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CONTRIBUTIONS FROM THE CLASS OF 1975

Representatives of the Class of 1975

1 **Chengi Kuo**
(University of Strathclyde)

2 **Hartmut Hormann**
(Formerly of Germanischer Lloyd)

3 **Anthony Morrall**
(BMT Group)

4 **John Martin**
(Formerly of University of Edinburgh)

5 **Allan Gilfillan**
(Formerly of Maritime Coastguard Agency)

6 **Alan Graham**
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7 **Sigi Kastner**
(Formerly of University of Bremen)

Contributions

1. Chengi Kuo (University of Strathclyde)

Reasons for organising the first conference in 1975

I met Mr Harry Bird of UK Board of Trade in 1968 and he was the UK representative at IMCO (Inter-governmental Maritime Consultative Organisation). He told me at IMCO most countries were supported by senior academics and in UK no one was interested in ship stability. Would I be interested in helping him. I said yes and became involved in devising criteria for assessing computer programs for calculating ship stability. Later I got to know various delegates to IMCO which became IMO. In 1972 I won a major research contract for three years to explore how theoretical methods can be incorporated into assessing ship stability. As we came near to the end of the contract, we wanted to share our work with people working on ship stability. The idea of having an international conference was our choice.

Aspects of particular personal interest in the 1975 Conference

There were a number of items of interest:

a) Static stability: Most of the interests were on static or quasi-static ship stability. The area under the GZ curve got a lot of debate. Generally it was about the quantities of areas up to certain angle of heel. It did not seem logical.

b) Theoretical solutions: Our team's attempts to introduce some theoretical solutions were not receiving much enthusiasm. The feedbacks we received were that the stage had not been reached for complicated equations; few understood the equations.

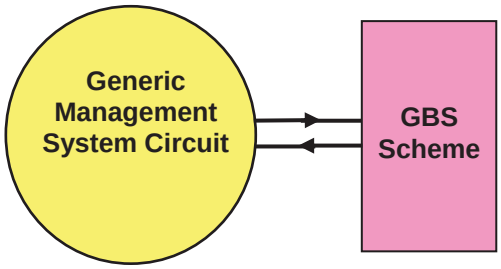
c) Ocean vehicles: Little special attention was given to the stability of ocean vehicles. These vehicles were shape and responses to ships, yet modified ship stability rules were in use. For example, semisubmersibles were being used for exploring drilling in the North Sea.

d) Meeting people: It was a valuable experience in meeting some of the people whose studies we were familiar with, and since it was the first biggish marine international conference to be held in Glasgow we were very well supported by the Glasgow City Council and the University.

Research priorities for the next 10-20 years

I would like to see more emphasis put on fundamental issues and their links to present approaches. Two examples are given here:

a) Non absolute nature of safety: Safety is dominated by personal perceptions as can be illustrated by two persons trying to cross a busy road. One thinks it is unsafe and the other thinks it is safe. Both of them are correct because judgement of safe or not safe is based on personal perception. By accepting safety is non absolute, a management system would be needed to address safety issues. The regulatory efforts such as FSA (Formal Safety Assessment) and GBS (Goal Based Standard) assume safety is absolute. It is necessary to link them to management systems if they are to yield consistent results such as the sketch for GBS.



b) Influence of human factors: Considerable advances have been made in technological aspects of safety but insufficient

efforts are being made to ensure improved methods are available for addressing human factors. For example, when defining a project goal and performance criteria both technological and human criteria should be included. The latter will ensure features such as human attitudes and behaviour are measured. By having this facility it may help in reducing maritime accidents

2. Hartmut Hormann (Formerly of Germanischer Lloyd)

Reasons for attending the first conference in 1975

It was something thrilling, this Stability Conference at Strathclyde University! I then was exactly 10 years within my professional life, in hindsight still a youngster, though I did not feel so at the time. – From the onset of my employment with GERMANISCHER LLOYD I had been dealing with intact and damage stability problems, including lots of routine work in approving respective design features and the stability booklets required to be put on board – and used there.

Stability was only one of my areas of activities, but my then boss decided I should attend the Conference. I was particularly pleased to be there together with my admired teacher Prof Kurt Wendel. – Again in hindsight this experience has played its part in developing my lifelong interest in stability; as my career developed, of course, dealing with stability problems represented less and less of my time; in later years it felt like a relief from daily pressures, once I had the chance to engage in a true technical stability issue.

In a classification society one is automatically at a hinge or joint between R&D, regulatory requirements, and on-board application. I treasured this position and I had lots of opportunities to work with researchers on one side, in regulatory bodies (chiefly IMO, where I had the privilege to chair the STAB-Subcommittee for six years), and on the other end to learn about all the related practical problems on board.

Aspects of particular personal interest in the 1975 Conference

I am supposed to think back to the 1975 Conference and I would offer just a few and certainly non-representative thoughts. For the majority of the attendees here today it might sound strange that then the accuracy of cross curves of stability was still a problem. Less strange, because it went on for many years if not for decades, is the fact that the Rahola-criteria in essence were the only tool which could be applied in practice. (It was not called so, but the stability values given in both international and national recommendations for application on board were simple derivatives of Rahola`s findings).

In 1975 the profession had just begun to apply the mathematics ruling ship motions, and the capacity of computers – rather still “electric calculation machines” at the time – was a problem with respect to the volume of data needed to adequately define the hull forms. We then remembered still the time, when another German professor, Georg Weinblum, had managed to describe ship lines by mathematical functions. (Prof Weinblum had just passed away in 1974).

In listening to the presentations at the conference, I got confirmed, what I roughly knew before: the scientists had made significant progress in understanding ship motions and their repercussions on the risk of capsizing; however, I could clearly see that there was a big gap between their results and an application in practice. Since then the profession has gone a long way.

Quite naturally, having spent almost my entire professional life in a classification society (with a short intermission at a yard), my main interest concerning stability focussed on the practicability of what research brought

about. The two areas towards which the mentioned gap had to be closed were, and are still, to formulate the regulations defining sufficient stability and to see to it that these requirements can be applied in on-board practice.

Research priorities for the next 10-20 years

And these sentences bring me to formulate my expectations for work to be done has the safety factor to be chosen to avoid a ship capsizing with a sufficiently high probability. I know, the discussion of this issue has not only technical aspects, it has also to take into account the acceptance of accident rates by the general public – not an easy task! The other area to be addressed is the big field of human errors; there are multiple "opportunities" to individually fail in assessing the actual stability while the ship is in service and to draw the right conclusions.

I am retired since 13 years now, and I have not any longer really followed the developments in my former profession, but I am reasonably sure that these aspects need attention also in future.

3. Anthony Morrall (BMT Group)

Reasons for attending the first conference in 1975

My reasons for attending the first conference in 1975 can be traced back to the UK's Holland Martin Committee Inquiry into Trawler Safety following the loss of three trawlers in 1968 in which a total of 58 crew members died, with just one survivor. My Director at this time was James Paffett, a member of this Committee, and he asked me to assist the UK Department of Transport with the drafting of new fishing vessel safety regulations, following the recommendations of the Inquiry. My first task was to help with the technical aspects through the "Freeboard Committee", now renamed as the Fishing Industry Safety Group (FISG), which led to the introduction of the UK's *Fishing Vessels* (*Safety Provisions*) *Rules 1975*. This new legislation introduced IMO's (IMCO's) intact stability criteria A168 for the first time and was one of recommendations of the Holland Martin Inquiry, which influenced subsequent UK legislation on maritime safety.

My role as a technical advisor to the Department of Transport continued for many years and in addition I attended numerous IMO meetings on fishing vessel safety as well as the Torremolinos International Convention for the Safety of Fishing Vessels in 1977. Prior to attending the first International Conference on Stability of Ships and Ocean Vehicles in 1975 I had therefore become heavily involved in fishing vessel stability and safety, although this was additional to my other responsibilities at the NPL Ship Division.

My paper at the first conference reported on an experimental and analytical investigation of capsizing of a side trawler in irregular beam seas. The results of this investigation gave an indication of the conditions in which capsize would occur. A time-domain analysis using an analogue simulator program was employed to model capsize and this approach was considered "a realistic proposition, providing roll damping coefficients for the ship, rather than for the model were used". The question of adequate safety for these vessels was more problematical, but the best criterion for survival was considered to be through "a simplified dynamic approach", "without forgetting good seamanship".

My interest in fishing vessel stability and safety continued long after the first conference and over the years I have been responsible for several experimental investigations into the losses of fishing vessel, such as the Gaul, Trident, and Solway Harvester. I was also involved in model experiments and computer flooding simulations investigating the sudden and catastrophic capsizing of the passenger/car

ferries the Herald of Free Enterprise and the European Gateway and the sail-training ship Marques.

Aspects of particular personal interest in the 1975 Conference

I found the first conference rather daunting even though many of the delegates were known to me at the time, particularly Prof Chengi Kuo and the late Harry Bird, Prof. Yucel Odabasi and Bill Cleary. Subsequently, many others became known to me through my work on stability, such as Professors Paulling and Motoro, or through IMO stability working groups with distinguished delegates such as Dorin, Dudziak, Kastner, Kobylinski, Kure, Rakhmanin, Takahashi, and Tsuchiya etc., all of whom attended the first conference.

Looking back on this conference many of the papers were attempting to produce a better understanding of specific aspects of stability, including dynamic considerations in irregular seas, as well as considering ways in which future stability criteria might be addressed. All of the presentations reinforced the need for further research on this topic in order to progress the state-of-the-art. This has become the lasting legacy of the first conference, thanks mainly to the efforts of Prof Kuo and the support given to him by Harry Bird and others. All subsequent work and progress made on intact stability criteria can therefore in my view be traced back to the first conference in 1975.

The most interesting aspect of the conference was the enthusiasm expressed by most of the delegates not only to understand the physics of all the phenomena related to ship stability in a seaway, but to question the status quo, and to consider how future stability criteria might include dynamic aspects. The phenomena of parametric rolling and the Mathieu instability are of course not new; for example the stability variations experiences by a ship moving in longitudinal waves have been studied by a number of eminent people in the past e.g.: Froude (1861), Kempf (1938), Graff & Heckscher (1941) and Pauling (1959, 1961, 1974, 2001), but at the conference these and other phenomena were being reconsidered, in the context of intact stability criteria and ship safety.

Research priorities for the next 10-20 years

Since the first conference in 1975 significant progress has been made in the field of ship stability, not only at subsequent conferences but at IMO. For example, IMO has undertaken the development of so-called “Second Generation Intact Stability Criteria” (SGISC) with the intention of providing a new set of rules covering the different phenomena. This development is in recognition of the fact that traditional intact stability criteria does not adequately address all intact stability phenomena and cannot give any indication of safety margins in any sea state except still water. However, despite its limitations IMO’s stability criteria A167 and A168, which are based on a statistical analysis of casualty data, have proven very effective since their introduction in 1968; this is mainly because of their relation to hull form geometry and obvious physical meaning to naval architects and ship’s officers.

The intact stability phenomena of particular interest include Parametric Rolling, Broaching, and Dead Ship etc. However, despite of the progress made, accurate prediction of extreme motion leading to capsize from these phenomena remains outstanding. More accurate modelling of the physics, including non-linear roll damping, rudder action, and the effect of stabilisers is therefore needed before these new criteria can provide reliable and practical guidance to designers and ship operators. A container ship after experiencing parametric rolling is shown in the picture.

At the moment the prediction of these stability phenomena remain a challenging task. The new generation of intact stability criteria may therefore only be able to provide an approximate guide for these phenomena, unless advances are made in the modelling. Although intact stability phenomena have been known for some time a database of incidents has to my knowledge, not been compiled. This would have allowed a risk assessment to have been made on these phenomena.

Most of IMO's work on the Second Generation Intact Stability Criteria has been supported by theoretical calculations and model tests, but very little emphasis appears to have been given to providing guidance to the master for avoiding dangerous situations. In contrast, MSC Circular 1329 for High Speed Craft provides guidance to the master for avoiding dangerous situations in following seas.

The survival of a vessel in heavy sea as a result of extreme motions, and of roll in particular, is one of the most fundamental requirements considered by a naval architect when designing a ship. New design and operational criteria for all intact stability phenomena will ultimately depend upon more accurate modelling of the physics involved, as well as making use of advanced simulation and virtual reality techniques. Education is also needed to improve the general understanding of the safety implications of extreme dynamic behaviour and how this relates to design and operational considerations. Guidance to masters for avoiding dangerous situations for vessel most at risk, perhaps by the use simulators, should also be a higher priority than at present.

In summary, my views on the current and future developments of new intact stability criteria are as follows:

i. Despite recent progress there is still some way to go before the Second Generation Intact Stability Criteria are introduced as regulatory design tools with more advanced guidance for avoiding dangerous situations.

ii. Future stability criteria must undoubtedly take into account all physical phenomena likely to occur during a vessel's service. The advancement of this aim through more advanced modelling and realistic simulation should be the main emphasis for stability and safety over the next decade.

iii. The prediction of capsize for all physical phenomena with an acceptable degree of certainty is an extremely difficult task; these phenomena are non-linear and extremely rare events of seakeeping behaviour that can be affected by both rudder and fin stabiliser action.

iv. Future intact stability criteria and the related safety of ships in critical sea conditions should ideally be quantified in terms of risk or loss or of exceeding certain bounds of motion, as a result of environmental forces.

v. The above approach is more appropriate to the seakeeping assessment of a ship's likely behaviour, and this approach could also help establish broad margins of safety.

vi. The emphasis of any new stability and safety research should be on ship design and operational criteria for all intact stability phenomena, including excessive roll motion and accelerations.

4. John Martin (Formerly of University of Edinburgh, Department of Mathematics)

Reasons for attending the first conference in 1975

At the time of the 1975 conference, I had recently become involved with the Strathclyde Ship Stability Group through my former research supervisor, the late Professor Fritz Ursell. My role was to help out with mathematical matters, such as advising them on their forays into the stability theory of differential equations and dynamical systems. I subsequently participated in workshops for naval architects and regulators to help them understand these ideas. I also undertook some personal research in nonlinear aspects of wave-body interactions such as the steady tilting of semi-submersibles in regular waves – a problem flagged at the 1975 conference. My involvement in ship stability work ceased during the 1980's so I am very far from up-to-date with more recent developments.

Aspects of particular personal interest in the 1975 Conference

As an applied mathematician, with experience in the linear theory of water waves and floating bodies, my overwhelming impression at the conference was that the real issues of ship stability and capsize far exceeded the scope of small amplitude approximations or perturbation expansions; it was fully nonlinear, involving large, highly nonlinear waves and extreme motions, whether leading to capsize or survival. This, therefore, called into question much of the classical modelling, whether deterministic or statistical, based on small amplitudes and superposition of various effects. It appeared that physical understanding of capsize mechanisms was limited at quite a basic qualitative level, with questions being raised such as: what forces are critical in the "ultimate half roll"; is coupling important e.g. between roll and yaw; is parametric resonance significant – a long list!

Systems of nonlinear differential equations were proposed, largely of the kind obtained in linear theory with additional hypothesised nonlinearities, and some of their qualitative predictions compared with observations of full scale events or model tank experiments. With many of these systems there seemed to be a huge problem with proliferation of parameters and near impossibility of measuring most of them. Indeed, even some of the most basic parameters in the linear theory (damping, added mass, etc) are only really defined in time-harmonic situations where they are frequency-dependent and really represent history effects in the time domain (i.e. needing integro-differential equations).

Wrapping all this up into usable stability criteria was the final challenge; something which, like the GZ curve, can be measured or calculated and simple criteria applied. There is a paradox here: that the better a theoretical model replicates the physics (even going to the "ideal" of a full numerical simulation) the more it replicates the difficulties of identifying dangerous situations, key parameters and stability criteria. High quality simulation may be useful as a cheaper alternative to tank testing (maybe offering the possibility of basing regulations on survival testing in defined "dangerous" conditions), but it does not lead to simple quantifiable criteria based on system parameters. Ironically this requires a simplification of the full physics – one which reliably captures all the key effects (if such a simplification actually exists).

Towards the end of the conference, there was optimism that the large body of work on stability for differential equations (phase space analysis and Lyapunov theory in particular) would translate directly to ship stability and deliver the required criteria. These theories, however, were mostly "local", i.e. giving conditions for an equilibrium position or some other particular solution to be stable to sufficiently small perturbations. I could not see how the forces leading to capsize could be regarded as "sufficiently small"! The mathematicians only demand existence of a Lyapunov function for local stability; it needn't be a particularly efficient one, often leading to unrealistically harsh stability conditions. The real challenge is the "global" problem of defining and using practical stability

boundaries (in whatever parameter space is found relevant), not over-pessimistic and expressed in terms which can be measured and applied for actual vessels.

Research priorities for the next 10-20 years

Most, if not all, of the above qualms were discussed in some form or other at the 1975 conference which did a wonderful job of agenda setting. Given that I ceased to work in ship stability during the 1980's, I would not presume to set any newer agenda for the next 10-20 years. However, it will be extremely interesting to discover what has been achieved on these matters in the past 40 years, which of the original agenda items are still open and relevant, and what new priorities have emerged.

5. Allan Gilfillan (Formerly of Maritime Coastguard Agency)

Reasons for attending the first conference in 1975

In 1975 I was still involved in the investigations in the loss of the trawler Gaul in February 1974. As you know the Gaul was lost in a very heavy storm off the north of Norway – the only clue being a lifebelt washed ashore in a Norwegian Fjord. The Gaul and her sister vessels had recently been acquired by Hellyer Brothers as part of their purchase of Ranger Fishing from P&O, and the owners were concerned for safety of the ships which they had bought. In the absence of any clues all we could do was to carry out a review of their stability and the impact that various fittings might have had on the safe operation of the vessels. Various scenarios for the loss were postulated, but it was not possible to agree on the most likely cause. After the Formal Inquiry had made its judgement, the Department of Transport (or whatever name it went under at that time) arranged for a series of model tests to be carried out at NMI and made the Gaul data available for academic study – but I can't remember whether the results from these studies were available in time for the stability conference – my copy of the proceedings was lodged in YARD's library.

Aspects of particular personal interest in the 1975 Conference

I think that I found most of the papers at the 1975 Conference interesting – but can't really remember many details. After 1975, my role in the company changed to a more general project management and administrative functions and this lasted until I retired from YARD/BAeSYSTEMS in 1999. This undoubtedly explains my loss of memory.

Research priorities for the next 10-20 years

Since 1975 a lot of work has been done both experimentally and through simulations to better understand flooding and stability in a dynamic domain, rather than the classical static approach taken previously. I don't believe it is feasible, or cost effective, to undertake these detailed simulations to every ship design and the challenge to the academic community is to turn the results into a practical set of rules which can be applied by naval architects working in ship design offices. After I retired I participated in using the results from the "Derbyshire" investigations into an amendment to the load line rules on hatch loading. One further point concerns probabilistic damage stability, which as you know involves calculating an "Attained index" of survivability against a "required index". (incidentally, when I worked in John Browns, I gathered the data for your exercise for the Swedish Authorities on the probabilistic stability of the "Kungsholm") I have long thought that the whole probabilistic method needs to be turned round so that the historic damage probability data is used to define the lengths and penetration at various locations along the length of the vessel which any ship design has to survive.

6. Alan Graham (Formerly of YARD Limited)

Reasons for attending the first conference in 1975

My keen interest in stability matters really began when I joined the Marine Division of the Department of Trade and Industry, (now the Maritime Coastguard Agency), in 1968.

Within a few days of joining the Department, I was invited to attend a meeting in London at the headquarters of the Inter-Governmental Consultative Organisation (IMCO) that is the present-day Inter-Governmental Organisation (IMO). The meeting was composed of a special group experienced in ship stability matters and were representative of the major maritime nations. The group had been commissioned by the Sub-Committee on Subdivision, Stability and Load Lines to investigate the manner in which Part B, Chapter II of SOLAS, (the regulations governing the minimum standards of subdivision and stability for passenger ships), might be improved. These anachronistic regulations were to be replaced by regulations based upon the concept of the probability of survival. This change was long overdue since they had barely been changed since the 1920's. From that time onwards, until my retirement from full time employment, a great proportion of my work was to attend IMO sessions as a member of that group. In the latter years, I became Chairman of the group.

Aspects of particular personal interest in the 1975 Conference

When I was invited to attend the STAB 75 conference in Glasgow, it gave me an opportunity to gauge what progress had been made in the research efforts in developing reliable stability criteria. As I recall, the majority of the papers presented at STAB 75 related to intact stability, rather than residual stability after assumed damage. However, effective subdivision regulations need to be underpinned by reliable intact stability criteria to be meaningful, so I was anxious to learn what research effort was being made at that time.

I had the rather optimistic impression that within a reasonably short timeframe such criteria might be developed, enabling them to be introduced into safety regulations. I did not appreciate how difficult a task it would prove to be.

Research priorities for the next 10-20 years

Safety regulations were becoming increasingly risk–based. Regulations of a highly deterministic nature will be phased out. Future research will take account of this.

Human behaviour in an emergency may significantly exacerbate a potentially hazardous situation. Regulations in the future will need to take care of this to discourage the use of an 'active' device in an emergency situation, where the use of a 'passive' device would be preferable.

There is a strong possibility that passenger ships carrying very large numbers may, in the future, be required to remain afloat for a minimum time after assumed damage. Clearly, urgent research is required if such a 'time to stay afloat' criterion is ever to become a reality.

Now that a revised text for the outdated Part B, Chapter II of SOLAS has been approved, I would like to see a similar procedure adopted - initially for cargo ships and later to other ship types, including high speed craft and multi-hulls. At each stage, extensive research effort would be needed.

7. Sigi Kastner (Formerly of University of Bremen)

Reasons for attending the first conference in 1975

I attended the conference because it offered an opportunity to meet other researchers who were working on ship stability from other organisations. It also enabled me to publish a paper at the conference.

Aspects of particular personal interest in the 1975 Conference

Personally, I found it very interesting to meet colleagues from other countries working in the same field of ship design and research on the improvement of ship safety at sea.

I remember discussions at and after STAB 1975 on whether further Conferences should be organized by IMO. However, it was decided that solely scientific bodies and not governments should organize the STAB Conferences. It turned out to be a big success: Since then, every three years the next STAB has been organized in another part of the world.

Research priorities for the next 10-20 years

Future emphases should be placed on problems of the environmental impact of fuel consumption and type of fuel, considering the growing number of large container ships and passenger vessels. However, safety with respect to the particular ship type, the human factor in ship operation, connection of ship and harbour, and modern computer technology, will play an important role further on.

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