

COWIfeature

COWI's international magazine - February no. 6 2003

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**Wood-chip heating
could be big**

Roads should be
built to Mozart

More metro in May



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Cover: Jens Dall Bentzen,
MSc Eng, COWI.
Photo: Tao Lytzen

New technology based on old know-how



Photo: Tao Lytzen

Gasification of biomass could be big, predicts a young researcher. The so-called two-step gasification plant stems from technology that was widespread during the Second World War, when vehicles were fitted with biogas generators to gasify wood—an alternative fuel to petrol, which was in short supply.

The knowledge of gasification acquired during the war was lost from the 1950s until the 1980s. But towards the end of the 1980s Denmark again began to look more closely at gasification, offering as it did the prospect of partial self-sufficiency in energy. Today the old methods of gasification have been radically improved. Read about the gasification plant development project currently under way at the Technical University of Denmark on page 28. Researchers are presently seeking an industrial partner to complete the development and put the plant into production.

John Jørgensen
Editor-in-chief, COWIfeature

Publisher COWI A/S
Parallevej 2, DK-2800 Kongens Lyngby
Denmark
Tel.: +45 4597 2211
Fax: +45 4597 2212
www.cowi.dk

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Editors
John Jørgensen (Editor-in-chief)
jhj@cowi.dk
Christina Tækker (editor) cht@cowi.dk
Susanne Junge sgn@cowi.dk
Jette Kingod

Translation
LanguageWire

Design & layout
Josina W. Bergsøe
Patrick Andresén
Jytte Dowell



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Big ships stranded like beached whales on India's mud banks. Sent to be broken up by European shipowners. Barefoot, unprotected workers performing dangerous, dirty work. Now Europe is on the lookout for shipyards to break up ships in a responsible way. In a recent report to the Danish Environmental Protection Agency, COWI biologist Frank Stuer-Lauridsen concludes that European shipbreakers can no longer compete with the primitive shipbreaking beaches in the East



Like beached whales



“Today a ship is no longer a creaking three-master, but a modern transportation machine”

By Jette Kingod

» COWI biologist Frank Stuer-Lauridsen is on the lookout for environmentally acceptable breaking up of large ships and is currently investigating whether any shipyards in the OECD countries can do the job. The preliminary results of an analysis submitted to the Danish Environmental Protection Agency in December make for discouraging reading. A few shipyards in Spain, Italy and Mexico have experience of breaking up big ships, but they all say it does not pay them to do it—costs are too high and the price they get for scrap in OECD countries is simply too low.

Comments Frank Stuer-Lauridsen: “There is agreement that an alternative to the breaking up activities carried out on the beaches of Turkey, India, Pakistan and Bangladesh needs to be found. But finding a solution to satisfy everyone is complex, particularly as it would place an obligation on, for instance, shipowners whose ships are registered in flagship states.”

The breaking up of tankers and other big ships on Asian beaches has come under scrutiny following documentation that the work goes on under appalling working conditions and with no attention

paid to the environment. Denmark’s Minister for the Environment Hans Chr. Schmidt became concerned on hearing that two Danish ships had been broken up under such conditions on a beach in Turkey. The ships lay there like beached whales, constituting a threat to both the environment and the people working with them.

Hazardous however you look at it

Denmark is a signatory to the Basle Convention, which controls the international transport of dangerous waste—not least from OECD countries to countries outside the OECD. The basic tenet is

that the producer must dispose of products containing dangerous materials and chemicals. They are not to be sent to another destination—transportation can be hazardous and wealthy countries are not allowed to export the problem to poor countries where environmental legislation is more lax.

Today a ship is no longer a creaking three-master, but a modern transportation machine packed with installations containing dangerous materials. When a ship is broken up, waste is produced which constitutes a potential danger to people and the environment. For instance, piping and boilers are insulated with asbestos, hydraulic oil

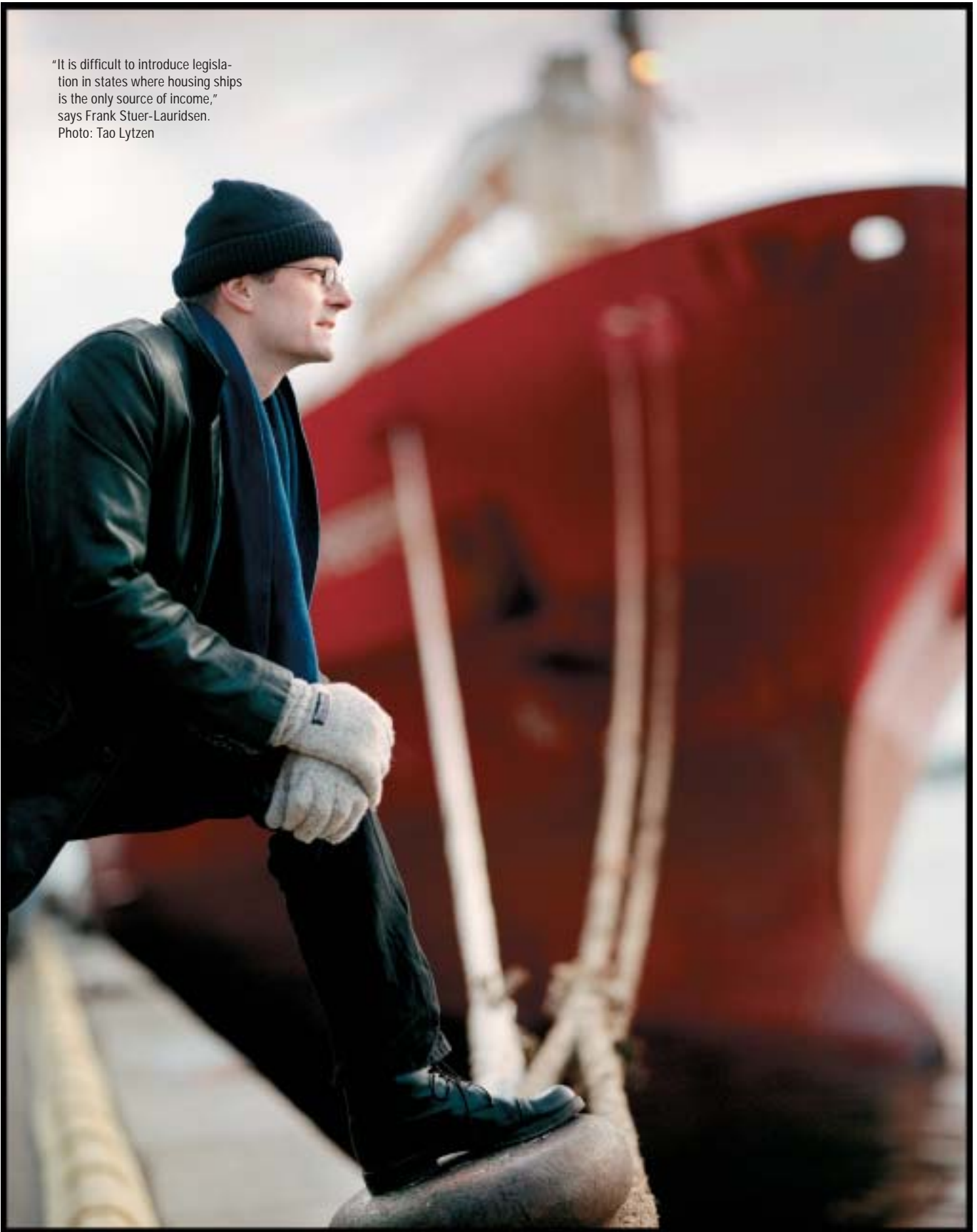
Legal blind alley

Many projects have been initiated under the Basle Convention, and the legal groundwork is currently being formulated in collaboration with the UN’s International Maritime Organisation.

Legally it is proving very complicated to find the right laws and agree how to apply them. When sailing, a ship is subject to maritime law, but if it has been decided to break up the ship it is classified as waste transport. Responsibility for law enforcement can also be a complex subject when the shipowner is from country 1, the ship is registered in country 2, the captain is from country 3, the ship is in dock in country 4 or sailing international waters between countries 5 and 6, and perhaps is to be broken up in country 7. No one is in any doubt that legislation is necessary.



"It is difficult to introduce legisla-
tion in states where housing ships
is the only source of income,"
says Frank Stuer-Lauridsen.
Photo: Tao Lytzen



» may contain PCB, thermometers and valves hold mercury, and the paint on the hull contains tributyl-tine (TBT), all of which are hazardous to man and environment. Considered in the context of a ship's life cycle, shipping is probably the most international form of transport in the world, with ships being built, owned, registered, operated, generating revenue and finally being disposed of—all at international level.

Technically possible...

The Danish Environmental Protection Agency has taken on the challenge of finding a sustainable solution, and COWI has identified shipyards in OECD countries where the breaking up of big ships can be carried out. The shipyard capacity is ascertained and checks made that the work is done in an environmentally responsible way and in an acceptable working environment. It was found to be technically possible for ships to be broken up in OECD countries in an environmentally acceptable way.

...but financially impossible

"But, sadly, being technically possible is not enough," explains Frank Stuer-Lauridsen. "10-15 years ago the OECD shipyards found they could no longer compete with the beach break-up practices going on in Asia. This, of course, is because the OECD countries have environmental and work environmental regulations in force that are actually adhered to, wages are higher, and the demand for recyclable steel is lower than in other parts of the world. Consequently, beach-based ship breaker's yards in India can offer shipowners more money for an old ship than the EU or OECD."

Environmentally acceptable


Visits to the few remaining shipbreaking yards in southern Europe show that the environmental and work environmental conditions are acceptable. Breaking up ships is hard, dirty work. But at least the southern European shipyards do it in an orderly manner.

"Considered in the context of a ship's life cycle, shipping is probably the most international form of transport in the world"

Draining of oil is done responsibly, no cables are burned so there are no dioxin emissions, employees are suitably protected and some shipyards are certified. They also have the capacity and can manage most big ships—one can accommodate ships over 300 metres.

A matter of urgency

Finding an alternative to the intolerable breaking-up practices on distant beaches is a matter of urgency. From 2016, single-hull ships will no longer be allowed to sail and must be broken up. This will double the demand for facilities to break up ships from 7 million tonnes to almost 14 million tonnes annually.

 Biologist Frank Stuer-Lauridsen, fsl@cowi.dk

Asian workers are paid pitiful wages. An investigative Danish TV programme documents working conditions for Asian beach shipbreakers. Photo: DR Arkiv



Chocolate milk heats factory

Cocio heats its new Esbjerg factory with energy from chocolate milk production

By Christina Tækker

Cocio Chocolate Milk is heating its new Esbjerg factory with energy from chocolate milk production. During bottling, the chocolate milk is heat-treated in large containers, or autoclaves—and the new factory's superheated water plant not only cuts Cocio's water bill, it also allows for utilisation of the surplus heat generated. After a year in production, Cocio has reduced its water and heat consumption costs by 40 per cent or DKK 850,000 a year.

Comments Cocio production manager Jesper Toft Mathiasen: "I expected to realise savings of about half what we have actually achieved. And at the same time the new factory is able to produce five times more chocolate milk."

Energy-saving solution

As the steam generating method used to heat the autoclaves in the old factory did



not lend itself to heat recycling, Cocio decided to modernise its work methods. A lot of hot water from production was literally going straight down the drain—while Cocio was paying for industrial water supplies and the heating to heat it up. Once the new COWI factory got the go-ahead, project manager Niels Stausholm decided to implement an energy-saving solution.

At a temperature of 170°C, the superheated water is used to heat up the industrial water in the autoclaves, which is then sprayed through nozzles onto the bottles of chocolate milk. The water and the chocolate milk are then cooled to 40-50°C, while the surplus steam is fed into an outside tank with a capacity of 100,000 litres. From here, the factory can tap into it to heat the production facilities and administrative offices, as well as selected dairy processes such as pasteurisation, sterilisation and bottle cleaning.

The project has received DKK 300,000 in aid from the Danish Energy Agency.

 Project manager Niels Stausholm,
nsj@cowi.dk



Roads must ha

Strandvejen, north of Copenhagen, runs through the forest, beside the sea and past impressive buildings. It has rhythm—even in rainy weather, say architect Michael Varming and COWI road engineer Klaus Hoffmann-Petersen. Like your favourite classical music, a road must have rhythm. It makes the road an experience for travellers and helps avoid accidents

ve rhythm



By Christina Tækker

» It is not difficult to see why motorists sit out the queues all the way up Strandvejen at weekends. Through forest and coppice, past pompous villas, sun worshippers on Bellevue Beach in the summer,



bracing fresh sea air and Arne Jacobsen's architectural wonders make it all worthwhile. The road

The rhythm of roads

The rhythm of roads is nothing new. Motorists may not think in terms of the rhythm or aesthetics of roads, but a flawed design can cause problems and even accidents. As early as 1936 the German psychologist Wilhelm Siegloch carried out a number of surveys of single-vehicle accidents on the German autobahns. He found that surprisingly many single-vehicle accidents happened at night when there was relatively little traffic. Often where there was a slight curve in the road or after a long, straight stretch of road. In 1967 architect Michael Varming followed up these results when he carried out a survey at the Danish Building Research Institute, where he interviewed motorists on the Halsskov motorway and studied police reports. He found out that most single-vehicle accidents occurred where a long, straight stretch of road was followed by a relatively sharp swing. The motorists hit the crash barrier "due to a momentary lapse in concentration", according to the reports. Not enough had been done to hold motorists' concentration and keep them awake.

traverses this lovely terrain with a good rhythm that holds the motorists' attention for long stretches. A COWI road engineer and a leading road designer, each with his own distinctive approach to future road design, readily concur.

Comments architect Michael Varming: "Those who were best at creating beautiful, coursing rhythm are the Viennese classicists—Mozart, Schubert, Haydn and Beethoven. Their symphonies often follow a pattern—a fast movement followed by a slow, then a minuet and finally another fast movement. I try to learn from the old masters and what they felt it took for people to feel a sense of rhythm. If there is too much to take in, we become confused. Too little, and we fall asleep or become drowsy. The Viennese classicists understood this well. In the same way, roads are all about holding motorists' optimal attentiveness—not least from a traffic safety point of view."

Textbook inspiration

That is not the COWI way. Which is not to say that the road engineers don't have rhythm. But as far as major road projects are concerned, COWI usually comes into the picture in the latter stages, after the corridor has been determined, sensitive areas identified and the line and layout generally agreed. The client may not always see the relevance of incurring the additional cost of an architect.

Engineers gain their inspiration from the technical textbooks and the guidelines issued by the Road Directorate on how to design nice roads. Here they learn to create a harmonious interplay between the horizontal and vertical alignment of the road and to avoid so-called tunnel vision which can occur when you drive very long, unbroken stretches of road.


"Architects are far from superfluous," says COWI road engineer Klaus Hoffmann-Petersen. "Given their education and qualifications, they take a more visual, aesthetic approach to placing a road through a landscape. There are some excellent examples of collaboration with architects that have enhanced the rhythm of new stretches of road, such as the Western bridge over Denmark's Great Belt and the projected road link between Qatar and Bahrain, where we recommended that the 40-km-long bridge and dam structure should incorporate long, gentle curves."

Roads from before Christ

In the opinion of Michael Varming, creating the ideal rhythmic road requires input from an architect, an engineer and a project manager. Michael Varming, who is currently working on the design of three alternative motorway corridors for the link to Sønderborg, Denmark, can sometimes be seen with the project manager and road engineer criss-crossing the motorway site in thick rubber boots and carrying a Cameralucida, an old instrument from 1820 which he uses to draw the landscape contours on a plate showing a CAD perspective of the road viewed from the point where he is standing. The instrument helps him plan how the road will skirt plantations, village churches and other landmarks. Michael Varming believes it is important to get the road design right from the start:

"Nothing has such a long lifetime as a road. The Via Appia dates from before Christ was born—and it is still in use today."

"Those who were best at creating beautiful, coursing rhythm are the Viennese classicists—Mozart, Schubert, Haydn and Beethoven"

 Engineer Klaus Hoffmann-Pedersen, khp@cowi.dk

 Architect Michael Varming, mvarming@mail.dk

 Read more at www.cowi.dk - News

"Nothing has such a long lifetime as a road. The Via Appia dates from before Christ was born—and it is still in use today"



Award for glass building

A small auxiliary heating plant can be beautiful. Aalborg municipality has awarded a prize for excellence in design to Aalborg District Heating Supply System's new auxiliary plant—a 10-metre high building housing the technical installations.

COWI Consulting was instrumental in the birth of the project. Explains head of department Mogens Bo Knudsen: "The auxiliary plant is encapsulated in sandblasted glass elements, giving a very attractive finish that matches the neighbouring buildings."

Explaining the award, the committee said the building's simple design adds quality to an area considered unattractive due to a major road system and incongruous constructions.

Architects: Friis & Moltke A/S, landscape architect: Willy Rossell.



Head of department Mogens Bo Knudsen, mbk@cowi.dk

Nursing home with community spirit

In 2004 the first occupants will move into a 50-unit nursing home on Sealand. Designed to avoid any suggestion of institutionalisation, it will allow residents—average age 83 years—a degree of independence while still enabling them to share a sense of community spirit. The

feeling of security this engenders will be balsam for body and soul alike.

COWI is collaborating with NCC and the firm of architects Friis & Moltke A/S on the project.



Project manager Claus Nyvang Kristensen, cnk@cowi.dk

Sulphuric acid for a fresher smell...

Now it is documented: sulphuric acid is effective against odours from stored wastewater. And complaints from neighbours are down—at least in the area around Karup potato starch factory, which took part in a pilot project with COWI.

Many potato starch factories spray their fields with wastewater from their production processes. The rules in Denmark regarding use of waste products as fertiliser have been tightened in the last decade, and from October to February it is banned outright. So during this period factories store their wastewater in lagoons—with accompanying serious odour problems.

Adding sulphuric acid to wastewater reduces its pH value—and hence limits a lot of bacterial activity. Previous COWI studies have shown that, from an environmental and energy point of view, chemical stabilisation with sulphuric acid is an attractive solution compared to other options. Last year the Danish Energy Agency took the initiative to finance a project at Karup potato starch factory in order to demonstrate and document the use of sulphuric acid to counter odours.

"The factories themselves had tried this some years ago, but they went about it

rather haphazardly," recounts senior specialist Thomas Dueholm of COWI. "This project enabled us to take precise measurements to document the impressively beneficial effect of chemical stabilisation of wastewater."



Senior specialist Thomas Dueholm, tdu@cowi.dk



We are not nerds

There is a looming fear it turns you into a numbers-and-spreadsheets nerd. Lessening the appeal of technical studies for many youngsters. But the reality is far from the stereotype. IDA, the Society of Danish Engineers, is now offering courses across Denmark that include visits to schools by real-life engineers from leading engineering companies.

"The courses help give the engineering profession down-to-earth appeal," enthuses construction engineer Søren Andersen, who teaches "COWI—we build houses" in Esbjerg.

Arranged by COWI, the course students design a house taking into account financing, legislation, construction and architectural style. The course includes a visit to a COWI construction site and culminates in an assessment of the students' projects.



Engineer Søren Andersen, snd@cowi.dk



Mapping the UK anew



Pilot Jacob Greve and navigator Allan Theill manage the photography assignment in the company's own aircraft, working at altitudes of up to 4,000 metres. In addition to the camera, the aircraft is equipped with computers, GPS receivers and control units. Photo: Morten Larsen



Kampsax navigator Allan Theill uses touch-screen technology to select flight routes and monitor the photography assignment. A computer messages the camera in the foreground when to take the picture. The camera is mounted on a gyro stabilisation frame in the bottom of the aircraft, and in front of it are the control units that compensate for speed and side wind. Photo: Morten Larsen

Small Cessna aircraft equipped with sophisticated photography equipment are to remap much of the UK. The assignment is one of the biggest to date for Kampsax Geographical Information, the leader in digital mapping



Mapping made easy

DDO Town: Denmark's Digital Orthophoto for urban areas is simple, comprehensible and user-friendly. DDO Town is supplied with a pixel size of 10 cm, enabling a hitherto unseen wealth of detail.



By Christina Tækker

» Over the next five years, Kampsax is to map much of the UK from a height of 1,500 metres using sophisticated photography equipment fitted into small Cessna aircraft.

The project came about as the result of a strategically important partnership established in autumn between Britain's Ordnance Survey (OS) and COWI's subsidiary UK company. The order, valued at about DKK 250 million, is the most important single assignment in the 40-year history of Kampsax Geographical Information—a history that includes mapping

and registering cocaine fields in Bolivia, and mapping extensive areas of El Salvador and Ireland.

"Over the years, mapping needs have changed tremendously," says Lars Flemming, cartographer with Kampsax. "From registering tracts of land, green areas and bus-stop locations to contingency planning for EU summit meetings and viewing your house from above at the estate agent's office."

Kampsax leads the field

With its own aircraft, camera equipment and full production capacity, Kampsax has exten-

sive experience in aerial photography technology and digital index maps. Today the company is market leader in digital mapping, photographing the length and breadth of Denmark and elsewhere to update its digital mapping products such as Kampsax DanmarksKort (KDK = Kampsax Map of Denmark) and Denmark's Digital Orthophoto (DDO).

National map products can be used as decision-making tools in municipal town planning or as background maps in Geographical Information Systems (GIS). In the private sector, the maps are used

Key words and phrases

Digital orthophotos—scaled aerial photos. Can be used in a great many contexts, wherever there is a need for visual depictions in detailed realism.

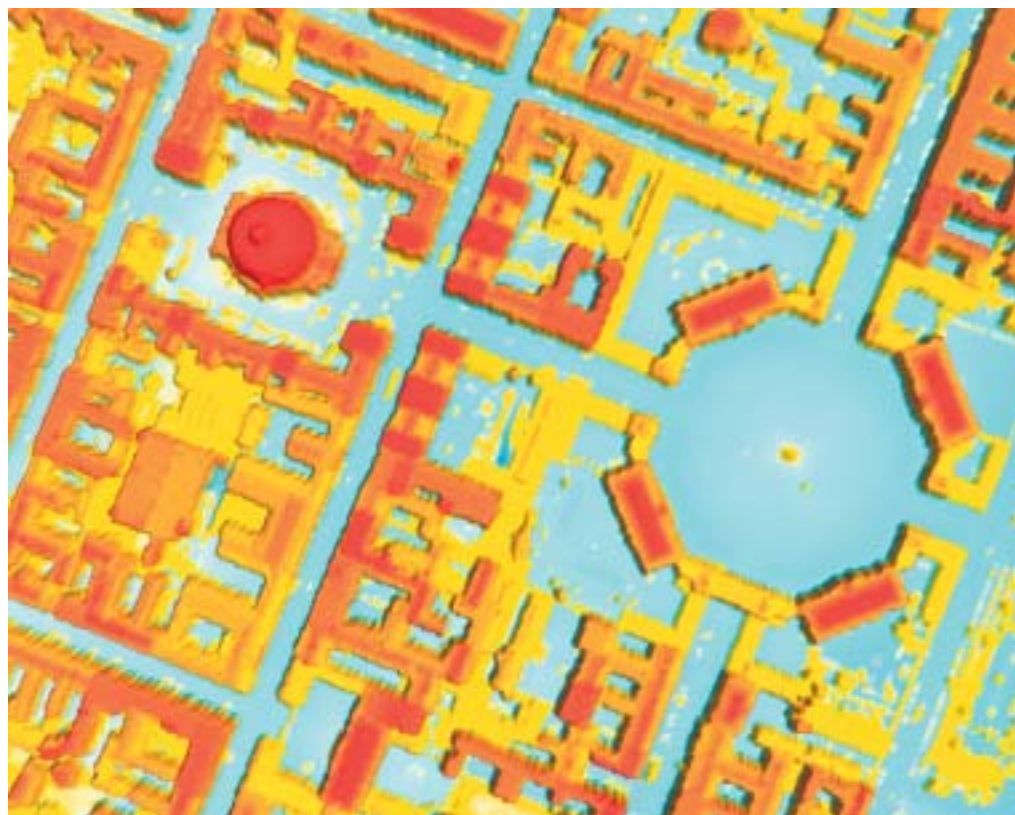
DDO—Denmark's Digital Orthophotos. Established by overflying and photographing Denmark with two sophisticated Zeiss cameras from a height of 4,000 metres. The images are scanned and transformed into a digital image mosaic.

DDH—Denmark's Digital Terrain Model. Together with DDO, DDH represents a unique form of data collation. In the summer of 2002, Kampsax completed the most recent digital mapping update of Denmark.

KDK is a standard, national cartographic product which is used as a general orientation map or as background when presenting other data. KDK can also be integrated into a company Web site.



The Digital Terrain Model (DDH) is a nationwide model which gives a 3-dimensional depiction of the contours of the landscape—hills and valleys—and shows natural and man-made changes.



to locate companies, tourist attractions, camping grounds and a host of other things.




A liking for mapping

As early as the 1960s Danish municipalities developed a liking for geographical mapping, which, at that time, was in analogue format. This liking for mapping was fed not least by the massive push to parcel out land for single-family housing. The beginning of the 1980s marked the advent of the digital age. With the coming of natural gas, there was an explosive growth in demand for technical

maps. This made it profitable for mapping companies to invest in digital mapping technology—which in turn enabled registration of water pipes, sewage systems, telephone cables, electricity etc.

“Maps have always been vital in planning and registration,” explains Lars Flemming. “Compared to early manual records, geographical mapping—digital aerial photos—is precise and extremely detailed. Aerial photos contain volumes of information and, at the same time, are very simple to understand.”

For this reason, orthophotos (scaled aerial photos) and map production based on them occupy a central position in our society. Maps are the backbone of any GIS system, and combined with relevant data they can serve as a basis for decision making and as an information tool.

-  Cartographer Lars Flemming,
lrf@cowi.dk
-  www.kampsax.dk
-  www.kortal.dk

From civil war to civil engineering



Civil engineer Ahmed Bile works closely with engineer Thomas Rudbeck and technical designer Lis Solbeck on a project in Vejle .
Photo: Niels Åge Skovbo

Ahmed Bile fled the civil war in Somalia. Today he works as an engineer in Kolding, Denmark. It is important to provide opportunities for immigrants to the country. We have a lot to give, he says

By Christina Tækker

Civil engineer Ahmed Bile glances at the architectural drawings of the building project to house luxury flats and clinics in Vejle, then briefs engineer Thomas Rudbeck and technical designer Lis Sølbeck.

Finally he has landed his dream job. But the road to success has been long and arduous. He fled the civil war in Somalia, graduated as a civil engineer in India and since 1994 has worked hard to build a new life for himself and his family in Denmark.

But despite having good qualifications, his job applications always resulted in rejections. Employment as an engineer and the closer contact to Danish society it would bring was eluding him. To improve his prospects, Ahmed Bile studied to be an IT administrator and building technician—and became familiar with Danish construction standards and environmental regulations in the process. A job training course arranged by the local job centre brought him to COWI's Kolding office—and culminated in a job offer as a civil engineer. Since September 2002 he has worked for COWI, specialising in plumbing and heating installations, dimensioning and design.

"My dreams have come true," smiles 33-year-old Ahmed Bile,

now happily settled in Kolding with his wife and four children.

"For integration to succeed, it is important to give immigrants to Denmark opportunities with Danish companies. Having a job gives you self-esteem and status; you feel that you are contributing to the national good. We immigrants don't just want to take—we also want to give, through work. The media tends to distort the true picture."

My heart will always be Somalian

Ahmed Bile was born the eldest of ten children in the capital of Somalia. His father, a former mayor and politician in the Somalian Ministry of Agriculture, often took his family along on his travels to Europe and Asia. But the civil war in Somalia forced the family to flee via Kenya to Cairo, where they owned a house. So it was that Ahmed Bile, with a university degree from Mangalore in southern India, could no longer return home where he had hoped to put his qualifications to good use.

But he did make one final visit—to be reunited with his wife-to-be who was waiting for him. Following a period as a refugee in Kenya, where he

worked for a time in construction and fishing, his wife applied for political asylum in Denmark. A year later, when Ahmed Bile successfully applied to be reunited with his family, they found themselves together again in Kolding.

Work at COWI has brought Ahmed Bile close to the Danish lifestyle and mentality. For an engineer to work independently and meet deadlines were new disciplines for Ahmed Bile, who was used to engineers and architects working closely together in bigger groups.

With his professional background and culture, he hopes to

“There are three barriers to integration into Danish society—ignorance, intolerance and language”

contribute to COWI's understanding of how best to approach engineering in Kenya and India.

Eventually he would like to be stationed or work on projects in third world countries.

"I have adapted to Danish society—not only in the workplace, but also in society. Like other Danish men, I do the laundry, cooking and shopping. But I can never forget my own culture. In my heart I will always be Somalian," says Bile, who sees his role as that of a kind of ambassador for Somalia in Denmark and Denmark's representative in Somalia.

Helping to resolve conflicts

Ahmed Bile plays an active role in the local Somalian community, the Committee for Integration and a national radio programme for Somalians, and understands the problems and barriers confronting the 13,000-14,000 Somalians in Denmark. He encourages new immigrants to enrol in school courses as a way to meet Danes. Now a well-integrated immigrant, he has the strength within himself to allow others the benefit of his experience, help resolve potential conflicts and assist Somalians integrate into Danish society.

"There are three barriers to integration into Danish society—ignorance, intolerance and language," continues Ahmed Bile. "The labour market requires that you speak perfect Danish in order to get a job. But I do not accept that an accent need be a hindrance.

"Many immigrants live off welfare. But it is not necessarily the lifestyle of choice. A lot of immigrants are well educated and qualified, and more effort should be made to help them upgrade their qualifications to meet the needs of the Danish job market. Just look around you—many companies lack qualified staff."

 Civil engineer Ahmed Bile,
rab@cowi.dk

Building with the senses in cyberspace





The building is already finished. Although it exists only in digital form. Wearing 3D glasses, the planners enter a virtual environment where they can sit down and check lighting, acoustics and colours



By Christina Tækker

» The new SAS building in Helsinki is taking shape - a joint effort between an architect in Finland, an entrepreneur in France and an engineer in Denmark. Crossing borders and cultural barriers, the project team is managing every phase of construction, including indoor acoustics, lighting and heating, site set-up and the actual construction.

But even though the building is apparently completed, you will not find it in the streets of Helsinki. It sounds like a riddle. But the answer is simple. The SAS building only exists in digital form in a multidimensional world. The project, known as Divercity, is a tool to help builders, architects, engineers and entrepreneurs visualise and coordinate all phases of the construction process.

"Divercity gives you a real feeling for the planned building—before construction even begins. Everyone works synchronously on comprehensive solutions based on optimal dimensioning of lighting, acoustics and heating—thus eliminating error," explains project manager Jens Ove Skjærbæk, COWI, Aalborg.

Sound simulation

Jens Ove Skjærbæk feels that a major advantage of the principles behind Divercity is that you work with one common model in which every detail is interconnected—and where you can foresee potential points of conflict and resolve them in a joint work effort.

A click on the mouse is all it takes to alter wall constructions or check how much noise that quiet room near the kitchen will pick up—simply by listening to the computer's three-dimensional sound simulator. The team works with light projections in much the same way. By entering a room wearing 3D glasses, team members find themselves in a virtual environment where they can sit on office chairs and determine if the light is too harsh or too soft, or the reflection from the walls is too much.

Three years with Divercity

Divercity is a three-year research and development project involving ten companies from Denmark, France, Finland, the UK and Italy. The project was completed in October 2002. Three trial runs were held and it is hoped that Divercity can be further developed under the sixth framework programme of the EU.

COWI, as sub-supplier to Aalborg University, has collaborated closely to draw up detailed program specifications, taking note of the industry's requirements regarding future work and ensuring that the program meets these requirements.

Timetable functionality gives the project team an overview of the different construction phases—and the communication functionality means the team can work together regardless of where in the world each person is. This offers numerous advantages: the team can work with specialists from around the world, the builders can follow the project's progress and solutions, and architects and engineers can work together simultaneously on the same solution, thereby avoiding having to send piles of blueprints back and forth. And the entrepreneur can plan the construction concurrently with the design phase—giving him a better idea of how to optimise the site layout.

Breaking down cultural differences

"Divercity is the result of a need for new ways of working together to meet the demands of internationalisation, greater efficiency and competition. If we are to introduce new methods of collaboration and organisation such as partnering, we need

tools that enable all participants to work together without necessarily meeting," explains Jens Ove Skjærbæk.

Trials from three test projects show that the model meets expectations. But as yet there is still insufficient bandwidth to digitally transmit virtual models of buildings. Jens Ove Skjærbæk expects the program to be on the shelves in three to four years:

"I believe that the collaboration methods available with Divercity can help break down cultural



“Where language can give rise to misunderstandings, images are universal”

barriers with the help of virtual images. Where language can give rise to misunderstandings, images are universal. For example, it will be much easier to convey your construction ideas by means of images. Not least for the customer, who of course is always in the centre.”

 Project manager Jens Ove Skjærbaek, jeo@cowi.dk

 www.e-divercity.com



Plumber in a virtual world

Special glasses with built-in prisms and a pocket-size GPS sender. An EU project is under way to make such work methods the norm for the European construction industry

By Christina Tækker

» When a plumber enters a building to install a pump, he must find his way around. But help is at hand. His special glasses have a built-in prism which functions like a mini data screen on which he can see a virtual model of how the finished building will look.

In his pocket he carries a GPS sender which, with the help of the model image on his glasses,

guides him to the cellar and the exact location where the pump is to be installed. A video film guides him through the whole installation process.

It sounds like something visionary. Yet much of the technology required is already available. Only the final push towards full utilisation is lacking. But that may soon change as the result of an EU project focusing on the European aircraft, auto and construction industries.

These industries, among the biggest in Europe, have in recent years experienced increasing demands for greater efficiency. To meet these demands, the sector will need to embrace new meth-

ods of collaboration, standards of data exchange and technological opportunities. In other words, it must be capable of juggling visualisations, simulations and virtual reality with as much familiarity as architectural drawings and rough designs.

Representatives from the three industries are now working together to identify the human barriers and technological challenges, and determine how they can motivate staff to become involved in these futuristic forms of collaboration in the coming decade.

The human barrier

"The human barrier would appear to be the biggest obstacle. The challenge is to examine how we can involve corporations and industrial organisations in future collaborative constellations and agree common standards of data construction and exchange," comments Jens Ove Skjærbæk, COWI project manager and project representative of the European construction industry.

The project, entitled Future Workspaces, will help the EU Commission initiate development projects under the sixth framework programme. Due for completion in spring 2003, the project is one of several in support of European Community development.

Greater demands

Jens Ove Skjærbæk believes those in the industry must learn to utilise each other's individual resources better. For example, a joint collaborative platform would facilitate the exchange of architectural drawings and other documentation. The industry would also be able to work with a joint construction model complete with comprehensive information about materials, prices, service life, manuals, timetables etc. Organisational forms of collaboration in the construction industry, such as partnering, will become increasingly important in realising the vision of greater efficiency and fulfilment of users' needs and wants.



The way to the future

Future Workspaces aims to bring together key players from the European aircraft, auto and construction industries to determine the individual and joint needs of these sectors.

The survey builds on interviews with key persons who, in a series of wide-ranging scenarios, discussed their particular industry's future expectations, the forms of collaboration and tools in use and the problems that can arise.

This so-called Roadmap Project forms part of the Information Society Technologies Programme (IST), which is pointing the way to the future. Eight companies and research institutions from five EU countries are taking part, including FIAT, Airbus, British Telecom and universities in England and Germany.

 Project manager Jens Ove Skjærbæk, jeo@cowi.dk

 www.avprc.ac.uk/fws/



Cleaning requires effective ventilation.
Photo: Scanpix/Nordfoto

Citrus fragrance gives bad indoor climate

Washing and cleaning materials can cause unpleasant reactions—whether you work with these materials or simply on premises where they are used

By Christina Tækker

Really clean means the smell of fresh citrus or pine needles. At least, that appears to be the prevailing opinion. But many of those nicely scented washing and cleaning materials contain ethereal oil or essence which, even in small concentrations, can cause allergic reactions or irritation to the skin, eyes and respiratory tract—whether you work with these materials or simply on premises where they are used. For years attention has been focused on the impact of these materials on the en-

vironment, but today the focus is shifting to include the impact on the indoor climate too.

Given the brief lifespan of such materials, to date it has been difficult to prove they are present and a potential health problem.

But surveys carried out by U.S. professor Charles Weschler and others are shedding new light. Weschler's latest research effort at the Technical University of Denmark was completed with support from the COWI foundation.

"Research suggests that substances formed by a reaction between the ozone and, say, limonene, which is found in lemon oil, can cause short-term allergic reactions or irritation," explain COWI consultants Sonja Hagen Mikkelsen and Anne Abildgaard. "The surveys also show that such substances form more easily in indoor environments with poor ventilation. Therefore cleaning requires effective ventilation or airing."

Fragrances unnecessary


COWI has extensive consultancy experience with washing and cleaning materials and their health impact. And with the increasing focus on our indoor climate, the company expects growing pressure to find solutions to indoor climate problems - especially in large rooms, which can be difficult to air properly.

"You tend to think that fragrances in washing and cleaning materials are natural and effective," explains Sonja Hagen Mikkelsen. "But this is not necessarily the case. Even some fragrances which occur naturally can cause health problems—and they very rarely serve any practical function in cleaning products."

For those wishing to avoid fragrances in washing and cleaning materials, not even eco-labelled products offer adequate assurances. They can also be allergenic, as eco-labelling places no demands on the fragrance content. Therefore information is essential.

Concludes Anne Abildgaard: "You can do a perfectly good cleaning job without it having to smell of lemons afterwards."

 Consultant Anne Abildgaard,
aab@cowi.dk

A close-up photograph of a person's hands holding a black bucket filled with wood chips. The person is wearing a blue jacket. The background is a blurred green field. The text is overlaid on the top left of the image.

"Biomass is widely used in heat production, as the price is only one-third of the usual alternatives: oil and gas (including taxes). For biomass to be used in electricity production it must be able to compete with cheap, imported, polluting coal which is not subject to taxation, or for that matter French nuclear power in a liberalised market. It's totally unrealistic," says Jens Dall Bentzen, MSc Eng, COWI.
Photo: Tao Lytzen

A bucket of wood chip



s suffices

The gasification plant at DTU resembles something Disney character Gyro Gearloose might have invented. But it works. COWI consultant Jens Dall Bentzen (right) and DTU lecturer Ulrik Henriksen (left) are having difficulty finding an industrial partner willing to put the plant into production. Photo: Tao Lytzen



Two kilos of wood chips an hour is enough to supply a house with heat and electricity for the whole winter. The technology already exists. But industry is hesitant to invest in environmentally friendly energy



“There is so much biofuel in the world, and so many people who want electricity”

By Christina Tækker



The gasification plant at the Technical University of Denmark (DTU) resembles something Disney character Gyro Gearloose might have invented. The plant consumes 20 kilos of wood chips an hour, which are fed into reactors where they are dried and gasified. The gas is then burned off in a gas motor to produce electricity and heat. With such a plant, it would take only two kilos of chips an hour to supply a single-family house with district heat and electricity in winter—with no pollution and no CO₂ gas emissions.

“I believe it can be big,” says Jens Dall Bentzen, COWI. “There is so much bio-fuel in the world, and so many people who want electricity. But gasification of biomass needs a technological breakthrough. With this process we can achieve it.”

The method he refers to is a two-stage process whereby gasification of biomass converts straw, wood chips or other types of biomass into a combustible gas which is then burned off in gas motors, gas turbines or fuel cells.

Lack of political backing

Ulrik Henriksen, lecturer at the Technical University of Denmark (DTU), is the man behind the two-stage process. He explains that this process differs from others in that it produces gas with low tar content yet high on thermal efficiency. But despite the obvious advantages, DTU and COWI have been unable to

find an industrial partner willing to complete development of the plant and put it into production. Because, while the process has been proven to produce power sufficient for a handful of one-family homes, for a company to consider it worthwhile the plant has to be able to run unmanned and problem-free.

“Danish companies have acquired unique know-how of bioenergy, giving them a leading position in a field which the EU prioritises very highly. The limited development seen to date is largely due to the lack of political support: the prevailing opinion is that biomass must not replace natural gas, which is widespread in Denmark. Also, writing off bioenergy electricity costs is presently a legislatively murky area. Consequently companies consider it too risky to invest in the development and commercialisation of this type of technology,” explains Jens Dall Bentzen, who has been developing and improving the two-stage process at DTU since 1995.

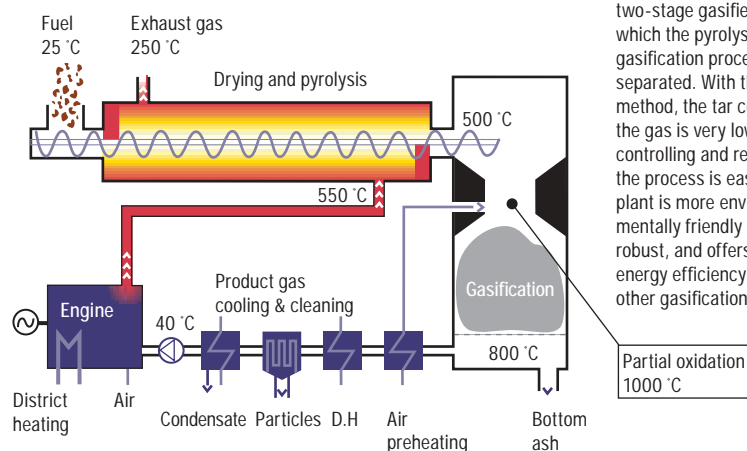
We can afford it

Jens Dall Bentzen admits that it is costlier to produce alternative energy than traditional. But this is not necessarily an obstacle. The most significant item on the electricity bill is energy taxes, and if the taxes on sustainable energy were reduced it would become competitive. In socio-economic terms this is a viable prospect, as the increased use

of biomass to produce heat and power would provide employment and export of Danish biomass technology. Not to mention the environmental benefits and supply assurances of biomass—

marked the start of his career in gasification of biomass.

Jens Dall Bentzen is so passionate about his cause that he spends his own time bringing alternative energy to the notice of



The gasification plant is a two-stage gasifier in which the pyrolysis and gasification processes are separated. With this method, the tar content of the gas is very low and controlling and regulating the process is easier. The plant is more environmentally friendly and robust, and offers greater energy efficiency than other gasification plants.

further arguments in favour of exploiting its potential.


“All things considered, we could easily afford to produce energy at slightly higher production costs than at present—particularly when taking employment, export and environmental considerations into account,” says Jens Dall Bentzen.


Letters to politicians


An interest in exploiting biomass took him travelling for two years to study Danish wind turbines in California and to see how the people of New Zealand get almost all their electricity from large hydroelectric installations. On returning home he studied sustainable energy and energy conservation at DTU, which

politicians and the media. As a board member of the Danish Biomass Association, in the autumn he wrote a letter to the Parliamentary Energy Committee proposing that the government allow environmentally beneficial bioenergy in areas with natural gas, and that a price be set for electricity produced using bio-energy-based heat and power.

“Discussions are going on in the Parliament this winter, so hopefully my letter can guide the politicians in the right direction.”

 Jens Dall Bentzen, MSc Eng, jdb@cowi.dk

 www.bgg.mek.dtu.dk

 For further reading www.cowi.dk - News

Consultant and researcher
Jens Dall Bentzen with his
four children, from left:
Mathias, Nanna, Bastian and
Karoline. Photo: Tao Lytzen



Consultant, researcher and father of four

Jens Dall Bentzen is an engineer, consultant, researcher and father of four. These very different roles form a synthesis when he combines research at the Technical University of Denmark with consultancy at COWI



By Christina Tækker

» 34-year-old engineer Jens Dall Bentzen is a busy man. As well as being an ardent advocate of Danish energy policy, for four years he has worked as a researcher and consultant. Two days a week he drives to the Institute of Mechanics, Energy & Construction at the Technical University of Denmark (DTU) in Lyngby. The rest of the week he works in the Energy Department at COWI's head office in the same town. And at home he has four children aged from one to seven years—a combination which, he smiles, succeeds very well in a home without TV.

Biomass

The term used to describe organic material, biogas, domestic waste, wood chips and straw.

His double job marks the continuation of many years' collaboration between DTU and COWI on the gasification of biomass. As the first stage in a two-stage gasification process which Jens Dall Bentzen is currently involved in, DTU and COWI together have developed a pyrolysis unit.

Explains Jens Dall Bentzen: "I joined COWI in order to work on real projects while continuing to research and develop the gasification technology. My mission was to find an industrial partner willing to complete development of the gasification technology and put it into production."

In shorts and sandals

Working at DTU keeps Jens Dall Bentzen abreast of research developments—especially in the gasification of biomass, a field in

which DTU is a leading researcher. Since 1995 he has worked on developing and improving the two-stage gasification process. He assists in trials and data collation, and takes part in research activities such as analysis of ash and examination of materials. His extensive knowledge of two-stage gasification is of great benefit to COWI.

He has also worked on improvements to the waste incineration plants, and worked in Rumania and Lithuania with biomass and energy. At present he is renovating boilers in Estonia and converting the Høng District Heating Plant in Denmark from straw to wood chip fuel.

Jens Dall Bentzen comfortably combines research and consultancy, although he finds himself working in two very different environments. COWI has

an open office layout and long, glass-enclosed walkways, while the ambience at DTU is much more informal, with iron lattices standing aslant and model solar panels spread around the grounds. The grass grows high, and in the old site-huts originally intended as temporary offices, researchers sit and think great thoughts for the future of biomass and alternative energy.

"The big difference is that at DTU I can come to work in shorts and sandals," smiles Jens Dall Bentzen, "and no one minds if I get dirty lending a hand in the workshop. It's not like that at COWI. Here you have a completely different mentality, and I have to be dressed ready to represent COWI at every opportunity."



Jens Dall Bentzen, MSc Eng,
jdb@cowi.dk



Having two places of work and four children is a combination which succeeds very well in a home without TV, says Jens Dall Bentzen, COWI.

Photo: Tao Lytzen


Follow products from cradle to grave

A new Danish LCA Centre aims to spread the use of LCA and the life-cycle mentality among Danish companies. The centre addresses the need among Danish business for help with more product-oriented environmental work, backed by relevant know-how and specific tools.

dk-Teknik, the Institute for Product Development at the Technical University and COWI will jointly run the centre. Engineer Erik Hansen, COWI, also on the centre management team, says life-cycle assessment is winning greater acceptance as the only tool that is holistic and covers all aspects of the environment.

The centre, located at dk-Teknik in Gladsaxe, near Copenhagen, offers impartial advice. Funding of DKK 9 m spread over four years has been agreed.

Life-cycle assessments follow products from the cradle to the grave in order to fully document their impact on the environment.

 Engineer Erik Hansen, eh@cowi.dk



New centre for stars on tour

David Bowie, Bob Dylan and Tom Jones have already been there. And others are sure to follow in the future. So the Danish town of Horsens is building a new, top class cultural and sports centre. Forum Horsens, which opens in the summer of 2004, will be a striking building housing a swimming pool and an

events hall big enough for major sports meetings and concerts. The hall, which has a capacity of 4,500 spectators for concerts (4,100 seated) and 3,000 for sporting events, will boast facilities on a par with The Danish Royal Theatre.

“One big challenge was to achieve the right acoustics

for optimal enjoyment of both sport and music,” explains senior project manager Lars Rosholm, COWI.

“We have achieved this with the arched roof design combined with innovative solutions for the acoustic materials on the walls and ceiling.”

COWI, which provides consultancy services in all engineering disciplines, solved the challenge in collaboration with KHR architects and Knudsen & Halling.

And yes, the first concert is already arranged. When the doors of this sporting and cultural gem open for the first time in September, popular Danish group “Sons of the Desert” will be the star billing.

 Senior project manager Lars Rosholm, lrj@cowi.dk

Solar panels and wind turbines for Namibia

A house with solar panels or a small wind turbine. The rural population of Namibia will soon have easier access to electricity. COWI is providing technical assistance for a Danida financed project to develop unearthen energy systems to enable the local population, many of whom live in desert conditions, to produce energy independently of external supplies.

“The project focuses on the use of rudimentary sun and wind based technologies.

The energy systems must be sustainable and easy to maintain,” says René Maillet from COWI, responsible for the technological side.

COWI is collaborating with the Global Training Research Centre (GTRC), an institution specialised in environmental conditions in deserts.

 Project manager René Maillet, rpm@cowi.dk



Combining the latest technology, Scandinavian functionality and a design that allows daylight to stream in to a depth of 20 metres, there is no doubt that Copenhagen now has the world's most modern metro
Photo: Polfoto

More metro in May



The first stage of Copenhagen's new metro is open. In May the next stretch from Nørreport to Frederiksberg opens, followed at the end of 2003 by the branch to Vanløse. Later the line will be extended to Copenhagen airport. And construction may not end there. A metro link under the old quarter of Copenhagen—the City Ring stage—is currently under consideration. Projected date of completion is 2012



By Jette Kingod and Christina Tækker

» When the first fare-paying passengers descended the stairs to Nørreport metro station on 21 October, COWI project director Anders Odgård felt his heart aglow.

Seemingly no one stopped to consider how much work had gone into the eight-year-long project—borings under Copenhagen, building tunnels, bridges and stations, laying tracks, developing an entirely new type of train with advanced electronic operating systems, establishing an operational organisation from scratch and training employees to serve the world's most sophisticated metro. The passengers simply boarded the train as if it had always been there. And that was the greatest tribute.

Metro construction is continuing - with no time to rest on one's laurels. Following the 11 km first stage, the first part of stage two—from Nørreport to Frederiksberg—is due to open in May, followed by the Frederiksberg-Vanløse line in December. The third stage, from Lergravsparken to Copenhagen airport, is projected to open in 2007. Tenders are currently being submitted for this

stage. And finally, the metro's fourth stage—the City Ring—is at the planning stage. If approved by Parliament, this 14 km stretch will cover parts of the City, Østerbro, Nørrebro, Frederiksberg and Vesterbro where there is no train service at present.

"The next stage to Vanløse presents us with new challenges," says Anders Odgård. "Construction work has been completed—now we are ready for integration, testing and commencement of operations. Work on the following stages will continue concurrently with stage one running smoothly and on time—something we have not tried before."

Tighter control of contracts

Since 1994 COWI has been the main consultant of Ørestad Development Corporation, which manages the overall construction and project management as well as tenders for the third stage of the project. Anders Odgård and Torben Johansen, technical director of the Ørestad Development Corporation, have worked together for a long time guiding all the involved parties, consultants and contractors through the complexity of contracts—a process which has

City Ring

The City Ring currently under consideration would considerably expand the metro network by linking the suburbs of Nørrebro, Østerbro, Vesterbro and inner Frederiksberg.

Ørestad company has been asked to assess the perspectives involved in establishing and operating a City Ring, which would give road-users in central Copenhagen an attractive alternative means of transport and ease the pressure of traffic in the streets. The assessment, to be completed in late 2003, would cover construction costs, traffic prognoses, operating costs and socio-economic benefits. A decision will then be taken on whether to go ahead with preparatory work.

The Ministry of Transport, Copenhagen and Frederiksberg municipalities and HUR, the Greater Copenhagen Authority, will carry out the preliminary study with technical assistance from Ørestad Development Corporation.

The City Ring



Source: Ørestad Development Corporation



Kongens Nytorv

A11



Copenhagen's metro is proving popular. In November over one million passengers rode on the driverless trains. Photo: Scanpix Nordfoto/ Jens Nørgaard Larsen



Late last year Copenhagen hosted a gathering of the world's leading metro builders when COWI and the other partners in the metro project arranged a two-day seminar. Discussions ranged from the stringent environmental requirements to experience with driverless trains and architectural visions.
Photo: Polfoto



Technical director Torben Johansen, Ørestad Development Corporation, and project director Anders Odgård, COWI, agree that the construction and operation of a modern metro is a highly complex project.
Photo: Stig Stasig

» not been entirely free of problems. The completion of stage one was delayed by two years.

“The difficulty with a large, complex project like this is to see the contracts through to completion where the contractors can see early on that they are going to end up with a loss,” explains Torben Johansen. “The problem with major contracts like this is that normal contract mechanisms do not work. We need to find alternative methods in the future. Normally contractors incur penalties or are fired if they do not honour their contractual obligations, but in a project like this it does not have the same effect. Another problem is that the larger consortiums do not have a corporate reputation to consider. If something goes wrong, you can simply blame the other parties in the consortium. But the stringent requirements attached to the tendering process do not allow us to exclude contractors from bidding—even those with whom we have previously had trouble.”

Adds Anders Odgård: “The difficulties we have encountered in managing the first-stage contracts have led us to adopt a different strategy for the subsequent stages. Instead of relying on a couple of major contractors, as we did for the first stage, we have divided the work—and the contracts—into smaller, more manageable packages. We also need tighter time schedule discipline. From the first stage, we have learned that there are lots of small things that can be dealt with much earlier in the process. Since construction commenced in 1994 we have adopted a traditional approach to managing this project, but in the run-up to the opening we were snapping at contractors’ heels like fox terriers.”

Metropolitan Copenhagen

Combining the latest technology, Scandinavian functionality and a design that allows daylight to stream in to a depth of 20 metres, there is no

doubt that Copenhagen has the world’s most modern metro. And with the projected new stage—the 14 km long City Ring—Copenhagen could well be on the way to achieving the status of a metropolis. The City Ring is important in terms of traffic—compared to the present, metro passenger numbers could be expected to double or even triple.

“I anticipate that the City Ring will carry its first passengers in 2012. By then, all of central Copenhagen will be within easy walking distance of a metro station—making Copenhagen a true metropolis,” concludes Torben Johansen.

 Project director for Copenhagen metro, Anders Odgård, aso@cowi.dk


 www.orestadsselskabet.dk

Hope for Lake Victoria



After an 18-month study trip, consultants can now confirm that the largest lake in Africa is in better condition than expected. However, there are many good reasons why environmental protection work should begin now





Some of the fishermen who help feed the 30 million people who live around Lake Victoria.
Photo: BAM

By Christina Tækker

The largest lake in Africa is in better condition than expected. This is the message of hope after a group of Danes worked with a team of Africans for 18 months to determine why Lake Victoria's ecosystem has changed.

The World Bank initiated the project after being informed that the water quality of the lake had been deteriorating over the last 40 years. It was feared that this would have disastrous consequences for the local fishing industry, an important source of income for the 30 million people who live around the lake. The most visible signs were the blue-green algae along the banks and a bed that was totally devoid of life in places. But although there are still patches of blue-green algae at the mouths of the rivers that flow into the lake and along the banks near the large lakeside towns of Tanzania, Kenya and Uganda, much of Lake Victoria is in good shape.

"It is somewhat surprising that the lake is in a better state than the media and people would have us believe," comments project manager Ross Warren, COWI, who completed the project in collaboration with DHI Water & Environment. "The problem was essentially lack of data - and also it was believed a sample taken from one part of the lake would indicate the condition of the whole lake. But our studies have shown this is not so, as the lake is so big and non-homogenous."

Clean water in the middle of the lake

The result of the in-depth investigation is an analysis of what causes the pollution and a series of recommendations for how to rectify the problems. One of the methods adopted was to take water samples from the lake and compare them with samples taken 40 years ago. They showed that conditions are worse than in the '60s but also that in that period of time there have been large variations in the concentrations of nutrients in the form of phosphates and nitrates. According to Ross Warren, the general increase in concentrations is man-made but the large variations are due to natural variations in the weather.

Much of the water in Lake Victoria, however, is clean. In fact, in the middle of the lake it is possible to see down to a depths of 8 metres—in Denmark that figure rarely exceeds 2 metres.

Algae along the coast

But there are problems with water quality in Lake Victoria. Over 100,000 tonnes of atmospheric nitrates annually provide excellent growth conditions for algae, although according to Ross Warren this is a global rather than a local problem. And while the levels of nitrates from industry, waste water and the surrounding area are small, Ross Warren points out that these discharges are causing the extensive algae problem in the bays and along the coast. It would therefore help to build drainage systems in the towns, collect and treat waste water, and encourage farmers to adopt different methods of cultivation.

Greatest success

Ross Warren predicts that, even if the recommendations are adopted now, the first improvements in Lake Victoria will not be evident for another 10 to 20 years. So the action plan proposed is very much a long-term endeavour that will not stop once the consultants have returned home.

A large part of the project did indeed involve training local people to systematically take water samples and hydraulic measurements from the lake and to analyse them in the laboratory. And to keep doing so. It is highly probable that the World Bank will provide continued funding for the project to the tune of DKK 2.5 billion over a 15-year period.

"It is comforting to know that the work we have kicked off will not come to an abrupt end. The local staff are more than capable of continuing on their own and are willing and eager to solve the problem through cross-border cooperation. I would almost go as far as to say that this has been the most successful part of the project," concludes Ross Warren.

 Project manager Ross Warren, row@cowi.dk

Making the grade

Social abilities are as important as professional abilities, says COWI project manager

By Christina Tækker

Diligence is a good quality. But good grades are no longer the only important factor when assessing job applicants. In the past it sufficed for COWI to view an applicant's examination certificate, but today personal qualities also rate highly. With customer contact increasingly important and competition sharp, note is taken of an applicant's ability to communicate. Similarly, active involvement in sports or other leisure pursuits involving human contact can be a plus.

"Being a superman is not enough," says Jens Christofferson, project manager, Traffic and Infrastructure Department, Århus.

"You are going to be in close proximity to your colleagues for

eight hours a day—and if necessary you must be prepared to battle on until three o'clock in the night. And communication with customers is extremely important. Previously, only very few staff had direct contact with customers, but today direct customer contact is much more broad-based."

No mediocre grades

In the autumn the Danish journal "The Engineer" phoned the ten biggest engineering companies in Denmark on this point. Group managing director Lars Krag from Carl Bro commented that good grades show only how capable you are at graduation—not what you will be like at age 35.

"Of course we take note of consistently mediocre grades, but it does not necessarily discourage us because human qualities also count for a lot," he stated.

Jens Christoffersen does not go that far: "I can understand that grades may suffer if, say, you have emigrated and have had to learn a new language parallel with your studies. In fact, I would say that extenuating circumstances are the only acceptable excuse for consistently mediocre grades. Because your grades indicate how genuine your interest is in the subject. And I do not believe you acquire that simply by ageing ten years."



Project manager Jens Christoffersen, jec@cowi.dk



"Being a superman is no longer enough. You must also have the ability to communicate with customers," says COWI project manager Jens Christoffersen.

Photo: BAM

(Visit us at www.cowi.dk)