Ships and Offshore Structures

Hall of Fame

A Pioneer of Maritime Safety

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Preface

Professor Dracos Vassalos FREng is Professor of Maritime Safety in the Department of Naval Architecture, Ocean and Marine Engineering at the University of Strathclyde in Glasgow, UK, where he obtained qualifications at PhD and DSc levels and where he served as Lecturer, Senior Lecturer and for 25 years as Full Professor in a career that spans 40 years. He was instrumental in merging the two Naval Architecture Departments from Glasgow and Strathclyde Universities in 2001, bringing together a unique heritage and a combined history in Naval Architecture of 2.5 centuries.

Professor Vassalos served as the first Head of Department for 8 years, building the foundations for NAOME to become one of the largest and most research active marine Departments worldwide. In research, he has laid the foundations and paved the way for complete modernisation of maritime safety, the full impact of which is still being delivered. In instigating a new design paradigm, treating safety as a design objective (Design for Safety), he catalysed the development of goal-based (performance-based) legislation in the maritime industry, promulgating the utilisation of first-principles-safety-performance assessment tools to foster cost-effective safety improvement or safety enhancement through innovation, a motto he has adopted from the outset.

To embed and disseminate the requisite understanding and knowledge to achieve this, Professor Vassalos spearheaded a sustained research campaign worldwide to raise awareness and to generate requisite knowledge to achieve a transformational change in the way maritime safety is conceptualised, formulated and implemented. The ensuing formalised design methodology (Risk-Based Design) is paving the way to step changes in ship design and operation, targeting zero tolerance in human life loss and environmental impact. This, in turn, motivated and facilitated the introduction of risk-based approaches at the International Maritime Organisation and alignment towards a risk-based future and Goal-Based Standards, a break change in maritime legislation.

Professor Vassalos FREng is the founder of the first Centre of Excellence on Maritime Safety Research in a University environment (Ship Stability Research Centre: 1996 to 2016), aimed at nurturing active international collaboration and fostering scientific approaches in maritime safety. To help disseminate my ideas and to facilitate better understanding, he supervised 75 PhD students, published over 500 technical publications and books, founded and organised Safety Conferences and Workshops and travelled and lectured worldwide as invited speaker. He also set up a design consultancy company in 1999, Safety at Sea Ltd, which merged in 2011 into a bigger Group, to facilitate and implement innovative safety solutions to passenger ships, the most-safety minded and technologically adept sector in maritime industries. Having served as Chairman of the Group for 3 years in a part-time capacity, I returned to academia in 2014. In 2016, he established a new Maritime Safety Research Centre with significant funding (initially) from Royal Caribbean Cruises Ltd, DNV GL Classification Society and (later) Meyerwerft Shipyard in Germany, promoting and facilitating synergies in maritime safety between industry and academia with the view to accelerating knowledge transfer and maximising impact. This has proved to be a significant initiative in catalysing industry-academia collaboration and an exemplar that is likely to enthuse further similar developments and breakthroughs.

For life-long contributions to maritime safety, he received the Lloyds List Technical Achievement Award for safety at sea in 2010, a Life Achievement Award from the Royal Academy of Engineering in 2011, the Froude Medal from the Royal Institution of Naval Architects in 2012, the David Taylor Medal from the Society of Naval Architects and Marine Engineers in the USA in 2015 and a Doctor of Science degree from the University of Strathclyde in 2016. In 2019, he was elected Fellow of the Royal Academy of Engineering in the UK.

Humble Beginnings

Professor Vassalos FREng was born in a little village in Crete in 1951, a place and a period during which the best educated person in the village had attended a few years primary school. Hence, going to high school was a novelty in his family and he had to move to a state-supported boarding school in the city for this, away from anyone, at the tender age of 12.

Most people born in an island in Greece are fascinated early in their lives by the sea and consider sea-going occupation as a naturally good development. As University education at the time was far removed from my dreams, he ended up pursuing a 2-year cadet training course for the Greek merchant navy, having received a State scholarship, in Hydra, a beautiful island in Greece. He completed the course, graduating first in the country and receiving a sextant and an omega watch as awards from the Greek minister, which he keeps to this day.

A few months at sea as a third navigation officer with a company called Alpha Express Lines, travelling from Brazil and the Caribbean islands to East Coast of Canada for two years, was enough to persuade me that choosing this trade was not a wise choice. As he had plenty of time to dream and plan whilst sailing, he raised his game and targeted University education in a profession still linked to the sea, namely Naval Architecture, at Southampton after gaining my 3rd Navigation Officer Certificate in 1973. He met his future wife there and they married in 1975 with a son coming in 1976 before they moved to Strathclyde University in Scotland to pursue a PhD. His second child, a daughter, came soon after completing my PhD in 1981. For the latter, he had received a scholarship to study safety of fishing vessels, a subject being targeted and funded by the UK Government, following the loss of the fishing trawlers Trident and Gaul in quick succession.

Discovering and Transforming Damage Stability and Survivability of Ships [1]-[35]

Professor Vassalos FREng started his research career at Strathclyde as part of a UK-wide team funded by the Department of Transport to study stability of fishing vessels. Appreciation of the staggering losses in human life in this industry sowed the first safety seeds in my young heart. In fact, it was his involvement with observing and measuring fishing vessels motion for over a year in the North Sea that made him acutely aware of the vulnerability of these ships.

Combining this with his experience of the treachery of the sea all those months battling the ferocity of storms with a small general cargo ship going up cape Hatteras in the USA, in his previous life as a 3rd Navigation Officer, helped bestow safety as his life vocation.

Having completed his PhD studies, he was offered a lectureship post in Naval Architecture at Strathclyde University, which he took in 1980, this time joining the team investigating the loss of the Ocean Ranger semisubmersible accident, off Newfoundland. The listing and capsize of the rig was due to malfunctioning of the ballast system, following boarding of extreme waves, with all 84 members of the crew dying.

His involvement with the investigation helped strengthen his sense of purpose with a strong desire to make a difference. At the time, he devised a rough and ready flooding mechanism, which provided the means for modelling progressive flooding and helped explain the loss of the rig. This necessitated considering the environment and time-evolution of flooding, hence dynamic damage stability, a real novelty in a subject that was at the time fundamentally unscientific. This development provided fertile ground for his contribution to modelling the Herald of Free Enterprise disaster in 1987, an accident involving 193 dead. This provided the motivation for the UK Government to fund his research Group for serious research work that helped advance considerably understanding and tools on damage stability and survivability of Ro-Ro passenger vessels and his advancement to senior lecturer in 1989.

With this, the foundation for real change was in place by the time the Estonia disaster happened in September 1994 with a loss of 853 lives, the biggest modern disaster in the western world since Titanic. A Joint North West European Project was set up, focusing on understanding rapid capsizing of RoPax and developing improved survivability standards. In this project, he formulated the first performance-based assessment of ship survivability, using first-principles tools, representing a landmark contribution in the history of damage stability legislation. This research led to the establishment of a European standard known as the 'Stockholm Agreement', the precursor of performance-based criteria for safety that led to the development of risk-based approaches and goal-based standards implemented in SOLAS 2009 and to his advancement to Professor of Maritime Safety in 1996.

It has also brought to surface huge gaps in knowledge and understanding on how ships and people behave in compromised conditions in the marine environment and, hence, the need for sustained technological development. He kept thinking that there had to be a more systematic way of approaching maritime safety, a way that safety will be the driver in ship design and operation.

It took a great deal of effort to generate momentum and critical mass to help conceptualise, develop and introduce a new design paradigm to reflect this. He called this initiative Design for Safety, influenced by the Design for X philosophy being promulgated at the time. This was not a one-man job! The need for large-scale resource and a systematic approach to addressing damage stability and safety post accidents provided the inspiration and the motivation to establish in 1996 the Ship Stability Research Centre (SSRC) as a first step in this direction. This was a good decision! Notably, SSRC grew up to 70-strong researchers from around the world and kept going for 20 years, providing focus for active international collaboration on maritime safety research, thus nurturing the development of critical mass in the subject. Since its inception, SSRC has instigated/participated/coordinated some 60 large-scale research projects, supporting over the period the development of major legislation on maritime safety, which in turn, fueled unprecedented innovation in the maritime industry.

In 1999, whilst being Head of Department at Strathclyde and Director of SSRC, it was considered appropriate, given these circumstances, to set up a University spin-out to help the industry design and implement credible ship stability enhancement solutions (upgrades), involving direct stability assessment combined with model testing in a sea basin. This was incredibly ahead of its time, considering that repeating this in a similar context is not in the brains of the regulators even today. In principle, Safety at Sea Ltd grew into another Centre of excellence for Innovative safety solutions in the maritime industry. Safety at Sea Ltd has eventually merged with a maritime accident litigation group, where he served as Chairman for 3 years (2011 to 2014) and later with a P&I club and is very active to this day.

Design for Safety, Risk-Based Design, Life-Cycle Risk Management [36]-[65]

Professor Vassalos FREng introduced the Design for Safety philosophy and the ensuing formalised methodology, Risk-Based Design (RBD), in the maritime industry as a design paradigm to help bestow safety as a design objective and a life-cycle imperative. This was meant to ensure that rendering safety a measurable (performance-based) design objective, through using first-principles tools, would incentivise industry to seek cost-effective safety solutions, in response to rising societal expectations. It turned out that removing regulations-imposed (largely-conservative) constraints and the adoption of a performance-based approach has had much more profound effects than originally anticipated, the full impact of which is yet to be delivered.

The kernel of this design philosophy is the measurement and verification of safety itself and the implications that this entails with regards to traditional approaches and the requisite new safety system. This is particularly true for knowledge-intensive and safety-critical ships, such as the giants of the cruise ship industry being built today, where the need for innovation creates unprecedented safety challenges that cannot be sustained by prescriptive-regulation-based safety. The reason for this is simple: traditional approaches to safety (regulation-based) are experiential and with change happening faster than experience is gained, the safety system is unsustainable.

This fact helps explain the need for changing the way safety is treated in the maritime sector, which in turn, forced the realisation that the maritime industry is a risk industry, thus necessitating the adoption of risk-based approaches to maritime safety. This is paving the way for drastic evolutionary changes in ship design and operation. Responding to these developments, he instigated and established in 1997 the first large-scale (€150M) EU Thematic Network in maritime research to promote this new design philosophy with the view to integrating safety cost-effectively within the design process in a way that safety drives ship design and operation. This, in turn, led to the development and implementation of Risk-Based Design (RBD) in the maritime industry as the formal design methodology treating safety as a design objective rather than a constraint. The biggest impact has been at the International Maritime Organization (IMO) regulation-making process and by IMO, leading to Safety Level, Alternative Design and Arrangements, Goal-Based Standards, to name but a few unprecedented legislative instruments, instigating safety changes at conceptual, systemic and implementation levels. The adoption of these is reshaping safety, marking the beginning of contemporary safety and catalysing changes at the fabric of the maritime profession.

Design for Safety → Risk-Based Design

Defining safety as the state of acceptable risk, the duality safety and risk becomes easier to grasp and this facilitates understanding of all the ensuing concepts. In this respect, Design for Safety refers to a design paradigm introducing safety in design as another objective, as explained above. This requires explicit consideration and quantification of safety, which is equivalent to evaluating risk during the design process; hence the term Risk-Based Design.

Discussions at IMO over Goal-Based Standards have given rise to another term Safety Level, a wrong choice of terminology (in that an artefact is either safe or it is not) but it was meant to designate through-life risk associated with a particular ship concept and, as such, it is becoming the focus to attaining safety cost-effectively. What this entails, however, is being able to quantify the life-cycle risk of a vessel by considering all passive (design) and active (operational) safety measures and do so during the concept design stage under tight cost and time constraints. Application of RBD is biased towards design concepts with high levels of innovation; hence the need to use knowledge in all its forms to assess risk. The essential advance attributable to RBD is the holistic, explicit, rational and cost-effective treatment of safety, achieved on the basis of the following principles:

- A consistent measure of safety must be employed (risk) and a formalised (generic) procedure adopted to measure safety consistently (risk analysis / risk assessment / risk management), following what has become typical safety assessment process.
- Flexibility to allow trade-offs between Performance, Earnings, Risk (Safety) and **C**osts, hence focus on life-cycle issues. This necessitates the use of KPIs (Key Performance Indicators and development of KIMs (Knowledge Intensive Models).
- Integration of such procedure in the design process (integrated design environment) with focus on holistic optimisation.

The aforementioned RBD principles are reflected in the following high-level definition: *RBD is a formalised methodology that integrates systematically risk assessment in the design process with prevention/reduction of risk embedded as a design objective, alongside conventional design objectives*.

Put differently, safety rules are being replaced by safety objectives, giving rise to additional functional requirements and design criteria and to the need for first-principles tools for verification of safety performance, in the absence of experiential knowledge. Key to understanding RBD is the integration of risk assessment in the design process and decision-making towards achieving the overall design goals but also as part of a parallel (concurrent) iteration within the safety assessment procedure to meet safety-related goals/objectives.

In relation to design decision-making, in the same way of using explicit ship performance evaluation criteria (design criteria) and economic targets (owner’s requirements), there is a need to define safety performance evaluation criteria and risk acceptance criteria. The latter could be related to safety performance criteria, so that safety performance could be used in the design iterations, alongside or even instead of explicit risk acceptance criteria. As a result, key design aspects of the initial baseline designs can be optimised from the point of view of ship performance, cost implications and potential earnings whilst ensuring that the safety level (as quantified) is appropriate and commensurate with tolerable risk levels. Another key aspect to RBD is that any ship design decision will be well-informed and will lead to design concepts that are technically sound, fit for purpose, and last but not least, with a known level of safety that is more likely (than by following rules) to meet modern safety expectations.

<u>Life-Cycle Risk Management</u>

Professor Vassalos FREng has gone a full circle before experiencing first-hand Plato’s philosophy on the circle of Knowledge, namely: knowledge enhancement leads to better appreciation of ignorance, in this case of the simple fact that risk management is a life-cycle process. As such, risk must be monitored and reviewed to ensure changes in design and operation are reflected in the way risk is managed. However, a generic framework for addressing life-cycle risk systematically in the maritime industry is lacking, thus leading to haphazard and ineffective approaches to managing risk. Such framework should enable addressing risk formally during design (risk reduction), in operation (managing residual risk) and ultimately in emergencies (crisis management), ensuring tolerable risk level throughout the life cycle.

Notably, in the quest for safety improvement, design (passive) measures have traditionally been the only means to achieve it in a measurable/auditable way. There are two reasons for this. The first relates to the traditional understanding that operational measures safeguard against erosion of the design safety envelop (possible increase of residual risk over time). The second derives from lack of measurement and verification of the risk reduction potential of any active measures. In simple terms, what is needed is the means to account for risk reduction by operational means as well as measures that may be taken during emergencies.

In addition, to demonstrate and justify the level of risk reduction and a way to account for it, the latter by adopting a formal process and taking requisite steps to institutionalise it. What is enthralling and exciting relates to the fact that a life-cycle risk management framework will divert focus of safety research and practice from supporting a regulation-making process that caters only for new-buildings (1% of shipping) to safeguarding life and the environment for all shipping activity. Merging Safety at Sea Ltd with Brookes Bell LLP, had as a main focus in my vision, to fuse academic and practical knowledge, experience and expertise to address life-cycle issues in maritime safety. However, the earnings from litigation in accident investigation and the ensuing short term high return, was a huge disincentive to focusing on other longer-term activities, even with potential for high earnings. Therefore, after three years of effort, despite demonstrable success in expanding Brookes Bell with Offices in Asia (Singapore, Shanghai and Hong Kong) and the UK (Liverpool, Glasgow and London), I decided to return to academia full time to pursue my vison, using the University as platform.

Maximising Impact: The Maritime Safety Research Centre

https://www.strath.ac.uk/research/maritimesafetyresearchcentre/

Whilst safety research has been a key target at National and International levels since the 1960s with activity intensifying after the mid-1990s, progress has been very slow and the impact of research weak. There are many reasons for this state of affairs, key ones being:

- Academic research continues to be of long-term nature (longer than will suit the industry) and hence detached, targeting problems in no particular order of priority from an industry perspective and offering in the best of times solutions to tomorrow's problems whilst leaving short-to-medium-term gaps unattended.
- Lack of close collaboration between industry and academia deprives industry of a massive knowledge base and resource, trained to undertake research and academia of focus and feedback, both key ingredients of targeted research and effective knowledge generation.

In the area of maritime safety, with the gap between academic and industrial research diminishing, some say that the gap is now reversing, the time was ripe for adopting a new model in reconstituting a Centre of Excellence on Maritime Safety in which vision, long-term and short-term goals and objectives are set, shared and served through close collaboration between industry and academia to target a truly interdisciplinary, common-threaded R&D with the vison to (re)shape maritime safety. Effort to realise such an ambition brought together (initially) Royal Caribbean Cruises Ltd, DNV GL Classification Society and Meyerwerft Shipyard (subsequently) with significant funding to create, nurture and sustain a Centre of Excellence to become the definitive authority and reference in Maritime Safety by instigating, leading and promulgating high quality research and development through close collaboration between industry and academia. My burning ambition was still to help the development and nurture the implementation of Life-

Cycle Risk Management, accounting formally and rationally for all cost-effective measures of risk reduction and leading to sustainable safety improvement in the maritime industry.

Within a few years, the Centre has grown to over 20 researchers, including academics, post-docs and PhDs, attracting significant additional research funding and carving a central role in the international safety arena. Efforts in this direction brought significant support from the Scottish Government towards establishing active and interventional means of safety enhancement post accidents, which led to a second University spin-out (Maritime Safety Innovations Ltd), in which he is the Chairman. In addition, for wider involvement, he brought together all the major stakeholders in the maritime sector in EU and worldwide to obtain funding from the EC for a new large scale R&D project to help establish a Life-Cycle Risk Management Framework in the maritime industry. One of the targets is to develop and through IMO to institutionalise this by nurturing the development of a suitable regulatory framework. Well, some way to go yet but the dream is still alive!

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