The history of NUS turned to a new chapter in June 2000 when Professor Shih Choon Fong took over from Professor Lim Pin to become the new Vice Chancellor. There were also major changes in the management of the Faculty of Engineering and the CE Department in the same month. Professor Ng Wun Jern, a CE Department staff from the Environmental Engineering group, is the new Dean of Engineering. Professor Fwa Tien Fang, a staff in the transportation engineering area and an NUS alumnus who has been with the CE Department since 1985, was appointed the CE Department Head with effect from 1 June 2000.

CE Department is now re-structured into four divisions: the Geotechnical Engineering Division, the Hydraulic and Environmental Engineering Division, the Infrastructure Systems Engineering Division, and the Structural Engineering Division. The creation of the Infrastructure Systems Division is a major change to re-align the Department’s curriculum focus and research directions to meet the challenge of the new economy. A separate article in this issue highlights the plans associated with this new development.
The Infrastructure Systems Engineering Division (ISED) was formed recently from faculty members specializing in transportation engineering and construction management. The formation of ISED reflects the growing importance placed on well planned, designed, constructed and managed civil infrastructure, even as the world goes digital. ISED is not alone as there are similar infrastructure programmes at premier educational institutions worldwide.

Roads, bridges, rail transit systems, water and gas pipelines, sewers, airports, harbours or ports form the infrastructure of major cities. Civil engineers have always been closely associated with the process of planning, design and construction of this infrastructure. As the original infrastructure ages, its maintenance and renewal of this infrastructure is receiving increased attention. Although less glamorous than buildings, well designed and maintained infrastructure is just as important to sustain the quality of life in the built environment.

Infrastructure Systems Engineering is also IT intensive

Whilst the physical aspect of the infrastructure is the most visible, we should not forget the data about the infrastructure and the dynamic flows that take place within it. This data is crucial to planning, design and efficient operation and has one special characteristic - there is a strong element of positioning information which makes it possible to depict the spatial relationships in the data. Civil engineers are familiar with this when they use maps and plans in their daily work, and are no strangers to the survey methods used to acquire the data. However, by using the latest surveying technologies, information storage and visualization techniques, civil engineers upgrade their IT knowledge and become fully engaged in the IT revolution that is sweeping over the world.

Take the example of roads. Civil engineers are not only involved during road construction but are actively participating in the planning, operation and renewal phases. In planning, they must consider the environmental impact, the long term cost and sustainability of their design, and work with other specialists to devise traffic management schemes that enable the efficient movement of traffic and commuters. Data about subsurface conditions, land-use and travel patterns are integrated spatially in a geographic information system (GIS) to support decision making.

During operation, an array of sensors (cameras, loop detectors, vehicle tracking and satellite positioning systems), as well as sophisticated computer simulations of traffic flow are used to try to keep traffic moving smoothly and safely. Pavement management systems keep track of the state of health of each road segment in the network, recommend treatment options and coordinate and schedule remedial work to minimize the amount of disruptions. Increasingly, data from the GIS of various agencies can be accessed seamlessly, presented as interactive displays and digital maps over the Internet to enable on-the-spot access to information. The road network example highlights the fact that there is a data ('soft') aspect that is equally worthy of attention and study by civil engineers as the physical ('hard') aspect that they have traditionally been trained to do.

New opportunities for civil engineers in the use of IT for infrastructure engineering

Many opportunities, as well, are becoming available due to this 'soft' side of infrastructure development. Some of it are due to the wealth of data coming on-stream from the data-banks of public agencies involved in infrastructure development, as well as the recent availability of high-resolution images from commercial satellite data providers. This data forms the basic raw material, waiting to be turned into useful 'information products' by people with the right combination of professional training, knowledge of ground conditions and IT skills. For example, high resolution imagery, combined with the use of the satellite global positioning system to locate objects on the earth's surface, are set to revolutionize the way engineers think about surveying, mapping and tracking. Advances in software development have also enabled more sophisticated mapping and data visualization applications to be developed by and for engineers in a wide variety of engineering applications.

The 'systems' in ISED's name is to emphasize the importance of not forgetting the 'big picture' even whilst working on the details. As an illustration, where previously, engineers concerned themselves largely with the details of their own projects, they must now see their project in relation to the physical environment to consider the impact during the construction and operational phases as well. More stringent environmental requirements pose a challenge to project designers but create new opportunities as well for research, enterprise and innovation. Specialized training in risk assessment, project evaluation and delivery,
system optimization and balancing conflicting demands will be useful to address the challenges and take up the opportunities.

All of us should be IT aware to some degree but adding a data and systems aspect to civil infrastructure offers a wonderful opportunity for civil engineers to acquire specialist IT skills and knowledge beyond that of the average IT user. These skills will enable civil engineers to remain relevant and fully engaged in today's knowledge economy even as they fulfill their traditional role as designers and builders of vital civil infrastructure.

Activities of the new Division

Some of the activities that ISED will undertake include:

- Developing new courses, both at graduate and undergraduate levels;
- Holding professional activities / skills development programme for working professionals who are keen to acquire new skills;
- Developing computer laboratory resources, and
- Promoting multidisciplinary research to involve expertise from non-traditional civil engineering disciplines.

These activities will focus on a few key areas like Intelligent Transport Systems (ITS), the use of spatial technologies like geographic information systems (GIS), geographic positioning systems (GPS) and remote sensing, and operations research and artificial intelligence techniques for infrastructure systems engineering.

New GeoInformatics laboratory

A geoInformatics laboratory was created to complement the work in the ITS/ Highway and Traffic laboratories. It will focus on the development and application of spatial technology like GIS, GPS and remote sensing. The laboratory will also be a resource for students interested in learning the use of software for image processing, feature recognition, mapping and 3D visualization.

Conclusion

ISED reflects the changing nature of civil infrastructure in an increasingly digital world. The data and systems aspect of civil infrastructure is becoming as important as the physical infrastructure itself. Civil engineers can seize this opportunity to participate meaningfully in the knowledge economy by acquiring the specialist IT skills needed to address the data and systems aspect of civil infrastructure. The activities being organized by ISED to help civil engineers achieve this will be different in emphasis from that of infrastructure divisions in civil engineering departments at other Universities. The activities will:

- have a strong emphasis on a multidisciplinary approach to infrastructure systems engineering, and
- make extensive use of spatial technologies, as well as AI/OR techniques in problem solving.

We believe such an approach will benefit civil engineers who need to work as partners in global, multidisciplinary teams, to innovate, develop and sustain infrastructure systems in the digital information age.

Short Course on Beams with Openings

One-day high-level short course on Analysis and Design of Concrete Beams with Openings was conducted by Assoc Profs M. A. Mansur and Tan Kiang Hwee of the Department through Professional Activities Centre of the Faculty of Engineering on 12 April 2000. The course provided the state-of-the-art information on the benefits and problems of providing openings through beams. The behaviour of such beams under bending, shear and torsion was described. Analysis and design methods based on plastic hinge mechanism, plasticity truss and strut-and-tie models, and skew-bending theory were discussed and illustrated with numerical examples. Suitable guidelines for the detailing of such beams were also presented. The course attracted nineteen participants from various statutory boards, consulting and construction firms, and tertiary institutions. A copy of the book entitled "Concrete Beams with Openings: Analysis and Design" jointly written by the course conductors and published by CRC Press LLC, USA was given out as part of the course material.

Contact Person: Assoc Prof M A Mansur
E-mail: cvemansu@nus.edu.sg; Tel: 8742284
Under the NUS-JSPS (Japan Society for the Promotion of Science) Programme, Assoc Prof C M Wang spent three weeks in March 2000 working with Professor E. Watanabe of the Structural Engineering Laboratory, Kyoto University on the dynamic analysis of very large floating structures.

These very large floating structures are very important for island nations with limited land resources, such as Singapore and Japan. They can be classified under two broad categories, namely the pontoon type and the semi-submerged type. The former type is a simple box structure and features high stability, low manufacturing cost and easy maintenance and repair. Examples of such pontoon-type floating structures are the Mega Float in the Tokyo Bay, the Heliport in Vancouver and the Floating Island of the Hiroshima Prefecture for amusement facility. However, this pontoon-type of floating structure is suitable for use in calm water. In rough seas, it is necessary to use the semi-submerged type to minimize the effects of waves while maintaining a constant buoyant force. Many off-shore structures such as oil drilling rigs and the Okinawa Marine Exposition’s Aquapolis are of this type. Floating structures in the form of bridges are also seen in recent times. For example, the Bergsøyssund Bridge in Norway and the Yumeshima-Maishima Floating Bridge in Osaka, Japan.

In addition to using the sea/ocean space, floating structures have the following features.

- They are not affected significantly by water depth and nature of the sea bottom. In fact, when the depth of the water is great, floating structures are very cost-effective when compared to other construction methods such as land reclamation.
- They have shorter construction periods as their structural parts may be fabricated at different plants and moved to the site location for assembly.
- They are little affected by earthquakes.
- They may be easily removed or expanded.
- Their positions with respect to the water surface are constant and thus facilitate small boats and ship to come alongside when used as piers.
- They have little impact on the marine environment since they do not cause any disturbance to the sea bed and they do not change the tidal currents.

The NUS-Kyoto University research collaboration involves the development of a plate model for very large pontoon-type floating structures, and the numerical method for determining accurately the vibration frequencies, modal functions and the stress resultants of arbitrary shaped floating structures.

Contact person: Assoc Prof Wang Chien Ming
E-mail: cvewcm@nus.edu.sg; Tel: 8742157

4

One-Day Seminar on Structural Concrete: Advances and Innovations in Design, Products and Systems

This One-Day Seminar on Structural Concrete continues the on-going series of high profile activities of relevance to the construction industry in Singapore organized by the Structural Concrete Research (SCoRe) Group, Centre for Construction Materials and Technology, NUS together with the Singapore Concrete Institute. The objective was to bring together practitioners in Singapore and visiting and NUS academics to focus on recent advances and innovations in design, products and systems in structural concrete both in Singapore and overseas. The seminar held on 23 May 2000 at NUS was attended by more than fifty participants.

Professor A E Naaman from the University of Michigan, Ann Arbor, USA gave an overview of FRP (fibre reinforced polymer) reinforcements in concrete structures. He touched on design issues, potential solutions and realistic applicability in his address. Assoc Prof K H Tan’s paper highlighted innovative structural strengthening techniques using external tendons including recommendations and FRP applications. Er Tan See Chee from TY Lin (SEA) Pte. Ltd. spoke on precast segmental bridges in Singapore and continuous framed bridge design. His talk touched on the new Telok Blangah Expressway Bridge, complete with animation. Assoc Prof M A Mansur dwelt on welded wire fabric as reinforcement for structural concrete, dealing with benefits, design issues and ideas for improvement. Dr M Maalej provided the audience with details about the innovative methods of structural monitoring used on two bridges in Canada. All present found the seminar to be very professionally enriching. The seminar ended with a lively question and answer panel session.
1000 Tonne High Capacity Actuator for Large Scale Tests

A high capacity test rig has been designed and fully commissioned in the Structural Engineering Laboratory of the Department in Feb 2000. This 10,000 kN capacity test rig is believed to be the first one of its kind in South East Asia. The self-straining rig has a computer-controlled actuator that facilitates data capture for the entire load-response history of the specimen. The rig has been designed to accommodate test specimens with different sizes and configurations. The four columns with pin holes at various heights and a strong base support provide a considerable flexibility in testing environment. The rig enables prototype full size testing of major structural elements and sub-assemblies and adds to the wide range of R&D facilities available in the Department.

ACI Concrete Lecture 2000

The Centre for Construction Materials and Technology of the Department and the American Concrete Institute - Singapore Chapter jointly invited Professor Antoine E Naaman, a world authority on Cementitious Composites, to deliver the ACI Concrete Lecture 2000 on 19 May. Dr Naaman is a Professor of Civil Engineering in the Department of Civil and Environmental Engineering at the University of Michigan, Ann Arbor, USA. He is currently the external examiner for our MSc (Civil Engineering) Programme.

Professor Naaman continues this prestigious Concrete Lecture series, launched in 1987, with his address entitled Ferrocement and Advanced Laminated and Hybrid Cementitious Composites. Past eminent speakers include Adam M Neville, V M Malhotra, Robert B Phillee, John M Hansson, V Ramakrishnan, B Vijaya Rangan, Surendra P Shah, and P Kumar Mehta.

Professor Naaman defined Hybrid Composites as composites reinforced with a combination of continuous meshes and discontinuous fibres. In these composites, at least two layers of mesh are placed one each near the outer surface of the composite, and intermediate layers of mesh are replaced by discontinuous fibres. The fibres may be premixed with the mortar matrix or used in a mat structure. After a brief introduction dealing with the need for, advantages, and cost trade-off of fibre reinforced polymer (FRP) meshes, the talk went on to focus on the results of an investigation on the flexural response of hybrid cementitious composite laminates. These were reinforced with meshes made from high performance FRP reinforcements, namely Kevlar, Aramid, Spectra, and Carbon. Results with steel wire meshes, and other meshes made with lower modulus fibres such as PVA and nylon were also described for comparison. The discontinuous fibres used were primarily PVA, Carbon, and Spectra fibres premixed with the mortar matrix. The performance was evaluated in terms of failure modes, cracking pattern, modulus of rupture, toughness index, and the production process (manual fabrication versus extrusion). A more exotic production method based on self-stressing using shape memory alloys was also presented to titillate the audience with what the future holds. The lecture, which was attended by eighty participants, ended with a lively question and answer session followed by dinner.
Staff Activities

Assoc Prof Choo Yoo Sang has been invited by the Maritime and Port Authority of Singapore to lead the Singapore Expert Group on Maritime Research & Development to review technological competencies and common R&D requirements in Singapore and Norway.

Assoc Prof C G Koh has been nominated to serve in the Dynamics Committee of the Journal of Engineering Mechanics, ASCE.

Assoc Prof C G Koh delivered an invited lecture entitled "Parameter Identification of Structural Dynamic Systems - Classical versus Non-Classical Methods" at the International Conference on Advanced Problems in Vibration Theory and Application held at Xi'an, China (June 19-22, 2000).

Assoc Prof David Ho Wai Sum has been invited as a Board Director of the Singapore Chapter of the American Concrete Institute and as a member of the Editorial Board for an International Journal, Cement and Concrete Research, published by Pergamon/Elsevier Science.

Dr Lee Der Hong has been nominated and elected as a member of the Committee on Transportation Network Modeling (ACTC05), Transportation Research Board, National Research Council, The National Academics USA.

Assoc Prof Leung Chun Fai has been invited to serve as the Secretary of the International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE)'s Technical Committee TC2 on Centrifuge and Physical Model Testing.

Assoc Prof Gary K C Ong was elected First Vice President of the Singapore Concrete Institute for a two-year term at its AGM on 29 April 2000.

Professor N E Shanmugam has been invited to chair the International Scientific Committee for the Third International Conference on Thin-Walled Structures, organized by Technical University of Lodz, Poland during the period 5-7 June 2001.

Professor N E Shanmugam has been invited as a member of the International Advisory Committee of the First International Conference on Steel and Concrete Composite Structures, Los Angeles, USA, 22-24 March 2000.

Professor Yong Kwet Yew has been re-appointed Council Member, Ngee Ann Polytechnic Board of Governors, for another 3 years from April 2000 to March 2003.

Professor Yong Kwet Yew has been appointed as Chairman, Board of Appeal on Debarment of Contractors with Bad Safety Records, Ministry of Manpower, from April 2000 to March 2001.


Wang, C M, K K Ang, and A Ajit, "Shape control of laminated cantilevered beams with piezoelectric actuators," J. of Intelligent Materials Systems and Structures, 10(2), 164-175.

Appointments

Professor Cheong Hin Fatt, Dean, School of Design & Enviroment, 1 June 2000 to 31 May 2003.

Professor Ng Wun Jern, Dean, Faculty of Engineering, with effect from 1 June 2000 to 31 May 2003.

Professor Chow Yean Khow, Vice-Dean (Graduate Studies), 1 June 2000.

Professor Fwa Tien Fang, Head, Department of Civil Engineering, 1 June 2000.
New Appointments

Dr Ganesh Dasari, Assistant Professor, 10 April 2000
Miss Lee Lai Yoke, Professional Officer, 10 April 2000
Miss Koh June Kim, Management Support Officer, 19 June 2000
Miss Tan Fea Mein, Laboratory Technologist, 6 June 2000
Mr Tan Seck Wei, Laboratory Technologist, 29 May 2000
Miss Ng Poh Leng, Laboratory Technologist, 11 May 2000
Mr Zhang Xiaoping, Laboratory Technologist, 1 April 2000
Miss Feng Yao Yu, Laboratory Technician, 27 March 2000
Mr Sng Yong Sin, Research Engineer, 15 March 2000
Mr Chai Khye Yeien - Design & Testing of Steel Concrete Structures
Mr Chai Jurn Wei - Study on Applicability on Lean Construction Principles
Mr Jin Jing - Computational Structural Mechanics & Dynamics
Mr Ng Kim Huay - Development of Higher-order Plate Theories
Mr Qian Xudong - Damage Assessment of Concrete Structures
Mr Seah Yew Teck - Geosynthetics Subjects to Blasting
Ms Sophia Andriany - Membrane Bioreactor
Mr Tan Teck Wee - Modelling of Water Reclamation Systems
Ms Teh Mei Ling - Hydraulic Effects of Soft Soils
Mr Van Thawng Lian - Structural Steel Construction
Mr Wang Yachang - Dynamics of Floating Plated Structures
Mr Zhang Shu Qiang - Study on Applicability on Lean Construction Principles

Research Scholars

Mr Chai Khye Yeien - Design & Testing of Steel Concrete Structures
Ms Chen Qian - Study on Applicability on Lean Construction Principles
Mr Jin Jing - Computational Structural Mechanics & Dynamics
Mr Koh Soo Jin, Adrian - Structural Dynamics
Mr Doan Chi Dung - Application of Evolutionary Computation in Water Resources
Mr Ma Zhou - Overstrength and Ductility of Earthquake Resistance Structures
Mr Ng Kim Huay - Development of Higher-order Plate Theories
Mr Qian Xudong - Damage Assessment of Concrete Structures
Mr Seah Yew Teck - Geosynthetics Subjects to Blasting
Ms Sophia Andriany - Membrane Bioreactor
Mr Tan Teck Wee - Modelling of Water Reclamation Systems
Ms Teh Mei Ling - Electrical Effects of Soft Soils
Mr Van Thawng Lian - Structural Steel Construction
Mr Wang Yachang - Dynamics of Floating Plated Structures
Mr Zhang Shu Qiang - Study on Applicability on Lean Construction Principles

Seminars held. April - June 2000

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<td>Professor T S Nagaraj AICTE-Emeritus Fellow, Dept of Civil Engineering,</td>
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<td>Dr Tan Kee Wee Building &amp; Construction Authority</td>
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<td>Information Technology in Precast</td>
<td>Dr Chen Weng Tat Assoc Prof, Dept of Civil Engineering, NUS</td>
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<td>Dr William E Hawkins Professor &amp; Chairman, Department of Coastal Sciences,</td>
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New Faculty
Dr Ganesh Dasari
Dr Ganesh Dasari has joined our Department as an Assistant Professor in April 2000. Dr Dasari obtained his BE in Civil Engineering from Andhra University, India in 1988 and MTech in Geotechnical Engineering from IIT, Kharagpur, India. He obtained his PhD degree in Geotechnical Engineering from Cambridge University, UK in April 1996. His present research interests include laboratory testing and constitutive modelling of geo-materials, characterisation of soils, prediction of ground movements due to tunnelling and diaphragm walls.

### Conference/Workshop

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To receive a complimentary copy of the Civil Engineering Newsletter, please contact:

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Editorial Committee Assoc Prof M A Mansur, Chairman. Assoc Prof V Thevendran, Member