

The ICF Story: The Evolution of a Multi-Stranded Global Society

DMR Taplin DSc (Aston) DPhil (Oxford) FICF (honoris causa)

Council Member 1969-2017; CEO-Treasurer 1984-2017; President Emeritus

Abstract

This paper addresses the history of ICF 1969-2017 and the challenges ahead for a new era of ICF 2017-2029. In 1969 ICF was established in Brighton, UK with a governing constitution via the Statutes & Bye-Laws. These Statutes & Bye-Laws are indeed an evolving, living document with progressive revisions followed over the decades since 1969. Many evolutions in developing our now mature ICF culture and *modus operandi* have occurred over the years. There will be others in the challenging era ahead 2017-2029 via ICF14, ICF15, ICF16 & ICF17 but we might highlight: (1) The **Gold & Silver Medals** introduced in 2009 at ICF12 as an important extra-statutory evolution of ICF for the benefit of our global brand via AwardCo; (2) The **Honour Lectures** introduced in 1977 at ICF4 via Ashby/Bilby and followed to the highest standard therefrom; (3) The **MoU System** to assure the autonomy and independent organization of our quadrennials in the context of the ICF Culture introduced at ICF12 via the Canadian Government and developed for ICF13, ICF14 & ICF15; (4) The **Quadrennials Regional Rotation** guideline introduced at ICF6 in 1984 to ensure wide global participation; (5) The **Interquadrennials Programme** initiated in 1983 in Beijing after ICF5 and continued very actively since ICF12 with various ICF regions; (6) The **Enlarged Portfolio-Based ExCo** introduced at ICF13 for wider representation and "New Blood"; (7) The **Enhanced Accreditation** of voting Council members to be introduced at ICF14 via NomCo; (8) The **Multi-Stranding** of the original ICF micro/macro brand from ICF4 and progressively at each quadrennial including geophysics, biomedical, bio-engineering, non-metallics, computational mechanics, adhesion, nano-scales, sustainability, energy, education, politics/society, safer engineering, risk & disaster analysis; (9) The **ICF Website** and accessibility to all our **Proceedings** introduced via IGF after ICF12; (10) The **Regional Groups** in the Far-East, Iberia/Latin America, Africa, India, Australasia, Europe, Canada, Egypt and variously from 1976 onwards originally via Dominique in Compiègne, France and EGF; (11) The **Chief Executive-Treasurer** role in structured leadership since ICF6; (12) The **ICF Culture** of friendly, human, transparent, democratic, harmony-oriented - respecting past contributions of "heavy-lifters" via emeritus standing and FICF election - towards **Safer, Sustainable Technology** for the common good.

Introduction

This paper is a personal odyssey regarding **"The ICF Story 1969-2017"**. Especially the development of the many strands that now bind and strengthen the world premier ICF brand. Also addressing the challenges ahead for ICF 2017-2029 (1), (2).

My own starting point in this personal historical perspective of "The ICF Story" is the strand of **"Physical Metallurgy"**. This encompasses optical and electron microscopy, visualizing & characterizing the micro-mechanisms of deformation, plasticity, crack nucleation, brittle fracture, fatigue, creep, alloy strengthening/toughening and structural integrity. Particularly on how a study of physical metallurgy has enhanced our understanding of the mechanical behaviour of industrial alloys.

This strand started in the 19thC with the classical metallurgical developments emanating from the work of Henry Clifton Sorby FRS (1826 - 1908) in Sheffield in the 19thC on optical microscopy of steel (7). This work by Sorby is a legend in Chesterfield/Sheffield where I was born & bred and Sorby transformed the steel industry. Indeed the area in which the still active Sorby Society operates is known to members as 'Sorbyshire'. Sorby was arguably the first physical metallurgist. Then there were the developments in metallurgy via structural metallurgists such as Constance Tipper (1894-1995), Norman Petch FRS (1917-1992) & Sir Alan Cottrell FRS (1919-2012) in Cambridge, Newcastle & Birmingham studying brittle/cleavage fracture in steel. This micro-mechanistic visualization and characterization is well exemplified in a series of ICF papers by John Knott FRS including his ICF4 Plenary and his ICF8 Opening Honour Lecture.

The second major ("macro") strand is **"Fracture Mechanics"** which began a century ago via Alan Arthur Griffith FRS (1893-1963) - building on the work of Sir Charles Inglis FRS (1875-1952) - leading to the Griffith Equation and very extensive later developments in the USA via George Irwin, Paul Paris, James Rice and others - all well exemplified in the 1973 book by Knott **"Fundamentals of Fracture Mechanics"** (6) and various ICF Honour Lectures at our fourteen quadrennial conferences accessible on the ICF website.

These are the two foundation strands of ICF united by Takeo Yokobori in his original ICF vision in 1961. Previously these micro/macro fields had worked rather in isolation; metallurgists being somewhat qualitative with metallurgy seen as something of an "art" - and solid mechanics being black-box

quantitative and more mathematical. This has all changed radically since 1960 in good part via ICF uniting these foundation strands.

A third strand additional to these original two "micro/macro" "Yokobori" strands of physical metallurgy & fracture mechanics was introduced: "**Composite Materials & Non-Metallics**" as exemplified by many researchers including the work of Anthony Kelly FRS (1929-2014) in his ICF3 and ICF12 plenaries, by Gordon Williams FRS on **Polymers** and by Anthony Evans FRS (1942-2009), Michael Lewis and others on **Advanced Ceramics** at ICF4. Metallurgy Departments in Universities steady transformed into Departments of Materials Science & Engineering as did the professional institutions such as IOM3 in England (originally, The Institution of Metallurgists/Institute of Metals) where I have been a member since 1957. Metallurgy from pre-historical times via the Bronze & Iron Ages and then from the 18thC via the Industrial Revolution dominated progress for millennia and the now wider field of Materials has continued to dominate technological developments this past fifty years

Fourthly is the new strand of **Bio-Materials & Bio-Medical Applications**. This strand was explored at ICF4 via Konstanty Piekarski (1914-1990) (Fracture of Bone) & more recently via the Opening Honour Lectures of Robert Ritchie at ICF12 and of Subra Suresh at ICF13. Ritchie was a doctoral student of Knott and Suresh was a doctoral student of Ritchie.

A fifth new strand was "**Fracture, Society & Politics**" as exemplified by the ICF4 interview with Cottrell by Knott which still has good resonance today. Political decisions have a huge determining influence on our work in the 21stC.

A sixth new strand is "**Education & Synthesis**" via firstly the inaugural ICF Honour Lecture at ICF4 by Michael Ashby FRS, the Open University Educational Round Table at ICF4 and now the Opening Honour Lecture at ICF14 by Ashok Saxena.

A seventh important additional strand is "**Geophysics & Earthquakes**" best exemplified by the Opening Honour Lecture at ICF12 by James Rice and the new work of Alberto Carpinteri on Earthquake detection.

All these seven strands are oriented to Academia & *Theory*. Another parallel set of seven **Industrial** strands is related to *Practice* "**Industrial Components & Implementation**", "**Risk Assessment & Disaster Avoidance**", "**Safer Engineering**", "**Industrial Ecology**", "**Sustainability**", "**Nuclear/Fossil Fuel Energy**", "**Renewable Energy & Energy Saving**".

ICF has always been strong in practical, industrial work as exemplified by the Opening Honour Lecture at ICF6 by Roy Nichols on nuclear power plants ("Leak before Break") but this is a domain of increasing importance ahead.

These fourteen strands are plaited together to make up the strong and tough cable of continuity that provides the backbone of the ICF Global Community in 2017 at ICF14 as embodied in the Quadrennial & InterQuadrennial ICF Proceedings since 1965 and largely accessible via the ICF website.

Historicity

This is a success story of which we can all be proud. Others will tell this story from their own historical and personal perspectives. Indeed each historian of **The ICF Story 1969-2017** would write a different story. However I was born in the 1930's in Chesterfield in the very shadow of the Great Blast Furnaces & Steelmakers of Sheffield. I began my working life as an Industrial Apprentice in Physical Metallurgy.

So I hope I might be forgiven for this personal *metallurgical* perspective on the ICF Story. A hundred different starting points would be found by a hundred different ICF historians. Some starting with the atomistic vision of Ancient Greece; the Bronze Age and Tubal Cain in Babylon; the Copper Crafts of Varanasi & the Iron Pillar of Delhi, India; Leonardo da Vinci in Italy; Charpy in France; Wohler in Germany; the Great Zhou & Shang Dynasty advances in China; Takeo Yokobori in Japan; George Irwin, Paul Paris & Jim Rice in the USA. Highlighting their own heroes and the many different great men and women of their own particular experiences in Industry & Academia. Such discussions on the very many strands in our multi-disciplinary story can be debated exhaustively and beneficially.

There has not yet been a Nobelist in our ICF community but some have come close - also in other famous World Prizes like the Japan Prize and the Queen Elizabeth II Engineering Prize. "Safer, Sustainable Engineering" is now a touchstone in its many manifestations within the fully multi-disciplinary ICF in 2017 as ICF has extensively evolved from the original Yokobori vision. However "Whither ICF?" is the question for delegates at ICF14. What are the Grand Challenges for ICF 2017-2029 through ICF15, ICF16 and ICF17 as we all meet in Rhodes, Greece? The Opening Honour Lecture at ICF10 by Anthony Evans on "**ICF's Grand Challenges**" is an important reference in this regard. As are the ICF Archives of Toshimitsu Yokobori in Sendai and the ICF Website of Francesco Iacovello with our freely accessible Quadrennial Proceedings.

Any analysis of the future prospective for ICF in our second half century needs to be set in an historical context after the first half century of ICF from the origins of the micro/macro vision of Takeo Yokobori and the many new strands developed since to a new and much wider, balanced, Global Vision to be further launched in Greece, one of the great cradles of Modern World Civilization. During this first half century ICF has evolved from simply organizing Quadrennial International Conferences as a "Great Meeting Place" in 1969 to become the *de facto* premier, multi-stranded, world association/academy for work on fracture mechanics, structural integrity and safer, sustainable engineering in the 21stC. Many view ICF as now possessing the global standing and remit at our half-century since ICF1 of a World Academy in Safer, Sustainable Engineering, Structural Integrity & Fracture Mechanics – as, in my opinion, the 1969 "Yokobori-Statutes" foreshadow. The world has changed extraordinarily since our foundation in 1969 as has ICF and the spoils of success go to the nimble, the agile in navigating the course ahead for ICF.

Scientific Origins

Alan Griffith FRS (1893-1963) in 1921 published his famous seminal paper on brittle fracture in the Transactions of the UK Royal Society (4) and developed this research at the first IUTAM Conference in Delft in 1924. Griffith perhaps represents our generally accepted fundamental scientific beginnings building on the work (3) of Sir Charles Inglis FRS (1875-1952) - perhaps most cogently for ICF (as an affiliate of IUTAM) via that pioneering IUTAM Conference in 1924. George Irwin (1907-1998) some 25 years later in the 1940's defined the fundamental concept of a critical stress intensity factor (KIC). In the peace following WWII there was a pioneering Fracture Conference organized by ASM/ASTM in 1948 at which Irwin presented his ground-breaking LEFM theory. During those years and in the 1950's & 1960's others like Orowan, Zener, Paris, Cottrell, Yokobori, Wells, Eshelby, Bilby, Friedel, Rice, Averbach, Williams, Swedlow, Tetelman, McEvily, Head, Lardner, VerSnyder, Ashby, Kelly, Kochendoerfer, too many to list, were very active in our burgeoning engineering mechanics/materials science realm.

George Irwin (5) was notably involved with Paul Paris in several ASTM committees during the 1950's which organized various important fracture conferences. From all this engineering foment & research in various countries arose the idea for ICF. At what we now view as "ICF0" Benjamin Averbach (1919-1992) of MIT organized a micro/macro Fracture Conference

in 1959 at Swampscott USA. Following various discussion meetings therefrom, including a key meeting of an embryonic ICF Committee at MIT in November 1961, Takeo Yokobori organized what became "ICF1" in Sendai, Japan in 1965 uniting the metallurgical/mechanics, micro/macro realms. ICF was indeed formally established with comprehensive Statutes at what was billed as "ICF2" organized in Brighton, England in 1969 by Roy Nichols. At ICF2 Yokobori became the first ICF President 1969-1973. The main architects of the perhaps hurried Statutes were Ben Averbach, Alan Head & Roy Nichols based around USA thinking & the great American Engineer's "Robert's Rules". ICF is thus governed constitutionally plus various later precedents and Bye-Laws.

In a recently published 2015 UK Royal Society Philosophical Transactions introductory article on "Fracturing across the multi-scales of diverse materials", Armstrong, Antolovich, Griffiths and Knott have given emphasis to the pervasive influence of fracturing events occurring in every day human experience, not just for larger scale events occurring between exceptionally designed or suddenly imposed catastrophic happenings. The offered perspective was broader even than Takeo Yokobori's comprehensive emphasis given to integration of combined microscopic and macroscopic aspects of fracturing. And on such broader scale, credit has to be given to the international phalanx of researchers and engineers who have contributed so much to our understanding of the failure of materials and to the efforts mounted at every level to exert control over fracturing behaviours. Beyond the attention given in other parts of the present description to leading persons on the topic, as an example mention might be made at the world-wide level of only these few persons: Head and Rosenhain in Australia; Lardner in Canada; Rossmann in Austria, Crussard and Pineau in France; Kochendoerfer and Mughrabi in Germany; Barenblatt in Russia; Broberg in Sweden; Wanhill in the Netherlands; McClintock & Argon in the USA - the length of a complete list would be longer than the present article. ICF has many heroes.

Roots

Whilst my roots are in Metallurgical Industry, after fracture research with Victor Whittaker in Birmingham 1959-1961 & with John Martin at Oxford 1961-1964, in 1967 I was appointed (from a Lectureship in Physical Metallurgy at Melbourne University in Australia) as an Associate Professor of Mechanical Engineering at the wildly ambitious University of Waterloo in

Canada. I presented a paper on my work in Melbourne on intergranular creep fracture at ICF2 crossing the Atlantic by sea from New York to Southampton indeed. It had been suggested to me by the innovative UW Dean of Engineering, Archibald Sherbourne, that UW Professors needed to not simply present key papers at International Conferences but they should bring such important World Events to the new green fields of Waterloo, Canada. And I was not backward in accepting the invitation of Alan Head to be the voting member on the founding ICF Council for Canada at ICF2.

Accordingly at ICF3 in Munich, Germany 1973 I made a "rookie" bid for ICF4 to be autonomously hosted (and very well-funded) by the University of Waterloo, Canada in 1977. The competition was the mighty MIT, USA led by Benjamin Averbach now the second ICF President (1973-1977). However brash Waterloo, Canada, happily won in the ICF Council in Munich under the Chairmanship of Takeo Yokobori. In Munich I was elected ICF4 Executive Chairman and as an ICF Director on ExCo. Being only 33 years old and but recently promoted as a Full Professor at UW I sought advice from similarly young "rookie" friends like John Knott, Ronald Armstrong, Michael Ashby, Jim Rice, David Embury, Bill Tyson, Brian Dyson, Palle Rama Rao, Michael Lewis, Dominique Francois, Tony Evans, Jerry Swedlow, Alan Tetelman, Bill Nix - seeking new ideas and new strands for ICF4 - and indeed for ICF generally.

ICF4

Thereby we set a new benchmark at ICF4. This included the first Opening and Closing ICF Honour Lectures (by Michael Ashby & Bruce Bilby); extra focus on non-metallics (via for example Anthony Evans & Michael Lewis) and composites (via Michael Piggott); entirely new realms e.g. biomaterials and biomechanics (via Konstanty Piekarski); Fracture, Politics & Society and Education (via Alan Cottrell & a team from the UK Open University); Full Archival Proceedings comprehensively peer-reviewed and hard-bound published prior to the Conference & internationally (Pergamon: six volumes); and a balanced and integrated micro/macro academia/industry vision for the common good.

At ICF4 there was a competition in ICF Council between France and the USSR to host ICF5 and Dominique Francois won for Cannes, France in 1981. At ICF4 Roy Nichols became the third ICF President (1977-1981). At ICF5 there was an open competition between David Taplin of Waterloo, Canada,

Dominique Francois of Compiegne, France and Janne Carlsson, President of KTH Sweden to be ICF President which I won by vote of ICF Council and thus became the fourth ICF President (1981-1985). This election was based on the "heavy-lifting" success of ICF4 and a mandate for an "ICF Strategy" presentation I made to Council.

ICF6-ICF14

ICF6 was won by Palle Rama Rao for New Delhi, India. At ICF6 in New Delhi Dominique Francois became the fifth ICF President (1985-1989) in competition with Harold Liebowitz well-known for his hugely influential Fracture Series of books & International Journals. I became ICF Treasurer and thereafter *de facto* ICF Chief Executive Officer (CEO) working closely with Dominique whom I had first met at Stanford in July 1967 via Oleg Sherby/Alan Tetelman. Extraordinarily I have been re-elected as CEO/Treasurer by each ICF Council at the seven subsequent quadrennial conferences working in close accord with eight ICF Presidents. Now I am 77 years old and it is surely time to pass the baton to someone else with fresh, new ideas.

This has been an exciting half century for ICF with various major triumphs and some historic difficulties overcome. The twelve years following ICF14 embracing ICF15, ICF16 & ICF17 2017-2029 provide enormous opportunities for ICF and a new leadership of now multi-stranded ICF.

NomCo (the ICF Nominations Committee) via Robert Ritchie (NomCo Chair) and Anthony Kinloch (NomCo Deputy Chair) issued a Call for Nominations for ExCo (the ICF Executive Committee) & Officers 2017-2021. There are some multiple nominations for the various posts. Accordingly there are likely to be competitive elections at ICF Council in Rhodes, Greece at ICF14 in June 2017 for some Officer posts 2017-2021. ICF has benefitted from such competitive, democratic elections in the past for key posts and indeed fierce competition for hosting our Quadrennials. It was the ancient Greeks after all who invented Democracy, Science, Literature and Socratic Discourse 2,500 years ago and ICF14 hosted by Emmanuel Gdoutos promises to be a very special ICF Quadrennial.

There are just two *ongoing* posts by Statute: Secretary-General and CEO-Treasurer. All other posts are limited by Statute to a single quadrennial term to ensure active turnover in ExCo and new blood each quadrennium.

Toshimitsu Yokobori is very likely to continue as Secretary-General 2017-2021 with Sendai, Japan being the ICF Registered Office. I have indicated that I will retire as CEO-Treasurer at ICF14 in 2017. Since ICF6 a major part of the leadership/management work of ICF has been conducted by the CEO-Treasurer. Therefore it seems useful at this juncture to address the nature of the role of the CEO-Treasurer in considering the way forward for 2017-2021 and beyond. In my opinion ICF especially needs a President and CEO-Treasurer who have both contributed substantially to the "heavy lifting" work within ICF over the years – with acknowledged beneficial impact. As in any organization the CEO acts in a principal leadership capacity and primary spokesperson (in harmonious concert with the Secretary-General, President and ExCo).

CEO-Treasurer is a pro-active, creative task in enhancing the evolution of ICF as the world premier, now multi-stranded organization in our discipline of fracture mechanics, materials science, structural integrity and safer engineering. As CEO there is additionally the macro-management task of ensuring the smooth and effective workings of the various ICF Committees. This includes ICF Council; ExCo (Executive Committee); AwardCo (Awards Committee); WebCo (Website & Publications Committee); NomCo (Nominations Committee); IQRCo (Interquadrennials & Regional Development Committee); QuadCo (Quadrennials Conference Committee). And responsibilities regarding finance as in the Statutes. There is quite a bit of travel for meetings of various sorts. Altogether the work-load involves some 300 hours/year, *pro bono* with a strong primary commitment to ICF and some personal financial support.

One of various policies that I set forth as ICF President in 1981 in order to enhance the balanced world standing of ICF (subject always to Council endorsement) was that ICF Quadrennials ought to be hosted in the initial years ahead by the then four super-powers: India, China, USSR, USA - and to develop an Inter-Quadrennials programme for balance and wider opportunity for all nations. The first step in this regard was to organize the very first ICF Inter-Quadrennial Conference in Beijing, China in November 1983 (I chaired the Beijing IQ International Steering Committee as ICF President). Yu Shouwen of Tsinghua University was an important early catalyst in ICF/China developments with Hwang Keh-Chi - as well as, later, Wei Zhou of NTU Singapore. This first ICF Inter-Quadrennial was a great success not too long after the end of the "Chinese Cultural Revolution" and

ICF-IQ Beijing 1983 was published in a handsome enduring volume of Proceedings.

The second step in this regard was the organization of ICF6 in New Delhi, India via Palle Rama Rao. This was at an historical time for India. Rama Rao created an extraordinarily successful Quadrennial in complex circumstances. At ICF6 there was a fierce competition USA v Australia for ICF7 (Houston vs Melbourne). In the event via a close democratic vote of ICF Council the third policy step was accomplished via ICF7 being organized in Houston, Texas, USA in 1989 very successfully via Kamel Salama & Ravi-Chandar. At ICF7 Rama Rao became the sixth ICF President 1989-1993. In Houston there was a forthright competition on ICF8 which was won by USSR with ICF8 to be in Moscow in 1993. This was the fourth step. In the event via internal USSR discussions and the break-up of the USSR, ICF8 was organized in Kiev, Ukraine in 1993 via Volodymir Panasyuk. John Knott became seventh ICF President 1993-1997. Several ICF IQ conferences (including a major ECF in Kazan) have been since organized in Russia especially in Moscow via Robert Goldstein.

At ICF8 Australia mounted another bid (this time successfully) for ICF9 in Sydney in 1997 via Bhushan Karihaloo & Yiu-Wing Mai. There was competition in Sydney for ICF10 including from Japan & USA and innovatively ICF10 was organized in Honolulu in 2001 via Rob Ritchie, Ravi-Chandar, Teruo Kishi & Toshimitsu Yokobori. At ICF9 Rob Ritchie became the eighth ICF President 1997-2001. China did not bid for ICF9, nor for ICF10, nor for ICF11. ICF11 was won in Honolulu competitively for Turin, Italy via Alberto Carpinteri. At ICF10 Yiu-Wing Mai became the ninth ICF President 2001-2005. At ICF11 China did indeed bid for ICF12 but Canada won ICF12 via Bill Tyson & Mimoun Elboujdaini for Ottawa in 2009. Ravi-Chandar became the tenth ICF President 2005-2009.

Exceptionally at this stage a special dispensation was then decided upon by ICF Council whereby from ICF11 Council would decide on the location of the Quadrennial eight years ahead rather than four years ahead. This also then allowed for extended negotiations on the Quadrennial MoU to ensure a clear Quadrennial Contract/MoU with ICF autonomy in the management structure and programme. At ICF11 it was decided by Council to host ICF13 in Beijing, China in 2013 via Shouwen Yu. This completed one of my ICF Presidential policies of 1981 supported by Council and the electoral mandate that the ICF Quadrennials should be organized in India, USA, USSR, China as the four

world super-powers with also the launch of the Inter-Quadrennials Programme.

This also created the *de facto* policy of Council deciding on the location of the Quadrennial eight years in advance taking account of the extended nature of negotiating and agreeing the Quadrennial MoU. ICF now needs to address South/Latin America and a Quadrennial in perhaps Brazil/Argentina and in Egypt/RSA, Africa.

ICF possesses a long reach with a long-range strategy for all ICF Regions and National Organizations via the burgeoning Regionals & Inter-Quadrennials Programme led by Mimoun Elboujdaini.

At ICF12 in Canada it was decided by Council that ICF14 would be hosted by Rhodes, Greece in 2017 with Emmanuel Gdoutos as ICF14 Executive Chairman. Alberto Carpinteri became the eleventh ICF President 2009-2013. NomCo (via Chair Yiu-Wing Mai and Council approval ICF) named for orderly progression Yu Shouwen as Senior Vice-President 2009-2013 and President-Designate 2013-2017 instituting another new *de facto* policy via Council decision.

At ICF13 in Beijing Shouwen Yu became the twelfth ICF President 2013-2017 with Emmanuel Gdoutos as Senior Vice-President - and ICF Council decided that ICF15 would be hosted by Vancouver, Canada in 2021 with also USA involvement envisaged. After much discussion ICF15 will now be in Atlanta, USA in June 2021 with Ashok Saxena as ICF15 Executive Chair. This decision is embodied in a draft ICF/ICF15 MoU. The change of venue is due to a combination of circumstances related to the MoU dual nation negotiation process (Canada/USA) with three professional institutions (ASTM/TMS/CIM) and the crucial requirement for ICF autonomy from untoward control by a collaborating organization. The ICF4 "standard model" of an independent, autonomous ICF structure for the Quadrennial organization (with US\$100K seed funding for ICF15 from Georgia Tech/University of Arkansas as the ICF4 University of Waterloo model) is being adopted. The hope would be that this independent "standard model" be generally applied ongoing. It is envisaged that Canada will be specifically involved in ICF15, Atlanta, USA June 2021.

At ICF11 in Turin the system of an ICF Quadrennial MoU was introduced by Canada (Laurier Forget) for ICF12. This has been successful for now ICF12,

ICF13, ICF14 and ICF15 and will be progressed for ICF16 at ICF14. ICF now has a wide range of understandings and MoU's with national groups such as DVM, ASTM, IGF, CSTAM, JSSFM, UKFESI, InSIS, AFG, IsSIS, EgSIS/FG, FrSIS, CFRC. ICF plans to build on this Regional Development for all the 50+ national ICF Groups.

At ICF12 in Canada via the AwardCo Chair Ashok Saxena a major new ICF policy was introduced regarding the establishment of world renowned ICF Gold Medals and other Awards to enhance the world-premier prestige of ICF. This built on the ICF Honour Lecture Programme whereby Mike Ashby gave the Opening ICF Honour Lecture at ICF4 and Bruce Bilby gave the Closing ICF Honour Lecture at ICF4 with prestigious ICF Honour Lectures thereafter by Jim Rice, Roy Nichols, John Hutchinson, John Knott, Tony Evans, Rob Ritchie, Alberto Carpinteri, Yiu-Wing Mai, Subra Suresh for example - and now an enormously worthy cadre of ICF Gold & Silver Medallists. Ashok continued this enormously important AwardCo work at ICF13 with truly world figures receiving our ICF Gold Medals. And Alberto Carpinteri is now continuing the AwardCo work of Ashok towards ICF14. There has been a call for award/medal nominations at ICF14 by the AwardCo Chair.

At ICF12 was introduced the major development of the ICF website led via Francesco Iacoviello currently President of the Italian Group on Fracture (IGF). This is directly funded in small part via an Agreement with Curran Associates via a contract on reprints of ICF Proceedings. In much larger part this is funded via IGF and this is an important matter to address by the new CEO-Treasurer with the WebCo Chair.

Highlights of the 2013-2017 Quadrennium

Highlights of the 2013-2017 Quadrennium include: An enlarged ExCo with now ten ExCo Directors representatively - and thus altogether sixteen new blood based voting members of ExCo; ICF Mid-Term ExCo in Anaheim May 2015; Official ICF Nominations for the Nobel Prize, the Queen Elizabeth II Engineering Prize and for the Japan Prize; Potential bids mooted for ICF16, 2025 by Bengaluru, India; Berlin, Germany; Melbourne, Australia; Paris, France for decision by ICF Council at ICF14; Addressing autonomy complications regarding ICF15, 2021; Various Inter-Quadrennials in Russia, Africa & Asia especially with plans for South America & variously; New Regional Groups (India, Egypt and others). A key ICF Inter-Quadrennial by InSIS in Bengaluru, India in July 2016.

Most importantly creative work on ICF14 in Greece.

Another important "guideline" policy introduced during my ICF Presidency was for regional geographical rotation of our quadrennials based on

(a) Americas;

(b) Europe/Africa;

(c) Asia/Pacifica

This has been followed almost fully. This started from ICF4 (Americas) with

ICF5 (Europe/Africa);

ICF6 (Asia/Pacifica);

ICF7 (Americas);

ICF8 (Europe/Africa);

ICF9 (Asia/Pacifica);

ICF10 (Asia/Pacifica/Americas);

ICF11 (Europe/Africa);

ICF12 (Americas);

ICF13 (Asia/Pacifica);

ICF14 (Europe/Africa);

ICF15 (Americas).

Accordingly ICF16 should be in Asia/Pacifica in 2025 and ICF17 in 2029 in Europe/Africa. This is a *de facto* guideline policy of ICF subject to quadrennial bids and Council voting on the best bid - taking account of all considerations on merit. Council in its collective wisdom may decide not to follow the rotational guideline.

Well-evidently ICF is in a very healthy state at the half-century stage 1969-2017 looking towards new and adventurous strategies during our second half-century. ICF has evolved from the micro/macro dual vision of being a "Great Meeting Place" quadrennially to become a premier multi-stranded World Association/Academy, as I believe was fore-shadowed by the agile vision of Takeo Yokobori. A key next step involves the work of NomCo towards the election by Council of a new ExCo and a potentially adventurous new blood era for ICF with an exciting new team with innovative ideas.

The proposal that ICF adopt a descriptor as a subtitle to the historic name; as **ICF: The World Academy of Structural Integrity** was passed by ExCo formally in Anaheim May 2011. This was via the introduction of a new Bye-Law rather than any change in the Statutes. In accordance with the Statutes this ExCo decision was actually in force 2011-2013. However via a narrow vote by ICF Council in June 2013 in Beijing this proposal did not find favour with ICF Council. This proposal can be now re-addressed by the new larger ExCo in Rhodes in June 2017 and explored by ICF Council in Rhodes at ICF14. This vision via the adventurous quadrennium of Alberto Carpinteri 2009-2013 is now most especially an issue for the new President 2017-2021 and the new CEO via initially ExCo2 as part of the exploration of the **ICF Strategy 2017-2029**.

Finances

Each Quadrennial/Inter-Quadrennial operates autonomously from a financial standpoint. The annual average ICF *central* expenditure during this quadrennium has been to date GBP 885.00/year (GBP 3,540.00 total over 2013-2017 - so far). This is similar to account expenditures 2009-2013 as in the previous CEO/Treasurer Report to ICF Council at ICF13. And indeed this is the pattern since 1969 at ICF2. The balance at ICF14 will be similar (GBP 9,268.51) to the balance reported at ICF13 after final disbursements. The details have been lodged separately with the Secretary-General. This is laudably frugal running ICF for fifty years on about US\$1,000-2,000/year. The way forward recommended for the 2017-2021 period is for the London Lloyds account to be simply closed and the final balance transferred to a new account established by the new CEO-Treasurer. Arrangements have been made so that Anthony Kinloch of Imperial College, London is now Deputy CEO-Treasurer and a co-signatory on the Lloyds account in London for any necessary facilitation after ICF14.

A key next step involves consideration of a possible new financial policy for ICF by the new CEO/Treasurer perhaps involving the establishment of an ICF charitable arm for fund-raising, national membership subscriptions and industrial subscriptions. For over fifty years ICF has operated via very modest central funds without ado.

Conclusions

It has been my honour and privilege to have served ICF 1969-2017 on Council since the Foundation of ICF at ICF2; on ExCo since 1973; as President 1981-1984 and especially 1984-2017 as CEO/Treasurer. I have been warmly supported by the whole ICF community and twelve Presidents. Through ICF I have had the privilege of working personally with many "Greats" including Alan Cottrell on especially "Fracture & Society"; Paul Paris on "Fatigue"; Michael Ashby on "Fracture Maps and Creep Fracture"; John Knott on "Micromechanisms/Mechanics" (6); Anthony Evans on "Metal/Ceramic Composites" at UCSB; Ashok Saxena on "Creep Fracture" as Rolls-Royce Professor at Georgia Tech; Michael Lewis on "Advanced Ceramics" via Warwick University; Gordon Dunlop & Wei Zhou on "Lightweighting & Industrial Ecology" via Nanyang Technological University/Queensland University; Robert Ritchie on the Bio-Materials domain & ICF10; Alberto Carpinteri on new adventurous realms for ICF and ICF11; Palle Rama Rao on ICF6; Emmanuel Gdoutos on ICF14; Takeo & Toshimitsu Yokobori at Sendai throughout; Mimoun ElBoujdaini on ICF12 & IQ's; Francesco Iacoviello on the ICF website; Ronald Armstrong on Grain Boundaries; Jim Rice on many discussions on "Fundamentals" including the fracture of the earth itself; Gordon Williams, Anthony Kinloch, Colin Humphreys, Victor Whittaker, John Martin & Peter Flewitt in England; Bill Tyson, David Embury, George Weatherly and David Wilkinson in Canada - my two homelands.

The cornerstone of my strategy for some fifty years has been that ICF has aimed to be a balanced, multi-stranded, imaginative, forward-looking community and virtual academy of very good friends worldwide - in a possibly unique way in such engineering societies as ours. With a mission of Safer, Sustainable Engineering for the common good of humanity and the planet.

This strategy has been facilitated through my career trajectory working in many countries. Starting from UK industry in Birmingham in 1957 and at

Aston, then research at Oxford University, England - onwards to Melbourne, Australia; Varanasi, India; Waterloo, Canada; Houston Texas; TCD, Dublin, Ireland; UCSB California; Exxon New Jersey; Plymouth, England; NTU Singapore; Queensland, Australia; UCC Cork, Ireland; Aston/Birmingham Universities, England - and an especially transformational year 1974-1975 at Cambridge with Ashby & Knott - and now based in Vancouver in 2017. All via my hopefully worthwhile work within the great multi-stranded landscape and well-balanced global hinterland of ICF.

Many, many thanks to the whole ICF community for electing me to the Founding Council in 1969 and supporting me over these many years in my various posts and especially for the many warm & creative friendships which have sustained, gloriously enriched and fulfilled my working life from the Sheffield Blast Furnaces to the Rocky Mountains of British Columbia.

Vancouver, Canada

March 23 2017

Acknowledgements

Many friends from the ICF global Community have kindly commented beneficially on drafts of this paper. I am especially grateful to my original teachers of metallurgy G Van Praagh of Christ's Hospital, V N Whittaker of Aston and J W Martin of Oxford and to T Yokobori, B Averbach, A K Head, R W Nichols, D Francois, P Rama Rao, A Carpinteri, J F Knott, R W Armstrong, R O Ritchie, E E Gdoutos, A Saxena, M ElBoujdaini, S Yu, J R Rice, M F Ashby, A T Yokobori Jr, A Kinloch, Y W Mai during my ICF years.

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