to continuously improve their joint performance”.

Thus, while Bennet and Jayes talk about “a set of actions”, the CII speaks of a commitment or relationship between parties. These two definitions and the differences between them, show important aspects of partnering literature. The literature is diverse, definitions are numerous, and there appears to be a fair amount of confusion over what partnering is [16]. As Skeggs put it, “The general use of partnering tends to propagate the perception of partnering as a set of actions” [26]. Skeggs does note that there is conformity over the general concept of partnering as a co-operative relationship to improve performance of the projects. Barlow [3] concludes that partnering is best considered as a set of collaborative processes. Processes which emphasises the importance of common goals and raise such questions as how such goals are agreed upon, at what level are they specified and how are they articulated.

Within the broader concept of partnering, a difference is often made between project and strategic partnering [9, 17]. Strategic partnering concerns a relationship between parties that extends beyond a specific project, while project partnering brings parties together for a specific project. In this article the focus will be on project partnering, although of course project partnering can result in, or be part of, a broader strategic partnering relationship.

Confusion often arises when defining partnering and alliancing [9]. Writers tend to see alliancing as a part of partnering. According to Hauck [16] alliancing may be viewed as an outgrowth of a partnering relationship. Alliancing can be seen as the legally enforced form of partnering [16, 27].

This is also confirmed by Tang. Tang [27] distinguishes partnering from alliancing by means of the relationship between Client and Contractor. He presents the traditional relationship, the partnering relationship and the alliance relationship in a scheme which is shown in Figure 3. His comparison is in line with Skeggs and with the partnering definition of the CIIA: “Partnering itself is not a contract. A partnering charter is developed to run in parallel with a traditional construction contract to provide guidelines to the relationship among the organisations [11].”

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**Figure 3. Traditional, Partnering and Alliance relationships based on Tang et al.**
When and why is partnering used?

Project partnering is now used and applied in projects on several continents. Examples are found in the UK, the US, Hong Kong and the Australian construction industry. The reasons for applying partnering lie in the negative experiences with more traditional approaches in the construction industry. The application of the partnering method is believed to have several positive effects on projects and to overcome problems encountered using traditional approaches in construction industry [18, 21].

In traditional practices the industry is relying primarily on contractual relationships based on duties and liabilities [4]. Authors have claimed that these traditional practices have negatively affected working behaviour [17] and project outcomes [4, 7]. The main characteristic following from traditional practices is the adversarial relationship between Contractor and Client. As a result of lack of co-operation, limited trust and ineffective communication, adversarial relationships have emerged [8], Chan [8] regards adversarial relationships as one of the major barriers to project success. Warne [30] notices a win-lose approach “if I win you have to lose and vice versa”. He argues that this approach is costly in both time and resources for both parties resulting in a lose-lose scenario.

In the traditional construction industry trends are noticed in claims and lawsuits. Contracting firms are about to employ more attorneys than engineers [30]. Furthermore, there is a tendency for projects not to be completed on time. Also, projects are growing increasingly complex [26]. “Losing” relates to expensive projects, not meeting schedules and claiming at the end which again costs time and money. Partnering has generated attention in the construction industry as a means for transforming the hostile, adversarial owner-contractor relationships into a more collaborative team and co-operative and caring environments [18, 21, 26, 5].

Partnering is believed to lower the risks of cost overruns and delays as a result of better time and cost control over the project [12, 22, 5]. Sanders and Moore [25] state that partnering aims for an organisational environment of trust, open communication and employee involvement. Benefits found by Bresnen and Marshall [7] are: increased productivity and reduced costs, reduced project times, improved quality, improved customer focus and client satisfaction and deploying resources more effectively. Tang found benefits produced by partnering: An improved ability to respond to the changing project environment, improved quality and safety, reduced costs and project time, improved profit and value and a more effective utilisation of resources.

What more is there to learn about partnering?

In the literature little attention is paid to the undesirable consequences of partnering. When mentioned, it concerned not achieving the desirable consequences of partnering, despite efforts. The limited attention for the negative consequences of partnering indicates a tendency to focus on success stories in partnering literature [7]. Also, there is a lack of attention to conditions for these success stories. However, some authors claim that attention is needed and conditions should be identified that encourage or inhibit partnering in practice [7]. Bresnen and Marshall note that it is much too simple to presume that the application of tools and techniques, backed up by an expressed commitment to partnering, is all that is needed. Green and McDermot [15] make a note that the use of partnering does not per se lead to effective outcomes (or even collaboration), in the same way that using traditional forms of contract does not necessarily result in poor performance or conflict. There are attempts to identify and structure the conditions and factors that influence partnering outcomes, but they are still limited in number and inconclusive in their findings [7, 2].

The conclusions from the partnering literature is that it is vast and that there are different, sometimes confusing, definitions about what partnering is [9, 26]. Furthermore no consensus exists about precisely what form partnering can or should take, under what conditions it is likely to develop and how such ways of working can be fostered and developed [3, 7]. To overcome these deficiencies in the literature, a more thorough understanding of the factors and conditions that drive and influence partnering processes is required. At the basis of such understanding should be a conceptual model that further specifies the relevant factors and relations concerned with partnering that can put success stories in perspective and provide some practical guidance for future partnering projects.

GENERAL CONCEPTUAL MODEL

To overcome some of the deficiencies of partnering literature mentioned above a conceptual model for partnering is needed. Only one explicit attempt to develop such a conceptual model was found in a recent paper by Anvuur and Kumaraswamy [7]. They developed a model for partnering and its effects on project performance. This model provides a useful starting point, but was developed solely on a theoretical basis, fitting it only with published literature. The purpose here is to adapt and extend this model, using additional literature, but, more significantly, by adding direct empirical observations from two cases of project partnering in the Netherlands.

Anvuur and Kumaraswamy based their model on two theories in social psychology. The first theory is on the “team approach” in organisations, in which attention is paid to prerequisites for an optimal team and the benefits of teamwork. The characteristics of an optimal team are described as being:
- unitary focus and common goals,
- interdependence,
- mutual accountability and
- confluence.

The second theory Anvuur and Kumaraswamy [7] use is the “contact hypothesis” in which the subject of prejudice and bias in intergroup contact situations is studied to understand their causes and to develop strategies for mitigating them. In the contact hypothesis four conditions for optimal intergroup contact are formulated:
- equal group status,
- common goals,
- intergroup co-operative interaction and
- support of authority, law or custom.
In this theory attention is also paid to how to achieve these conditions. In both theories it is emphasised that optimal (inter) group contact takes time and effort.

The model of Anvuur and Kumaraswamy forms the basis for the conceptual model for partnering presented here. It will be extended and adjusted on some aspects. Most importantly, where the original model is based on theories in social psychology and group relations, the adapted model departs from a system perspective, using a system model as a basis [see e.g. 29].

The central notion here is that interested parties have certain instruments which they can use to influence key factors and relations in a certain system of interest, leading to certain outcomes of interest. Besides the instruments, however, systems and thus the outcomes are also influenced by external factors that cannot be influenced. This perspective leads to a certain re-organisation of the conceptual model, most notably in relation to the external factors affecting the implementation partnering and the relation between “process effects” of partnering and the “project consequences of partnering” as the final outcomes of interest.

The resulting conceptual model (see Figure 4) is structured by means of five components:
- external influences on partnering,
- instruments for partnering,
- the partnering relationship,
- the cognitive and behavioural effects of partnering, and
- project consequences of partnering.

Also, four relations can be distinguished:
The project consequences of partnering are a result of the partnering project. Within the partnering project the instruments used for partnering result in a partnering relationship, which results in cognitive and behavioural effects. The partnering relationship, instruments for partnering and the cognitive and behavioural effects together form the

**Wieringerrandmeer**

The Wieringerrandmeer is a spatial development project. In the development vision of the municipality of Wieringen it was concluded that more recreation and tourism was needed, as in other areas no development was possible anymore. Therefore, a feasibility study was performed for the Wieringerrandmeer by the municipality of Wieringen and neighboring municipality Wieringermeer. A “randmeer” is a lake between former coast and empoldered land. The province became involved and it was decided that a project would be set up to develop the Wieringerrandmeer. A “development competition” was held. The winning party had the exclusive right to negotiate with the involved public parties about the development of the project. The public and private parties signed a letter of intention to co-operate. At the time of the research the definite agreement was worked on. When the agreement is definite the Ground Exploitation Company (GEC) will be set up. The GEC has the task to design develop the Wieringerrandmeer, the nature involved and the land on which houses will be build. The GEC will sell the ground developed to the private parties that are also involved in the GEC. On this ground these private parties that have the right to build and sell houses. In the GEC the above-mentioned public and private parties, are represented with both taking risk in the GEC and each has a 50% share. The private parties profit from participating in the GEC in two ways: They are entitled to buy the land and they have influence in what the land will look like. There may be a third source of profit from participating in the GEC, which is executing the construction works necessary for preparing the Wieringerrandmeer. However, because of certain European Union tender legislation it may not be possible for the GEC to grant the execution rights directly to one preferred contractor as this may limit the chances of other contractors to win the execution contract.
“partnering project”. The fourth relation is the relation between the external influences on partnering that influence the partnering in a project. The relations in the conceptual model are assumed. By assuming relations it is possible to order the information found in literature and in case studies on partnering. Two case studies are presented below.

**FITTING THE CONCEPTUAL MODEL WITH PRACTICAL EXPERIENCE**

The two case studies used here are projects in which partnering was applied and both are located in the Netherlands: The Wieringerrandmeer project (Figure 5) and the Waardse Alliance (Figure 6).

The Wieringerrandmeer project is a spatial development project in which the participant will co-operate in Ground Exploitation Company (GEC). The project was at the time of research in an early stage, and the GEC was not yet formed.

The Waardse Alliance is a finished infrastructure project where Client and Contractor co-operated to find optimisations in design and realisation.

Information for the case studies was gathered from relevant documents and by interviewing involved people, including both the Client and Contractor, so that different views were integrated in the results. A further description of the two case studies can be found in Box 1 and Box 2. The detailed conceptual model that resulted from the case study research is found in Figure 7. In this figure the five components are filled in with elements. Each component is described below.

**Instruments for partnering**

Anvuur and Kumaraswamy (2) define five different activities that serve partnering. These activities can be seen as instruments for enabling partnering:
- workshops and champions’ meetings,
- charters and alliance agreements,
- issue resolutions/escalations procedures,
- periodic performance assessments, and
- training on problem solving and joint decision making.

Chan (8) did literature research and empirical research to find out the critical success factors of partnering. This resulted in instruments for partnering. In his empirical research he identified:
- the establishment and communication of conflict resolution strategy,
- a clear definition of responsibilities and
- regular monitoring of the partnering process.

These three instruments correspond with the change/integrations strategies or instruments found by Anvuur and Kumaraswamy (2), although they do not explicitly mention the clear definition of responsibilities.

The case studies indicated that the identity and location of the partnership played an important role in the formation of

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**Box 2**

*Figure 6. Under the Waardse Alliance – a type of partnering agreement – the first part of the Betuwe double track freight railway (which will extend from Rotterdam to Germany) was successfully completed on time.*

**Betuweroute 1-2**

The Betuweroute 1-2 is a part of a freight railway construction project in which one of the six parts of the trajectory of the Betuweroute is developed. The trajectory entails 22 kilometers, running through 6 different municipalities concerning 1,000,000 m³ earth-moving and 4,000,000 m³ spouted sand in the project. Difficult aspects of the project are the very weak soil, the difficult social environment in which land has to be obtained and unwilling municipalities. For the project an alliance was formed between the Client and the Contractor after tendering a design and construct contract. With the alliance a new organisation was formed. The alliance was paid from an alliance fund. Both the Contractor and the Client filled this fund. By applying optimisations in the design, cost savings could be made. The balance was made up at the end of the project and split by a 50/50 ratio. The main responsibilities of the alliance are: Making the design, gear activities and deliberate with the environment, manage the alliance fund, supervise the executive contractor and its delivered work. The Betuweroute 1-2 project finished with a positive result. It was the only trajectory of the Betuweroute to be finished on time and within budget.
Partnering. The right person in the right function was mentioned as important; when and if necessary, people should be replaced. A third instrument found in the case study was transparent working within the partnership. Periodic performance assessment, regular meetings and agreements can all contribute to transparency, but it also requires an open attitude, as well as clear and structured procedures. Transparency helps avoid distrust. It should be noted, that although some authors believe that partnering is an informal and organic development under certain circumstances [7], the focus here is on instruments that enable partnering.

Partnering relationship
The second component of the conceptual model is the partnering relationship, which is assumed to emerge as a result of the instruments for partnering applied. Four elements of the partnering relationship have been defined by Anvuur and Kumaraswamy [2]:
- equal group status within a contact situation,
- co-operation and interaction,
- common goals and objectives
- support of authorities, law or custom.

Anvuur and Kumaraswamy base these characteristics of the partnering relationship on the contact hypothesis between groups, which has gained support over the years [1]. Black [5] also mentions the shared objectives and co-operation.

When looking at the case studies, no new elements for the partnering relationship were found. In the case studies the relevance of common goals and objectives was emphasised. However it was also noted that in the organisations of the alliance or partnership the individual goals of the organisations must be taken into account because if a party cannot pursue its own goals as well, it is not likely that they will commit to the partnership. It was...
Cognitive and behavioural consequences of partnering

As a result of the partnering relationship, the cognitive and behavioural consequences of partnering are assumed. For the cognitive effects, Anvuur and Kumaraswamy mention group homogeneity, trust and re-categorisation (from them to us). For the behavioural effects they mention co-operation, helping and productivity.

The cognitive and behavioural effects found by Bresnen are: increased productivity and improved customer focus. Another note was made on the element “authority support”. Although Anvuur and Kumaraswamy mention group homogeneity, trust and re-categorisation (from them to us), the first element of “group unity” overlaps with the first element of “group homogeneity”. Although Anvuur and Kumaraswamy distinguish between these two elements, the conceptual model here does not. “Group unity” here indicates a group where people feel in the first place part of the group and the group functions as one entity. The elements “co-operation” and “helping” overlap, the assumption being that co-operative people are willing to help. “Helping” is thus not mentioned separately.

External influences

The external influences on partnering are presumed to determine how well partnering can function. External influences are “facts of life” that project partners have to work with at a given time. Although some of these elements can be changed in the long-term, they cannot be changed significantly within the duration of a single project. The external influences are divided in characteristics of the projects and characteristics of the partners.

Several authors have addressed the skills of partners. Bresnen and Marshall address the problem of culture related to partnering: “The problem here is that it is well established that it is difficult enough effecting cultural transformation within organisations, let alone between them”. Partners should be able to overcome these culture differences. Chan investigated the barriers to partnering. Nine headings of the most common problems were identified. Amongst them were: misunderstanding of partnering concept, lack of experience, cultural barriers and uneven commitment. Clearly, a good understanding of partnering is needed, and commitment to the project is an important attitude.

Another problem noticed by different authors is that “empowerment” is needed to participate in a partnering relationship. In an empirical research by Chan the commercial pressure to compromise on the partnering attitude is seen as the main problem. Also Ng mentions the lack of empowerment of Clients and their large bureaucratic organisations and the commercial pressure Contractors are dealing with as a problematic issue. Empowerment relates to commitment to the project. Is a partner able to commit? This ability to commit has an important influence on the authority support that is required to ensure a functioning partnering relationship.

Ng identified problems specifically for the project, mentioning that applying partnering in projects which are not suitable for partnering presents a problem. However he does not specify what suitable projects are. Rijkswaterstaat claims that an alliance is only applicable in complex projects. Alliances and partnering form a departure from the traditional way of working, and this departure from standard practice brings certain costs with it. Rijkswaterstaat argues that alliances are about optimisations and that in the case of complex projects there are optimisations to be made through combining the knowledge and roles of the different partners involved.

The case studies indicate that partners should have self-confidence, communication skills, open attitude (flexibility and empathy) and professional knowledge. Regarding the project, the possibility of optimisations in the design should be present.

The ability to overcome differences is not separately mentioned in the conceptual model as it is assumed that “open attitude” and “communication skills” will contribute to the ability to overcome differences. A note should be made for the element “available knowledge and understanding of partnering”. This element can be influenced during negotiations, as happened with the Waardse Alliance case study. Therefore this element is not fully an external influence.

Project consequences of partnering

For the improved performance of the project Anvuur and Kumaraswamy mention cost, quality, schedules and innovations. The benefits of partnering for the project found by Bresnen are: reduced costs, reduced project times, improved quality, and client satisfaction and more effective deployment of resources.

The project consequences found by Tang are improved quality and safety, reduced costs and project time, improved profit and value and a more effective utilisation of resources. Black [5] mentioned the improvement of partnering as the elimination of the adversarial relationship and the win/win outcome instead of the win/lose outcome.

From the case studies, new project consequences of partnering became evident: Pleasant project atmosphere, prevention of problems, improved competitive position (for the Contractor), national (media) attention, use of preparation knowledge (Client) and assurance of work during the project (Contractor).
Not many undesirable consequences were found and little mentioned of the negative consequences of partnering is found in the literature, perhaps because partnering literature tends to focus on success stories [17]. Also in the case studies presented here there were few negative experiences: The case study on the Waardse Alliance finished successfully; the case study of the Wieringerrandmeer was not yet finished.

**INTERPRETATION OF THE CONCEPTUAL MODEL FOR PARTNERING**

What results from the information by Anvuur and Kumaraswamy, other literature on partnering and the case studies is an extended conceptual model, with five components and numerous elements within. However, it is not clear which elements in the framework are considered to be more or less relevant in applying partnering. In the case study research, therefore, attention has been paid to decisive factors and special points of attention within the projects. Four decisive factors for a well-functioning partnering are found: People, risk-sharing, financial arrangements and showing commitment.

“People” refers to the people who execute the partnership. How the people are determines a great deal how the partnering functions. Risk sharing and financial arrangement serve as decisive factors as they are an incentive for executing the partnership. In the case studies, this was perceived as important. Showing commitment by the parties resulted in enough trust to start the partnership.

Three pitfalls were noticed in the case studies: The first relates to the tender arrangements. It is difficult to tender a partnership. In the case studies this was a result of the influence of EU tender legislation. The second pitfall is the dependency on trust. When trust is lacking, the partnership will collapse like a house of cards. The third pitfall is the dependency on people outside the partnership, such as citizens in a democracy.

Based on the these decisive factors and pitfalls, five elements which are more relevant in the conceptual model are indicated:

- characteristics of partners,
- a partner’s ability to commit,
- the allocation/definition of responsibilities,
- ability to (re)place the right people and
- trust.

The apparent importance of trust as a factor in partnering confirms earlier findings, but also illustrates a last important aspect of the conceptual model. The model itself is basically a rough and static model, which helps to describe the situation at a certain point in time. In its current form, it does not contain specific relations between the elements in each of the five main components, nor does it contain feedback loops. However, the apparent importance of trust, which is here depicted as an effect of partnering, suggest that certain factors, such as trust, play a role in various parts of a partnering project as well.

Following Anvuur and Kumaraswamy, depicting trust as an effect of partnering, as trust can, and needs to, be built through a smart use of partnering instruments and by a functioning partnering relationship seems justified. Thus, it seems fair to characterise it as an effect of partnering. However, the level of trust also influences the partnering relationship, and the effectiveness of partnering instruments.

This means that, from a systems perspective, there is an important feedback loop related to trust in partnering projects. There are other examples of feedback loops as well, for instance, between project consequences of partnering and some of the external influences. If a partnering project is successful, in terms of lower costs, higher quality, client satisfaction, and so on, this has a positive impact on the self-confidence, the attitude and the available understanding of partnering in future projects. Project partnering seems to contain numerous positive feedback loops, or self-enforcing cycles, which reinforces positive, but also negative, tendencies.

The model can be seen as a contribution to theory and to practice. The contribution to theory is that in the model different definitions are integrated and success stories in the literature can be put into perspective. In the conceptual model an overview of the available knowledge in the literature of partnering is presented. The contribution to practice is that the conceptual model may be used when a party considers the application of partnering, or is applying partnering. When a party considers partnering, it is assumed that expected successes could be extracted from the project consequences of partnering described in the model. The expected success of a party is dependent on how partnering is applied and on the external influences. The conceptual model can be used for checking-up, to see whether all instruments are applied, to evaluate the partnering relationship, and the cognitive and behavioural effects.

It should be noted here that the model is a descriptive model, not normative. This means it does not prescribe what should be done to achieve a positive result for partnering. This conceptual model is based on explorative research with assumed relations, so no conclusive statements on how partnering works can be drawn. The model was not tested. Based on the research one cannot conclude how partnering “should” be applied, only on assumptions about how partnering works.

**CONCLUSIONS**

In the beginning of this article it was argued that sustainability in decision making might be increased by effective and efficient co-operation. Co-operation is necessary as in construction projects there are different parties with different but interrelated responsibilities. Partnering is presented as a method for co-operation.

Partnering should be applied when it is expected to generate more success in a project than conventional methods. Partnering is presented as a method with the potential to have positive results in terms of time, cost and litigation. In literature as well as in case studies the advantages and the benefits dominate the discussion on partnering. But, as some authors noted, partnering does not
necessarily lead to success. The conceptual model that is developed puts the success into perspective and integrates the differing definitions on partnering. Therefore the model can be regarded as a contribution to theory.

The conceptual model for partnering is an instrument that may help to determine whether applying partnering would be appropriate. When partnering is applied it may serve as a check-up and an evaluation tool. The case studies have shown the importance of the partners involved in partnering in general and more specifically their ability to commit to another partner. The importance of allocation and definition of responsibilities, of having the right people in the right spot and of having trust amongst partners is stressed.

A conceptual model has been developed. It is, however, a model based on exploratory research with assumed relations and it has not yet been tested. Further research to develop and improve the model is recommended. And the last recommendation based on this report is that when the risk of achieving success is low, partnering should definitely be considered as an option.

REFERENCES

ABSTRACT

When the British Environmental Agency issued a tender in the late 1990s for a Public-Private Partnership to build coastal defences, its first aim was the restoration of the basic coastline at Pevensey Bay, UK, including the management and maintenance of the area for 25 years. Ultimately, a consortium, Pevensey Coastal Defence Ltd (PCDL), comprising four parties was awarded the contract to improve defences that protect a 50 km² area of low-lying land behind the coast. This area includes the main south coast trunk road, a railway line, caravan parks, several villages and a Ramsar nature reserve with cultural-historical significance. The contract was the first of its kind for coastal protection to be undertaken in the UK and was thus designated a "pathfinder project", a status allocated by the Treasury. This means that no model existed as a basis to work from. Till now the manner in which the project is being implemented has met with favourable reaction from the residents and from the Client, suggesting that the form of tender and contract utilised at Pevensey Bay may offer advantages for other coastal defence procurements and policies in the UK and other countries as well.

An added benefit of the 25-year contract with PCDL is that it offers unique opportunities for researchers to collect coastal data over a longer period. It allows them to test alternative methods that can potentially make the management of a beach more efficient, sustainable or more beneficial to the environment. Pevensey has as a consequence already attracted several research institutes and universities which should certainly provide useful data for all concerned with the long-term protection of coastal regions.

INTRODUCTION

Pevensey Bay lies along the east coast of England between Dover and Brighton. A number of permanent homes are built on the beach up to the floodline. Until recently, the beach, comprised of sea stones or shingle and timber groynes, provided sufficient protection for the coastal community.

However, in the last several years because of climate change and rising sea levels, erosion had increased significantly. During a storm in October 1999 the threat of a breach was imminent. As a result, some 50 km² of hinterland where a main road, railway, caravan parks and a nature reserve with cultural-historical value were threatened with severe flooding. This included the ecologically sensitive Pevensey Levels, which is an important Site of Scientific Interest (SSI) now designated as a Ramsar site. Should the defences here be permanently breached, the area would be in danger of being inundated and damaged by salt water at every high tide (Figure 1).

Because of these circumstances, the Environment Agency had been considering initiating beach defence trials as a "pathfinder project", a status allocated by the Treasury. This means that no model existed as a basis to work from, to assess the suitability of a PPP for flood defence procurement. In this framework, negotiations were begun to implement the Pevensey Bay Sea Defence Strategy, which would include a long-term sustainable care and maintenance plan and a strategic emergency plan. The storm in the autumn of 1999 served to confirmed the necessity for such a scheme to protect the area.
The UK Environment Agency, which was established in 1996, is the Government entity responsible for coastal protection. Since many places along the English coastline are in need of maintenance, the then-newly-created Agency sought a new approach to coastal protection as well as a comprehensive, more modern financial construction.

The form of contract known as Public-Private Partnership (PPP) is one of the methods that the UK Government uses to involve third parties in the realisation of large infrastructure projects.

The Environment Agency felt that this form of tender would also be suitable for the coastal protection project at Pevensey Bay. In addition, the Agency felt that both the financing and the area management should be brought under the oversight of the Contractor. Having decided to pursue the PPP procurement route for the Pevensey Sea Defences, the Agency placed a notice in the Official Journal of the European Community in May 1997. Over 50 firms expressed interest and were sent information packs and questionnaire by the Agency. A total of 13 consortia responded to the questionnaire.

As a result of the tendering process, a consortium called the Pevensey Coastal Defence Ltd (PCDL) was awarded the contract in May 2000. The consortium comprises Westminster Dredging (an operating company of Royal Boskalis Westminster nv), Dean & Dyball Construction Ltd., J.T. Mackley Co. and the Mouchel Group.

**PROJECT DESCRIPTION: THE PEVENSEY STRATEGY**

The project consists of the restoration and reinforcement of the coastal defences at Pevensey Bay, including the care and maintenance of the coastline for a period of 25 years. Pevensey Bay’s sea defences are approximately 9 km long, running from Eastbourne to Bexhill-on-Sea in East Sussex. They consisted of an elongated shingle bank, supported by 150 timber groynes, which aid in absorbing and reducing the power of the waves. The coastal defence was required to protect the low-lying hinterland with some 3,000 residences and commercial properties and important nature reserves (Figure 2).

As a result of the tendering process, a consortium called the Pevensey Coastal Defence Ltd (PCDL) was awarded the contract in May 2000. The consortium comprises Westminster Dredging (an operating company of Royal Boskalis Westminster nv), Dean & Dyball Construction Ltd., J.T. Mackley Co. and the Mouchel Group.
In the mid 1990s, a variety of defence options for Pevensey Bay, ranging from doing nothing through to constructing rock islands, were examined in an Environment Agency study. The conclusion was reached that defending Pevensey Bay in the foreseeable future was possible, and that a good degree of defence could prevent the Pevensey Levels from reverting to permanent salt marshes. The sea defence would not necessarily guarantee protection against temporary breaches or overtopping of the defences at any location but it would defend against permanent flooding.

As an added requirement, the preferred option had to comply with strict economic guidelines that the costs of such a defence scheme would not exceed the potential flood damage thereby avoided. The Strategic Study for Pevensey Bay concluded that an “open shingle beach” solution would satisfy these economic criteria whilst other options involving large rock groyne structures could not be justified.

To achieve this in a cost-effective manner, the Government requested that the Agency explore the possibility of providing sea defences through a Public-Private Partnership (PPP). The Environment Agency wanted to achieve the following:

- Private pre-financing
- Better risk allocation (a spread between the contracting parties and the Agency)
- Opportunities to implement innovations directly
- Clear identities and responsibilities for the partnering companies
- Co-operation and ability to utilise opportunities
- The enjoyment of direct advantages from the delivered services
- Financial security and defined costs/payments per year, with a savings on the project costs

Government was very aware that in the coming years, as a result of climate change and the accompanying rise in sea level, coastal defence will be an expensive affair. To make the coastlines conform to regulatory safety demands requires a rather large pre-investment. For instance, shingle for the project was available at another English Channel location. Traditionally this was dredged and placed on land and then transported by lorry to the coastal area. This form of transport caused disturbances for residents, damaged local roads and caused unsafe traffic situations.

By choosing for a PPP, the costs have been spread over the long term, more efficient and innovative transport solutions have been found and this has lead to increased financial security.

Specifically, in order to bring the coastal defences to the legally required levels, a large pre-investment was necessary. To achieve this, 200,000 cubic metres of shingle for the beaches and the construction of a new, hard defence mechanism (a boulevard), with the appropriate infrastructure, were recommended. After achieving these construction goals, the coastal area will have to be maintained at a safety level which required 20,000 cubic metres of shingle per year.

**CHOICE OF CONTRACT FORM AND PREPARATION OF THE CONTRACT**

Because of the lack of experience with a PPP for a coastal defence project, the contract preparations and tendering was time consuming and a learning process for all parties. The Client continued to find areas where more transparency was desirable and the questions seem to concentrate on the level of provided services: the regulatory stipulations of safety demands in relation to breaches, erosion and overtopping. In order to meet these legal requirements attention was focused on finding a collective vision in relation to design parameters. Examples, for instance, are: data about storms in the area and the long-term morphology of the coastline.

The risks which come under the responsibility of the consortium are:

- Storm conditions
- Rising sea levels
- Approval from the Client
- Expectations of the citizenry (customer satisfaction)
- Design uncertainties

An important concern was that the capital costs of the project would be higher by using a PPP than if the public sector had secured a loan for the same finances. This was a real possibility, as the interest on a Government loan is lower than one in the open market. This concern proved to be unfounded.

A Contractor can usually save on costs in two ways: One way is to design a total plan including long-term services that the public sector wants and then develop innovative tools to accomplish these goals that will result in significant savings. Another cost-saving method is that the Contractor can assume responsibility for a number of established risks that otherwise the public sector would have to guarantee, thus reducing the costs of the Client. In the maritime construction sector risks are often related to guaranteeing the timely delivery of the work which can be influenced by weather conditions, purchase price of materials, winning and transport of construction materials and the development of an emergency evacuation plan. In addition, the integral long-term concept and flexibility in planning of the operation are important. With the use of a PPP contract, the optimal balance between freedom and responsibility can be realised.

**SPECIFICATIONS**

The contract for the coastal protection of Pevensey Bay describes operational specifications which must be met by the designs of the tenderers. In addition, the bidders were encouraged to create innovative solutions which would result in cost reductions without compromising safety and sustainability. Out of a short list of three potential bidders, the consortium Westminster Dredging, Dean & Dyball Construction Ltd., J.T. Mackley Co., the Mouche Group were successful. Their design is based on a one-time restoration of the coast in order to meet safety standards. Not only would this include restoring the 200,000 m$^3$ shingles but thereafter over a period of 25 years the consortium will provide maintenance to a safety level of < 1:50. When the safety
Long-Term Coastal Defence and Management at Pevensey Bay, UK: A Public Private Partnership

IMPLEMENTATION OF THE PROJECT

The consortium developed a design which will protect Pevensey Bay for the coming 25 years as well as comply with the needs for recreation and the development of nature reserves. Furthermore, a number of innovations offer both cost savings and advantages for the region. For instance, in the coastal protection design, 350 tyre bales containing 40,000 used car tyres – which otherwise had no other destination – were buried in the beach in front of the Environment Agency depot on Coast Road. This disposed of unwanted tyres and also substituted for a good amount of shingles and achieved a better ground-mechanical balance in the construction. The trial helped examine whether bales of compressed, scrap vehicle tyres can help offer sustainable, economic and environmental solutions to some port, river and coastal engineering problems (Figures 3 and 4).

Another innovation developed by Westminster Dredging as part of the consortium was the method of bringing shingle onto the coast. Rather than using road transport, the material was mined up the coast by the hopper dredger the Sospan Dau (capacity 1500 tonnes) and then spouted onto the beach (Figure 5).

levels are at 1:50-400 the risk is then for both parties. At a safety level of >1-400 the risks and costs revert to the public sector.

After the contract with operational specifications was established, the negotiations for the formation of a PPP between the consortium and the public sector were begun. Agreements were made about the co-operation, the operation and the monitoring of the work. A private financier was sought and found. As pre-condition about 50 percent of the net cash value of the project had to consist of the annual maintenance costs and other additional services.

The Environment Agency saved about 15 percent on recurring obligations by signing a contract in which a good proportion of the risks were assumed by the contracting consortium. In addition, a number of cost-savings were realised by allowing the use of innovative methods. Furthermore, savings were achieved by closing a one-time contract for 25 years.

By creating a partnership for a lengthy time period, the consortium has time in which to gain experience in the area and to get to know the concerns of the residents who are interested in the management and safety of the region.

Figure 3. Placement of the bales with car tyres for the coastal defence system. Figure 4. Insulation of the tyre bales.

Figure 5. The trailer Sospan Dau delivering shingle to the coast.
When the tide was low, the shingle was spread by bulldozers and given the correct profile (Figures 6 and 7). This mitigated one of the disturbances (unwanted road traffic) for the area and also offered sizable cost reduction. The development of the nature reserves was given special attention. By separating the recreation areas from the nature reserves, people are able to enjoy recreational beach activities without damaging the very special biotope of the shingle beaches.

**RESEARCH AND MONITORING**

The 25-year contract with Pevensey Coastal Defence Ltd also offers unique opportunities to collect coastal data over a long period of time and to try different methods that can potentially make the management of the beach more efficient, sustainable or more beneficial to the environment. For these reasons, the long-term contract has attracted attention to Pevensey and several research institutes are actively involved with conducting ongoing monitoring and research projects. Monitoring of the project is being conducted by the consortium, in co-operation with the Client, and with universities and research institutes, such as the Southampton Oceanography Centre, the universities of Brighton, of Bristol and of Sussex and others. Doing this work over such an extended period allows a good comparison of experiences with diverse monitoring techniques and it makes truly independent monitoring and evaluations possible.

**CONCLUSIONS**

As a “pathfinder project”, the Pevensey Strategy using a PPP for coastal protection can certainly be considered to be successful, and its application to to other European coastal projects in countries such as the Netherlands and Belgium is recommended. Using a system of benefits and burdens, a carrot-and-stick approach, has the advantages to stimulate private investors to pre-finance. For the Client the advantage is that per project the fixed costs are paid over an extended time period, and the care and maintenance are done by third party experts. In these sorts of projects, contractual agreements and division of risks are important. Large unforeseeable risks should not be allocated to third parties because this will cause the costs of the projects, in connection with insurance, to rise remarkably. So sharing the burden of risks is a more cost-effective solution. On the other hand, innovations suggested by the Contractor that may result in cost-savings must be allowed.

The experience with the project at Pevensey Bay indicates that that taking on a integral coastal protection project, including improvement and maintenance, development and implementation of an emergency plan is certainly financially feasible.

Furthermore, long-term PPP contracts for coastal defence such as at Pevensey Bay, create an atmosphere in which important beneficial research data on coastal reinforcement can be accumulated. Of course, specific coastline situations will demand specific research by the Client or research institutes and, these may be influenced by the cultural-political situation which varies from country to country. Still, the PPP contract allows Client and Contractor to establish a mutually responsible relationship which benefits all parties.

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Figure 7. Viewed from onshore, bulldozers at work spreading the shingle.
ABSTRACT

Work-stopping archaeological discoveries during waterfront construction further increase awareness of the risks associated with construction undertakings in potentially sensitive areas of historic interest. The increasing awareness combined with the risks themselves introduces a challenge to the waterborne transportation industry. Specifically, a tool is needed that allows for more efficient representation of site data to accurately define an Area of Potential Effects (APE) and the effects to be caused by planned undertakings. As a progressive solution, subsurface 3D modelling shows existing conditions with utmost clarity, in a manner comprehensible to all associated parties. The application provides a focal point for stakeholders, regulatory agencies, and project teams, and in turn, leads to the ongoing and collaborative communication necessary for beneficial project planning and development. Subsurface three-dimensional modelling is unique in nature, and this article attempts to demonstrate its benefit to the waterborne transportation industry on a universal level. The article outlines a progressive approach intended to assist in evaluations of sites as potential points of waterfront access. It offers a modern approach to the challenge, utilising computer software to compile a site’s topographic and subsurface data and effectively present it as a visually lucid three-dimensional (3D) model.

This article is based on the author’s paper, “Subsurface 3D Modeling: An Application to Waterfront Project Planning and Site Evaluation” which was the PIANC USA 2008 De Paepe-Willems Award winner and a presentation at the PIANC USA Annual Meeting in June 2008. This adapted version is reprinted with permission.

INTRODUCTION

Significance

Throughout past decades, the unearthing of ancient artifacts and ancestral remains of races indigenous to waterfront regions has brought with it an increasing likelihood of further archaeological findings. A notable example was the discovery of more than 10,000 artifacts along with more than 300 intact skeletons of the ancient Klallam village, Tse-whit-zen. The discovery was made in late 2003 along the Port Angeles waterfront during construction of a new graving dock as part of the Hood Canal Bridge Project, funded by Washington State Department of Transportation (WSDOT). The graving dock was intended to be used for casting concrete floating pontoons and anchors to be used as part of the proposed Hood Canal Bridge. Construction was halted indefinitely, while WSDOT faced high-stakes decisions revolving around the state’s need for a casting facility in conjunction with the right of a resting place for the Klallam Tribe’s ancestry. Abandonment of the site severely delayed the project and ultimately amounted to construction losses in excess of $60 million.

Arguably the most significant archaeological discovery in western Washington State in the U.S. to date, the unearthing of the Tse-whit-zen village is one of numerous occurrences to halt construction of a public works project. In 1994, artifacts were recovered during excavations for expansion of the West Point Sewage Treatment Plant in Puget Sound, Washington. The project
was under a court mandated completion date and the discovery introduced concerns that the public would potentially be exposed to fines for each day of construction extended beyond the mandated completion. In Kahului, Hawaii, construction of the Lahaina Bypass was delayed as a result of recent discoveries of archaeological sites. Another similar occurrence was the series of archaeological findings that delayed revisions to U.S. Route 101 near Astoria, adjacent to the Oregon-Washington border. With the continual emergence of historic discoveries made throughout the state of Washington alone, the importance of a site’s history becomes increasingly apparent to waterfront projects everywhere.

As a result of adverse impacts introduced by unanticipated discoveries during construction, agencies are adapting to a more stringent protocol for preliminary site investigation of waterfront construction projects. Requiring deep-site testing is becoming more frequent, along with a greater utilisation of consulting firms during pre-construction phases in order to define and evaluate the Area of Potential Effects (APE) of a given site.

The APE is defined by 36 CFR Part 800 – Protection of Historic Properties, Section 800.16 (Definitions), as “the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist. The area of potential effects is influenced by the scale and nature of the undertaking and may be different for different kinds of effects caused by the undertaking”.

**Conventional modes of site evaluation**

Waterfront sites are currently evaluated for archaeological potential by collecting data from a variety of sources, then using the data to create documents that intend to convey to an assortment of parties, an understanding of potential effects to existing site conditions. The presentations and documents created depend on the project’s nature, extent, and requirements set by governing agencies. The documents, combined with presentations and other communications, provide the definition of a site, including the APE and known effects, and serve as basis for opinions and decisions during a site assessment.

Formal methods of site documentation that are often contained in reports and presentations include various archaeological predictive models, geographic information systems (GIS) maps, geologic profiles and stratigraphic sections, and composite representations such as fence diagrams or combinations of models. The majority of archaeological predictive models are essentially maps, indicative of archaeological remains likely to exist in a given area relative to a specific region. “This is a map which cartographically indicates predictions with regard to the situation of (as yet) unknown archaeological sites” (Marrewijk 1997:62).

Predictive modelling is further enhanced by GIS, which captures, stores and analyses data spatially referenced to the earth, and is becoming more popular as a setting for predictive modelling. GIS-based models are capable of revealing spatial relationships of prescribed variables, such as density or frequency, as they are distributed across a broad region. “Readily available digital data and ease of GIS software application facilitate the entire modelling process” (Kvamme: 2006:4).

Different types of predictive models are derived from different hypotheses, but they all share a common trait: They are all accounts of probability. Different types of predictive models are desirable for different purposes. For example, a waterfront developer would have interest in a predictive model useful for deriving statements about the probability of potential finds underlying a specific area within a region of available project sites. On the other hand, an archaeologist participating in a university study that aims to define a region for future archaeological survey might seek a predictive model capable of defining specific environmental parameters that can be used in a layer-identification process.

Archaeological predictive maps are useful to designers when superimposed onto conceptual design drawings by assisting in site selection and horizontal design considerations. Vertical design considerations are similarly assisted by geologic profiles and stratigraphic sections, which are typically included in waterfront project documents and can be accurately sketched from borehole data or archaeological trenches. However, when section cut lines are established and sections are drawn prior to design development, the sections may be of little or no use to designers, depending on their locations and orientations relative to design features. This is often the case when sections are drawn for environmental purposes before a design is fully conceptualised.

For example, if a section cut is taken in the north-south direction and sketched during an environmental permitting (pre-design) phase, but is located 50 feet to the west of a future utility line that will be routed in the same direction, it will be useless in comparison with a profile drawing of the utility unless additional analyses are conducted to verify material consistencies within the 50-foot separation distance. Probabilistic models such as Markov Chains can be used to simulate stratigraphic sections (Krumbein 1969:1) and to quantify geologic units, although these types of analyses are generally not practical enough to be considered well suited for waterfront construction projects and their associated environmental processes. “Budget and time constraints often undermine the depth to which background investigations can occur” (Naunapper 2006:279).

Project documents created by numerous parties during successful projects of the past prove that available sections and various predictive models can be useful tools during different phases of waterfront construction, particularly when they are overlain by design drawings. An array of information is provided and the associated parties must then use the information as a foundation to apply judgment and form opinions that are ultimately weighed to make decisions. Those parties, some of whom are decision-makers, likely to utilise the materials typically include:

- Cultural resources specialists;
- Environmental specialists;
- Archaeologists;
- Geomorphologists and Geologists;


• Regulatory agencies;
• Engineers and designers;
• Stakeholders including developers, investors, land-owners, indigenous peoples, and interested public.

The primary disadvantage associated with review by different parties of a widespread collection of information is a loss of collaborative communication. As a result, a consultant may need to develop several different drawings, tables, figures, and descriptions to convey a single understanding to multiple agencies.

Aside from difficulties that are inherent to a network of communication, there are other drawbacks to conventional methods of conveying information about a site’s APE and the effects. Utilising drawings to fully understand a site adds an unnecessary degree of complexity to the already arduous task of defining an APE and the layers beneath it. The definition of an APE is typically included in a Request for Proposals (RFP) if it is known. If they are not provided an adequate description of the APE in an RFP, proposing consultants attempting to provide a reasonable scope of work and budget are at a disadvantage.

Plan and section drawings provide a limited amount of definition to a complex formation of materials underlying a site. The possibility of overlooking information when interpreting between plan and section drawings as a means to understanding subsurface conditions introduces an amount of risk. The intricacy in the configuration and arrangement of the materials allows localised occurrences of significant materials to be overlooked. However, interpolation between section views is currently the most commonly accepted form of interpretation of existing subterranean conditions. In other words, attempts to define a 3D formation in two dimensions is insufficient. The exercise is lengthy and intensive, thus the method lends itself to error.

3D site modelling as a progressive solution

Computerised 3D modelling provides a single display of a site, its subterranean conditions, its APE, historic and proposed excavations and disturbances, and any other known features related to potential developments. A 3D model ties together virtually all the information that is typically required of a site, which would otherwise be documented by multiple forms, to convey a common understanding. The application is useful as a stand-alone tool, but also provides standard forms of site definition including plan, profile and section views as desired.

Rather than horizontally generalising across a broad region, such as predictive models often do, it allows specific existing and proposed features within a project site to be seen and exhibits thousands of precise, physical survey points. Another important characteristic of a computerised 3D model is its user’s ability to rapidly magnify focus from a broad-based plan, isometric or perspective view to a small area relative to an entire project site. The physical arrangements of features visible at angles between plan and section views are effortlessly captured from as close in or as far away as desired.

A key feature that further sets this 3D modelling application apart from others is its unique user-interface. Namely, its users experience nearly unlimited virtual interaction. Because a 3D model is navigable, it provides users with a unique ability to intensely focus on individual areas of concern. This gives leeway for archaeologists, geomorphologists, geologists, and other specialists to collaborate in front of a projector screen and formalise their notions on “what exists where” while benefitting from each other’s expertise. An APE can be defined with a high level of confidence. Moreover, the effects to an APE can be shown and project designers can be involved in these types of discussions to weigh in on design standards, possible deviations and limitations. These discussions are also extremely beneficial all parties faced with programme-level decisions.

The primary advantage of modelling a site in three dimensions is that it provides an accurate replication of subterranean conditions, which makes them visible and understandable to all parties interested in the site’s potential development. The application is an ideal means of site representation because it displays known locations of existing data points and the interpolated conditions between them, and makes the intricacies of subsurface material formations clearly visible. The model is navigable and can be used interactively by allowing viewers to orbit and view anything from any angle.

Efforts of translating between plan and section views to understand what lies beneath a site are eliminated. Furthermore, project alternative layouts can be compared by superimposing excavation scenarios into the layers beneath a site and identifying interferences.

The overall influence of 3D modelling on a project is the encouragement of continuous and collaborative communication between interested parties. The application portrays data and information more conveniently and effectively so that communication is maintained amongst all parties and decisions can be made in a timely manner.
APPROACH

Data
The input data used for the inception of a model is important because it serves as the basis of a 3D model. Data is gathered from as many relevant resources as possible to ensure that a set of information is complete and not conflicting. Data obtained from the sources is used to show three pieces of a 3D model: the site as it appears above ground, or the terrain; past, present, and proposed construction excavations; and subsurface conditions, or the layers of soil and other matter below ground. A 3D model typically includes but is not limited to input from the following resources:

Survey
- Basemaps
  - Topography and bathymetry
  - Existing utility locations
  - Existing structure locations

Agency and Project Team Files
- Historic drawings
  - Former utility locations
  - Former structure locations
- Alternative project layouts
  - Proposed utility locations
  - Proposed structure locations
- Geotechnical reports
  - Soil boring location map
  - Soil boring logs
    - Lithologic and stratigraphic data
- Environmental and cultural resources reports
  - Plan view of APE
  - Known effects
- Hazardous material reports
  - Location of contaminated soils
  - Location of underground tanks

From the data, a system of points is established. Interpolation between data points decreases as the number of data points increases, although some amount of interpolation and judgment will always be required.

In addition to gaining site background from documented data and information, agencies and stakeholders often turn to specialists including geologists, geomorphologists, archaeologists, and cultural resources specialists for further rationale and input to a site’s definition. For instance, a geomorphologist might theorise on the chronological formation of a site based on definition from the above data combined with knowledge of surrounding geology, past cultures and their associated uses of the area.

Terrain development: Application of survey data
Figures 1 and 2 show progression of a site’s terrain. Figure 1 shows the first stage, stand-alone 3D contour lines in a set co-ordinate system. Figure 2 shows the resultant surface, with a tide added in at mean lower low water (MLLW).
A co-ordinate system and other vertical and horizontal references are established. From the contour lines, a surface is generated. Figure 2 demonstrates the relationship between the survey contours and the modelled landscape.

Construction excavations: Application of drawings
Plan view locations of site features are known from drawings. From drawings, excavations are added into the landscape as shown in Figure 3. Trench and foundation excavation dimensions for features of proposed alternatives are estimated. The goal is to display the effects introduced to a site, and for some projects, excavations are not the only potential effects. Vibrations from pile driving, soil displaced for drilled shafts, and soil contamination are undertakings that potentially alter the character of historic properties.

Subsurface conditions: Application of borehole data
Boring logs are first evaluated to identify layers in each sample. The layers, defined by numbers in spreadsheets, are then named and categorised. For lithology and stratigraphy, top and bottom depths of each defined unit as it occurs in each borehole are included in the spreadsheet.

A triangulated irregular network (TIN) is created for the upper and for the lower surface of each layer. Figure 4 shows a set of soil borings in 3D, and the TIN lines used to form the upper and lower surfaces of a layer. The soil sample widths in Figure 4 are exaggerated so the colouration is visible. The colours represent instances of different units, or layers detected in each sample.

The layer bound by the TIN lines in Figure 4 is designated by purple. The green lines represent the upper TIN surface and the lower is represented by the purple lines. The TINs show how data points between actual boring locations are interpolated.

The presence of every unit will not necessarily be detected in each boring, which leaves gaps in some layers. More specifically, it is common for some borings to indicate presence of all known units, while others exhibit only two or three as seen in Figure 4; therefore, some of the layers have openings, or discontinuities within the network borings.

Insignificant layers are typically not shown in the model. For example, a consistent layer of fill existent from past site uses is commonly detected in a group of borings. Such layers are located above the more significant layers. Fill can be modelled and shown if desired, although doing so is unnecessary for all intensive purposes and its visualisation will likely be toggled off during the majority of the time spent viewing the model.

Input from specialists
Commonly one or more layers of special interest which require special consideration by experts are found to exist throughout most historical sites. These layers often establish the APE.

A common example of such layers is a “midden”, a word used by archaeologists to describe a deposit containing shells, bones, or other evidence of human settlement. A midden is often a source that leads to further archaeological investigation after it is discovered. A latter section demonstrates how 3D modelling lends itself to assist specialists in the layer definition process.
Visualisations, Uses and Benefits

Visualisations
A 3D model is interactive. Viewers can navigate or orbit around a 3D model and zoom in and out in any area as much or as little as desired. The application also saves a variety of views specific to individual needs. The model can be viewed through a perspective or a non-perspective standpoint. Perspective views are more realistic in comparison to isometric views. When section cuts or plan views are desired, a non-perspective view is favorable. Figure 5 shows a sampling of different views.

Existing features visible above ground can be shown if desired, but take away from the application’s overall intent. A navigable model is extremely useful for viewing subterranean arrangements of features and effects. Viewers are able to look up toward the underside of the surface, as demonstrated in Figure 5. A 3D model also allows for individual features to be toggled on or off during a viewing session and provides different view renderings that can be continuously changed throughout a viewing session. Renderings include but are not limited to frame-style views that clearly show TIN lines, X-ray views, or views that show surfaces but exclude lines and edges.

Use for comparing project alternatives
Modelling is a beneficial application for viewing alternative construction impacts to an APE. Stakeholders prefer to avoid impacts near a sensitive area whenever feasible; their needs can be facilitated with a 3D model that provides a project team the ability to fully view and consider different options. Below-ground views are especially useful because they allow a project team to evaluate the overall risks of disturbing an area by choosing one alternative over the other. Provided a graphical representation of future excavations combined with existing subterranean conditions, the project team can discuss layer avoidance strategies.

For example, Figure 6 shows a midden overlain by soil displacements for two potential utility layouts. Trenching for an initial utility design layout is shown in brown, a midden in turquoise, and trench excavations for an alternative route are designated by red. The brown trench clearly intersects the midden in two locations, so the route shown in red is planned as an avoidance strategy.
3D modelling is especially beneficial when a subsurface layer requires special definition. A 3D model uses borehole data and TIN lines as basis for specialists to apply judgment to precisely define a sensitive layer. The application promotes an iterative process of layer alteration, so layers reach final definition with a high level of confidence. Sensitive layers typically undergo several iterations before reaching a satisfactory definition. During the process, iterations are each documented and clearly viewed by agencies.

Figures 7 through 10 illustrate a process commonly used to modify a layer with input from specialists. Figure 7 depicts a network of 27 borings in an AFE. Three layers are detected in the network. Layers 1, 2 and 3 are designated by brown, green, and purple, respectively. Say that layer 2 is determined to be a midden. Only 8 of the borings indicate presence of Layer 2. These 8 borings are connected by the red lines. Horizontal movement of utilities, or rerouting conflicting runs, requires analysis and co-ordination with governing agencies to determine the possibility and feasibility of doing so for individual lines and tie-in points. To adjust utilities vertically requires designing systems to a higher elevation, which usually means raising the proposed grade elevation to maintain minimum depths of cover above the utility lines. Optional grading and utility layouts vary between each alternative, so combining different utility and structure layouts gives leeway for many different scenarios aimed at avoiding a sensitive area; a 3D model facilitates the process.

Vertical and horizontal constraints must both be considered when strategizing avoidance measures. A site near the waterfront is typically limited by grade on at least two sides: The shore and the land access point. For example, a site planned for a new pier and roadway is vertically constrained. A new roadway would have to tie into an existing street at some point, which limits the amount of grade to work with. Transition between the new roadway and pier would limit the elevation for an access point to the pier. The second limiting factor is the use of the pier. For waterside access to the pier, vessel freeboard elevations must be considered and limit the design elevation of the pier.

To avoid conflicts to potentially sensitive areas while recognising limiting factors, there are essentially two options: Shift construction horizontally or adjust vertically (in lieu of shallower excavations). Utility layout and small structure designs have the most flexibility. Changes in the design of pile supported structures, buildings, and bridges are more difficult because the structures often cannot be moved without rearranging an entire project.

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Other factors that should be considered include the size and nature of the project, the extent of the potential effects caused by undertakings, the location and arrangement of the layer relative to the water, the significance of the layer itself, and most importantly, the level of acceptable risk. For instance, if the definition given in Figure 10 is conducting additional field sampling is a favourable course of action when project schedule and budget permit. If the 27 samples shown in Figures 7 through 10 were surrounded by hundreds of other borings, or if the borings were densely spaced, Figure 8 might be a more reasonable definition than Figure 10.

Several factors should be taken into account during a layer’s definition process. The number of borings and size of the sampling grid (sampling density) determine the accuracy of the analysis. Accuracy increases with higher density, so...
deemed more realistic than that in Figure 8, the latter is still a more conservative shape that would better avoid risk when excavating around the material.

The risk of uncovering archaeological finds near a layer depends on how conservatively the layer's boundary is defined. The risk is generally greater along the shore-side boundary than it is on the side exposed to open land, so a combination of Figures 8 and 10 could be applied, with the full boundary assumed on the water-side, and the 25% factor applied to the land-based edge.

More complex definitions are also possible to achieve. Probabilistic methods of volume definition are available, but are not always desirable. As a method becomes more complex, the time and data required for analysis increases. Complex statistic and probabilistic approaches are often used in subsurface applications such as quantification of a soil contamination volume or estimation of a strata deposit. A special paper presented by John Dennison at the 82nd Annual Meeting of the Geological Society of America in 1969 demonstrates applications of statistics to geologic field work and how they relate to quantification processes. The paper is included in *Quantitative Geology*, by Peter Fenner (1972). Complex probabilistic approaches are generally better suited for applications involving highly irregular geometry and those in which the quantity of material is more significant than the boundary. "Many of the constructions and deposits for which volumetric data would be valuable are not of regular shape, so their volumes are not easily calculated by use of standard geometric formulae" (Sorant 1984:599).

There are also far less complicated methods of definition than the one outlined in Figures 7 through 10. For example, say a predictive map is used because sample data is insufficient. In this case a hand-sketched boundary around a high-sensitivity zone indicated on the map could suffice in combination with an assumed uniform depth. However, such methods can be highly inaccurate and overly conservative.

**CONCLUSIONS**

Decreasing site availability leads to increased consideration of subterranean conditions at potential waterfront project sites. Conditions beneath potentially sensitive sites are further regarded because of a timeline populated with instances of construction-stopping archaeological discoveries. Such instances strongly suggest the need for a more progressive tool that can be used by a project team to fully understand subsurface conditions with any high-risk undertakings.

The intent of three-dimensionally modelling a site is to provide an unhindered definition of its Area of Potential Effects (APE) and known effects so collaborative project-planning decisions can be made with a high level of confidence. Application of a 3D model makes efficient use of the information known about a site and allows it to be fully understood by stakeholders and regulatory agencies, specialists, designers and engineers. The overall concept is straightforward: A single 3D representation of the existing site and its subsurface layers, its historic excavations and proposed construction impacts. The approach also takes into account the significance of a site’s planned uses, historic and geologic developments.

Conventional modes of conveying data and providing subsurface definition to evaluate project sites are useful to a limited extent, but lack the benefits appropriate for high-stakes waterfront construction projects. The 3D modelling application can produce the same forms of media common to the majority of past project documentation, including plan and profile views, so utilisation of past methods is enhanced, rather than precluded. Providing adequate assessment of an archaeologically sensitive area is an undertaking of utmost importance and should not be undervalued.

3D modelling promotes the ongoing, collaborative communication between agencies, stakeholders, specialists, designers and engineers necessary to adequately assess a site. Several goals are achieved by enabling all parties to interactively view a variety of information and concepts.

Overall, data is more efficiently used to allow for planning of alternative project layouts and options, which minimises the risk of disturbing potentially sensitive areas.

**REFERENCES**


**A Resistable Force: When man meets the sea**

**BY PAULINE VAN LYNDEN**


Pauline van Lynden is a Dutch/French photographer, writer and book designer based in the Netherlands. After a Masters degree in Political Sciences she trained as a bookbinder, and practised and taught this skill for many years before returning to art school. This book is about the breakwaters of Walcheren, an ancient system of coastal defence in the Netherlands that exists nowhere else in the world on this scale.

Pauline van Lynden has spent a number of years not only drawing and photographing these long lines of black palisades, but also delving into the history and technique behind them. This has led to a rather scientific approach, combining her own art work with historical documents and a thorough exploration of this ancient system of coastal defence; of the lives of the people who built and maintain it; and of a culture marked by its relation to the sea. As coastal management has become a matter of international importance and solutions for the protection of the coasts are more vital than ever, the palisades on the beaches of Walcheren represent a fine example of inventiveness for other shores of the world.

Also available from the publisher in Dutch with the title "Donkere Palissaden". For further information see: www.visual-legacy.com

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**Smart Rivers 2007 Conference Final Report**

**EDITED BY PIANC USA**

Smart Rivers 2007 Conference, with the title, "Positioning Inland Navigation as a Powerful Link in the Global Supply Chain", took place in September 16-19, 2007 in Louisville, Kentucky, USA. This Final Report contains the papers and presentations from the eight Technical Sessions including: Changing markets: What Drives Cargo on the System?; Promoting a Sustainable Inland Navigation System; System Perspectives; Policy Comparisons and Project Determinations: How are Local Projects Done?; Reliability and System Use; PIANC Activities: Port Management in Europe; Future Challenges to Industry.

This report is now available from:
PIANC USA, 7701 Telegraph Road, Casey Building, Alexandria, Virginia 22315 USA
Email: Kelly.J.Barnes@usace.army.mil
www.pianc.iwr.usace.army.mil

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**Integrated Coastal Policy via Building with Nature**

**BY RONALD WATERMAN**

450 pages. Full color. ISBN/EAN 978-90-805222-3-7

This comprehensive book can be seen as the standard work in the field of Building with Nature® and represents a milestone in the history of the development of delta technology. The book is available in English and in Dutch (Naar een Integraal Kustbeleid via Bouwen met de Natuur) at www.ronaldwaterman.com. (See also Terra et Aqua Special Edition, nr 107, June 2007).

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**FACTS ABOUT...**

In an effort to reduce the information overload inherent in today's business world, in 2007 IADC launched a new series of concise, easy-to-read “management summaries”, entitled: Facts About. Each offers an overview of a specific dredging and maritime construction subject. Facts About are available at the IADC website www.iadc-dredging.com where you can subscribe to receive them digitally.

Since IADC’s aim is to provide information to support clients, consultants and others, the question to our readers is: Are these Facts About working for you? Please take the time to let us know what you think by filling in the questionnaire at http://www.iadc-dredging.com/survey.
Coastal Management, Proceedings of the two-day international conference organised by the Institution of Civil Engineers, Cardiff, October/November 2007
EDITED BY DR ROBIN MCINNES OBE.
Thomas Telford Publishing, 1 Heron Quay, London E14 4 JD, UK. 270 Pages. Hardcover. £ 105.00.

To introduce this publication, one can do no better than borrow from the Editor’s Foreword:

Those with an interest in the diverse aspects of coastal zone management are facing increasing challenges as a result of development pressures, environmental impacts as well as increasing risks arising from the impacts of climate change. With the objective of achieving sustainable development many nations worldwide are progressing and implementing legislation or policies to fulfill this aim.

Dr Robin McInnes, Isle of Wight Council, Chairman of the Organising Committee

These proceedings are the outcome of the Institution of Civil Engineers’ conference specifically organised to draw together those experts practising coastal management and researchers in this field, to present work relating to the following themes:

1. Coastal policies and management arrangements
2. Managing the dynamic coast
3. Mapping, monitoring and new technologies
4. Coastal and estuary engineering
5. Coastal environment management and enhancement
6. Achieving a better integrated coastal zone management.

These six themes are the titles of the conference sessions and the presented papers have been well chosen to describe developments and works within these areas of interest. With a team of world-renowned coastal practitioners at the helm – a highly experienced UK Organising Committee, supported by an Overseas Advisory Committee with Europe-wide, Middle Eastern and Caribbean members – the conference highlights innovation and best practice in the field of coastal management. Co-sponsors of the conference included the Environment Agency, SCOPAC, Maritime Journal and Birse Coastal. There are numerous parallels between themes in this conference and those encountered by “dredging” practitioners. For example, the practice of engaging with stakeholders is well advanced in the coastal management field, as is also the appreciation of the value of long-term monitoring.

These are lessons that those engaging in dredging works might do well to emulate. Modelling as an aid to prediction and thence long-term management is also of great importance. Surprisingly, the twenty-two authors (is this a record?), who expounded on “the development of an integrated coastal simulator for supporting long term coastal management” (Mokrech et al.), actually managed to also produce a well integrated paper!

As one would expect these days, risk management features strongly in the papers, both in terms of its advantages, e.g. “SaferSands – a new risk management scheme for tourist beaches” by McCue and its potential pitfalls as described in the paper, “Courage, caution or cowardice. Has the shift towards risk management in flood and coastal erosion directed attention from the more complex issues of coast and estuary management?” (Guthrie, Ash and Trewhella). This latter paper abounds with delightful philosophical aphorisms, quoting both Albert Einstein and Martin Luther King, but possibly encapsulates its message best in the abstract:

With a growing confusion as to what drives decisions, coupled with a sectorial approach based solely on risk, the profession is in danger of both falling back on uncertainty as an excuse for temporary fixes and replacing vision with expediency”.

With its many case histories, from the United Kingdom, Sri Lanka, Namibia and the United States, its examples of design and modelling, and illustrations of best practice, this set of papers is both thought-provoking and a valuable insight into how the coastal management community is moving forward towards sustainability and, at the same time, dealing with the effects of climate change. Or, as Sir John Harman, Chairman of the UK Environment Agency, put it in his keynote address abstract:

We live in exciting times, and the challenge we all face on the coast, fuelled by climate change, is an exciting opportunity to make a real difference for the natural environment, the built environment and the communities who live and work there.

Anyone who works in the coastal management field or anything related to it should have access to a copy of this publication. The book is available from Thomas Telford in hardcopy or downloadable online at www.thomastelford.com

NICK BRAY
38th Dredging Engineering Short Course  
CENTER FOR DREDGING STUDIES,  
TEXAS A&M, COLLEGE STATION, TEXAS USA  
JANUARY 12-16, 2009

The dredging engineering short course includes a mixture of lectures, laboratories, and discussions at the Texas A&M University campus in College Station, Texas. The course is administered by the Center for Dredging Studies, Ocean Engineering Program, and Zachry Department of Civil Engineering. A textbook and course notes on all lecture material are provided. A certificate and continuing education units (~3.0 CEUs) are earned by attending this short course. Course fee is US$1,325 and includes textbook, lecture notes, banquet and local transportation. Advance enrollment is required and may be made by individuals or companies. Applicants must mail or fax the completed enrollment application and mail payment. A minimum of 4 participants is required to offer the short course and enrollment will be limited to a maximum of 6 participants.

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Cutter Suction Dredge Simulator Short Course  
CENTER FOR DREDGING STUDIES  
TEXAS A&M UNIVERSITY  
COLLEGE STATION, TEXAS USA  
JANUARY 19-21, 2009

A cutter suction dredge simulator course is offered to demonstrate the fundamentals of hydraulic dredging using a cutter suction dredge. Basic concepts of cavitation, deposition of sediment in the pipeline, pipeline length limitations, pump power limitations, and swing winch limitations are simulated. Different sediment conditions and channel currents are also simulated. A PC computer is interfaced to actual controls for a cutter suction dredge. A training manual for the course is provided. The course is held in the Haynes Coastal Engineering Laboratory at Texas A&M University. The course fee is US$1,500 and advance enrollment is required and may be made by individuals or companies. Applicants must mail or fax the completed enrollment application and mail payment. A minimum of 4 participants is required to offer the short course and enrollment will be limited to a maximum of 6 participants.

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Seminar on Environmental Aspects of Dredging  
DELFT, THE NETHERLANDS  
JANUARY 29-30, 2009

The Seminar on Environmental Aspects of Dredging, organised by PAO, Post Graduate Education, in co-operation with IADC and CEDA, will take place on January 29 and 30, 2009 in Delft, The Netherlands. The course is based on the book Environmental Aspects of Dredging, edited by Nick Bray and a team of experts from CEDA and IADC, which was released earlier this year. In order to responsibly plan and execute environmentally sensitive dredging projects, a thorough understanding of all aspects of dredging, environmental impact assessments and environmental dredging equipment and techniques is essential. The course, given by highly respected leaders in the dredging industry, emphasises an integral approach to these often urgent, but sensitive, projects. It provides detailed insight into the perspectives of the various stakeholders and the significance of international and national regulations. Realistic case studies are used to help participants understand their role in the sustainable development of dredging related projects.

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Email: cammel@iadc-dredging.com
Aquaterra 2009
AMSTERDAM RAI, THE NETHERLANDS
FEBRUARY 10-12, 2009

Predictions indicate that a staggering 80 percent of humanity will be residing in urbanised areas by and around seas and large rivers within the next few decades. Pressure on living space is increasing and a life close to water often carries risks. As the equilibrium between environmental resilience and human activity threatens to spill over, the question is: How do we maintain the balance?

Aquaterra, the world forum on delta and coastal development and an adjacent exhibition, are aimed at all stakeholders involved with the management and development of delta and coastal areas, bringing governments, businesses, scientists and NGOs together to create solutions, ideas and visions for the future. The conference will focus on trying to balance people, planet and profit and the five main themes: Urban planning, Managing natural systems, Climate change proofing, Risk management and Innovative delta projects.

Topics include: Hydraulic engineering; Land reclamation; Water quantity management; Water quality management; Soil management; groundwater management; delta technology; financing; risk management; and public-private co-operation.

For further information contact:
www.aquaterraforum.com

Maritime Vietnam 2009
HO CHI MINH CITY, VIETNAM
FEBRUARY 25-27, 2009

A comprehensive event that features shipbuilding, supply chain management and port related opportunities, Maritime Vietnam is the definitive international platform for buyers and sellers to network and explore business opportunities in the buoyant maritime industry in Vietnam.

For further information contact:
Tel.: +86 (21) 5375 0688
Fax: +86 138 1869 0676
Email: silence.song@iirx.com.sg
www.maritimeshows.com/vietnam/index.php

Port & Terminal Technology Conference
HOUSTON TEXAS, USA
APRIL 6-8, 2009

Following its success in Europe over the last 5 years, Port & Terminal Technology Conference will be held for the first time in the USA. The two-day programme will explore the latest developments, issues, trends and technology affecting ports and terminals around the world. The conference is specially designed for representatives from operations, maintenance and engineering from port authorities, terminal operators, consultancy firms, dredging contractors, maritime construction firms and suppliers of cargo handling equipment to the ports industry and those involved in the effective development and operation of container ports and terminals around the globe.

For further information contact:
Claire Palmer, Project Manager
claire@millenniumconferences.com

Smart Rivers 2009
VIENNA, AUSTRIA
SEPTEMBER 14-15, 2009

The Smart Rivers 2009 conference is being organized by TINA Vienna Transport Strategies and will include technical sessions, industry exhibits, and networking events. This conference will be the fourth in a series of international joint conferences on synergies for an efficient waterway system in Europe and the U.S. The theme of the conference is “Contribution of Inland Water Navigation to Climate Protection.” Extract of topics include the impact of extreme weather conditions, the availability of infrastructure, efficiency of technological policy, container transportation, the role of ports, and so on. The first conference was held in Pittsburgh in 2005, the second took place in Brussels in 2006, and last year’s conference was held in Louisville, Kentucky. More than 200 port and waterway executives, policy and technical professionals from the U.S. and Europe attended the 2007 conference, organized by PIANC USA.

For more information please contact:
Otto Schwetz, TINA Vienna Transport Strategies
Email: otto.schwetz@tinavienna.at.
**CALL FOR PAPERS**

**WEDA 29 Conference and TAMU 40**
**BUTTES RESORT HOTEL, TEMPE, ARIZONA**
**JUNE 14-17, 2009**

The theme of the 29th Western Dredging Association (WEDA 29) Annual Western Hemisphere Conference/Exhibition and Texas A & M’s 40th Annual Dredging Seminar (TAMU 40) is “The Importance of Dredging”. This will be a forum for discussion amongst Dredging Contractors, Port Authorities, Government Agencies, Environmentalists, Consultants, Academicians, and Civic/Ocean Engineers. The Technical Papers Committee will review all one-page abstracts received and notify authors of acceptance. One-page abstracts must include: descriptive title, author names, author contact information (company name, address, phone, fax, and email address) and abstract (<300 words). Deadlines are the following:

- Submission of one-page abstracts: December 19, 2008
- Notification of Authors: January 16, 2009
- Submission of Final Paper: April 15, 2009

The International Association of Dredging Companies Best Paper Award by an author under 35 years of age for a contribution to the literature on dredging will be presented. Authors who qualify should indicate their age on their abstract.

One-page abstracts should be sent to one of the following members of the Technical Papers Committee.

Dr. Ram K. Mohan, Partner  
Anchor Environmental, LLC  
Tel.: +1 267 756 7165, Fax: +1 267 756 7166  
Email: rmohan@anchorenv.com

Dr. Robert E. Randall, PE.  
Center for Dredging Studies, Texas A&M University  
Tel.: +1 979 845 4568, Fax: +1 979 862 8162  
Email: r-randall@tamu.edu

Bob Wetta, President  
Dredging Supply Company  
Tel.: +1 985 479 8050, Fax: +1 985 479 1367  
Email: rbwetta@dscdredge.com

**CEDA Dredging Days 2009**
**AHOY ROTTERDAM, THE NETHERLANDS**
**NOVEMBER 4-6, 2009**

The theme of the annual CEDA conference will be “Dredging Tools for the Future”. CEDA invites stakeholders and the dredging equipment industry to present and discuss upcoming challenges and their suggestions for solutions. Many new possibilities have emerged since 2003, when Dredging Days last focused on tools and technology.

Subtopics of the conference will include dredging tools and energy scarcity / high energy costs, climate change, extreme conditions, increasingly stricter environmental regulations and the dynamics of nature. The Conference and Exhibition in conjunction with Europort Maritime 2009. Corporate members of CEDA are invited to sponsor the conference.

Prospective authors are invited to submit titles and abstracts (maximum 300 words) of papers. Abstracts must be submitted on-line and on-line submission will open on November 15, 2008. Deadlines are: Submission of one-page abstracts: January 15, 2009. Notification of Authors: February 15, 2009. Submission of Final Camera-ready Papers: October 1, 2009

The International Association of Dredging Companies Award for a contribution to the literature on dredging will be presented for the best paper of the conference by an author under 35 years of age. Authors who qualify should indicate their age on their abstract.

CEDA Secretariat  
Radex Building  
Rotterdamseweg 183c  
2629 HD Delft, The Netherlands  
Tel.: +31 (0)15 268 2575  
Fax: +31 (0)15 268 2576  
Email: ceda@dredging.org

**Ports 2010: Respecting the Past, Building the Future**
**JACKSONVILLE, FLORIDA, USA**
**APRIL 25-28, 2010**

The Ports and Harbors Committee of the American Society of Civil Engineer’s (ASCE) Coasts, Oceans, Ports, and Rivers Institute (COPRI) is pleased to announce the Ports 2010, the 12th in COPRI’s successful series devoted to port and harbor engineering. The conference will focus on current projects, practical issues, innovative engineering and construction, and state-of-the-art developments for port engineering.

Interested authors are required to submit abstracts online at http://submissions.miramcd.com/ASCE/Ports2010/login.asp.

- Abstracts should be in English and no longer than 500 words.
- Paper titles are limited to 50 characters.
- ASCE/COPRI membership is encouraged, but not required for submission.

For questions regarding abstract/submission, please contact: Ports2010@mirasmart.com. Further updates see: www.portsconference.org.
Africa
Dredging and Reclamation Jan De Nul Ltd. Lagos, Nigeria
Dredging International Senegal Ltd., Bissau, Senegal, Senegal
Nigerian Westcoast Dredging and Marine Ltd., Lagos, Niger
Dredging International SA, Port Louis, Mauritius
Boolels South Africa, Pretoria, South Africa
Aqua
Van Oord ACZ Marine Contractors B.V. Hong Kong Branch, Hong Kong, P.R. China
Van Oord ACZ Marine Contractors B.V. Shanghai Branch, Shanghai, P.R. China
Van Oord India Pvt. Ltd., Mumbai, India
Van Oord ACZ Marine Contractors B.V. Almada, Portugal
International Seaport Dredging Private Ltd., Navi Delhi, India
Jan De Nul Dredging India Pvt. Ltd., India
P.T. Boolels Indonesia, Jakarta, Indonesia
P.T. Percancangan Laut, Jakarta, Indonesia
Penta-Goose Construction Co. Ltd., Tokyo, Japan
cnr Engineering & Construction Co. Ltd., Seoul, Korea
Van Oord Dredging and Marine Contractors b.v. Brazil Branch, Brazil
Ballast Ham Dredging (Malaysia) Sdn. Bhd., Johor Darul Takzim, Malaysia
Tideway B.V., Ede, Netherlands
Van Oord ACZ Marine Contractors B.V., Rotterdam, Netherlands
Van Oord Offshore b.v., Rotterdam, Netherlands
Van Oord Offshore b.v., Rotterdam, Netherlands
Nordsee Nassbagger - und Tiefbau GmbH, Wilhelmshaven, Germany
Sodranord SARL, Le Blanc - Mesnil Cedex, France
Société Anonyme Dragagp 1Sp “SEDA”, Rome, Italy

Australia
Boolels Australia Pty Ltd., Sydney, Australia
Dredgeco Pty Ltd., Brisbane, Qld, Australia
Van Oord Australia Pty Ltd., Brisbane, Qld, Australia
W. A. Shell Sands Pty Ltd., Perth, Australia
NZ Dredging & General Works Ltd., Macpac, New Zealand

Europe
DEME Building Materials N.V. (DBM), Zwijndrecht, Belgium
Dredging International N.V., Zwijndrecht, Belgium
Jan De Nul n.v., Hoofdstede, Belgium
Baggenwerken Decloedt & Zn N.V., Oostende, Belgium
Deme Westermarck Dredging & Contracting Ltd., Cyprus
Van Oord Middle East Ltd., Nicoz, Cyprus
Ronde Nielsen, Copenhagen, Denmark
Temarema Bezi OU, Tallinn, Estonia
Temarema Oy, Helsinki, Finland
Atlantique Dragage S.A., Nantes, France
Atlantique Dragage S.A., Perros Guirec, France
Société de Dragage International T.D.T. S.A., Lorient, France
Soobrood SARL, Le Blanc - Massialot, France
Shreebala Waterbathengelscha ft. Flemm, Bremen, Germany
Hanchel Holms G.m.b.H., Hamburg, Germany
Irish Dredging Company, Cork, Ireland
Van Oord Dredging and Contracting Ltd., Dublin, Ireland
Boolels B.V., Roskilde, Denmark
Deme Westermarck Dredging & Contracting Ltd., Den Helder, Netherlands
Dredging and Contracting Rotterdam b.v., Bergen op Zoom, Netherlands
Wijfjens zand en grondstoffen b.v., Gorinchem, Netherlands
Tideway B.V., Brede, Netherlands
Van Oord ACZ Marine Contractors B.V., Rotterdam, Netherlands
Van Oord Nederland b.v., Gorinchem, Netherlands
Van Oord Offshore b.v., Rotterdam, Netherlands
Van Oord Offshore b.v., Rotterdam, Netherlands
Dredging International JAPAN Ltd., Tokyo, Japan
Ballast Ham Dredging (Malaysia) Sdn. Bhd., Johor Darul Takzim, Malaysia
Tideway B.V., Ede, Netherlands
Jan De Nul Singapore Pte Ltd., Singapore
Van Oord Dredging and Marine Contractors b.v. Singapore Branch, Singapore

Australasia
Boolels Australia Pty Ltd., Sydney, Australia
Dredgeco Pty Ltd., Brisbane, Qld, Australia
Van Oord Australia Pty Ltd., Brisbane, Qld, Australia
W. A. Shell Sands Pty Ltd., Perth, Australia
NZ Dredging & General Works Ltd., Macpac, New Zealand

Middle East
Boolels Mediterranean Middle East Ltd., Manama, Bahrain
Ballast Westminster (Oman) Ltd., Muscat, Oman
Middle East Dredging Company (MEDCO), Dubai, Qatar
Boolels Mediterranean Middle East, Dubai, Qatar
Boolels Westminster Al Riyadh Co Ltd., Al Dhahiri, Saudi Arabia
HAM Saudi Arabia Company Ltd., Dubai, Saudi Arabia
Boolels Westminster M.E. Ltd., Abu Dhabi, UAE
National Marine Dredging Company, Abu Dhabi, UAE
Gulf Ceiba Limited Liability Company, Dubai, UAE
Jan De Nul Middle East Ltd. Dubai Branch, Dubai, UAE
Van Oord Gulf FZ LLC, Dubai, UAE

The Americas
Compania Sud Americana de Dragados S.A., Buenos Aires, Argentina
Van Oord ACZ Marine Contractors b.v. Argentina Branch, Buenos Aires, Argentina
Ballast Ham Dredging do Brasil Ltd., Rio de Janeiro, Brazil
Van Oord Curacao n.v., Willemstad, Curacao
Draganes S.A. de C.V., Coatzacoalcos, Mexico
Dredging International Mexico S.A. de C.V., Veracruz, Mexico
Wetlands of Mexico S.A. de C.V., Mexico City, Mexico
Coastal and Inland Marine Services Inc., Bethania, Panama
Dredging International de Panama SA, Panama City, Panama
Société d’Activités D’Aménagement des Ports, de la Navigation, de l’Hydraulique et de la Construction Maritime, Panama
Boolels Internacional Uruguay S.A., Montevideo, Uruguay
Dragasans S.A., Valencia, Spain
Dredging International N.V. - Suzukin Venezuela, Caracas, Venezuela

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