A celebration of mechanics: from nano to macro.
The J. Michael T. Thompson Festschrift issue

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This Theme Issue is dedicated to the topic ‘Mechanics: from nano to macro’ and marks the 75th birthday of Dr J. Michael T. Thompson, Fellow of the Royal Society, whose current affiliations are as follows: (i) Honorary Fellow, Department of Applied Mathematics and Theoretical Physics, Centre for Mathematical Sciences, University of Cambridge; (ii) Emeritus Professor of Nonlinear Dynamics, Department of Civil, Environmental and Geomatic Engineering, University College London; and (iii) Professor of Theoretical and Applied Dynamics (Distinguished Sixth Century Chair, part-time), University of Aberdeen. He also serves as Chairman of the Board of Directors at ES-Consult (consulting engineers) in Copenhagen, Denmark. The pertinent question that arises from the very start is: should we first salute Michael and then describe the Theme Issue, or vice versa? Indeed, according to Blaise Pascal (1623–1662), the last thing one discovers in composing a work is what to put first. I would like to take the liberty of deviating from the tradition of the Philosophical Transactions and start with the tribute to Michael; after all he is the prime cause of this Theme Issue.

1. Celebration of J. M. T. Thompson’s 75th birthday

This introduction is an attempt to capture in a few, personal words Michael Thompson’s remarkable impact on, and contribution to, theoretical and applied mechanics and more broadly to engineering science. The task would have been truly daunting were it not for
Figure 1. Michael at the time of his election to the Fellowship of the Royal Society in 1985.

the ‘foundation’ laid on the occasion of Michael’s 65th birthday by his mentor, Lord Henry Chilver (1926–2012) (there are not many mentors who live to see their students get to age 65; even fewer are the students who get to 65 and merit their advisers contributing to a special issue dedicated to the occasion). I refer to the Modern Trends in Theoretical and Applied Mechanics workshop, held in 2003 at University College London (UCL) whose proceedings were published in the journal *Nonlinear Dynamics*. The first paper was characterized by van der Heijden [1], Guest Editor of the issue, as ‘essentially a transcript of the meeting’s opening address by Henry Chilver, with whom Michael worked in his early years at Cambridge and UCL’.

Chilver [2] opens his address, which is tellingly titled ‘Michael Thompson: his seminal contributions to nonlinear dynamics—and beyond’, by describing Michael (who is pictured in figure 1) as one ‘who over a period of four decades, has become a world leader in the development of modern concepts of nonlinear dynamics and the application of these concepts to modern problems’. I take the liberty of quoting an extended excerpt from his testimony:

Michael came to Clare College, Cambridge in 1955, where he studied mechanical sciences. He was a brilliant undergraduate. In Part I of the Mechanical Tripus he won the Rex Moir Prize. In Part II he won the Archibald Denny Prize. Both of these were top prizes in mechanical sciences. After graduating in 1958, he was determined to pursue a research career.

I had come from Bristol to Cambridge in 1954, with structural stability interests in both teaching and research. In teaching I had developed a series of lectures on structural stability in Part II of the Mechanical Science Tripos and this brought me into contact with Michael and other final year students. This led to Michael deciding, on graduating, that he would like to pursue research into some of the most challenging stability problems of engineering structures. And so began the career of one of the most distinguished researchers, in our time, in nonlinear mechanics and its applications.

In 1958, when Michael graduated, the leading thinkers in the field of structural stability were concerned with, what one might call, static elastic stability, and researchers concentrated on the extension of simple static stability principles to new and evolving structural forms. One of the most baffling problems, at that time, was our inability to predict accurately the uniform, external, elastic-buckling pressure of thin spherical shells.
Michael began his researches with the study of very thin copper shells, which he formed by the electro-chemical deposition of a very thin spherical layer on a solid internal sphere of paraffin wax. After deposition, the internal paraffin wax was melted slowly through a pin-hole in the copper shell, to yield probably the most perfect shells ever produced for such research.

What became evident from these studies was that, well before the theoretical critical external pressure could be achieved, the spherical geometry of the sphere was becoming minutely distorted from its original spherical form. As external pressure increased, the shell reached a highly dynamic condition of instability at external pressure well below the theoretical elastic buckling pressure. It was clear that the simple linear theory of elastic stability alone was inadequate for the analysis of such a problem...

In 1960, while still a research student, Michael won the John Winbolt Prize for a research essay, thereby making a ‘clean sweep’ of all the top graduate and undergraduate prizes. In the following year, and towards the end of his PhD researches, he won a research fellowship in Peterhouse. This enabled him to continue over the next 3 years, with complete independence, his studies of nonlinear mechanics. During the second year of this fellowship, Michael and his young wife Margaret spent a year in California where Michael was a Fulbright Research Associate in the Department of Aeronautics and Astronautics at Stanford University.

In 1961, I myself moved from Cambridge to take up the Chadwick Chair at University College London (UCL). At the end of his research fellowship in Peterhouse, in 1964, Michael also came to UCL, where he began a remarkably successful career in nonlinear phenomena, and its applications to practical problems. A research group in Structural Stability at UCL was quick to develop, and very considerable progress was made in fundamental research.

Van der Heijden [1] emphasizes that ‘Michael has been a member of UCL’s Civil Engineering Department for 38 years. He is best known as the Founder/Director of the Centre for Nonlinear Dynamics and its Applications. The Centre was set up in 1991 and quickly became an internationally renowned centre for interdisciplinary research in nonlinear dynamics’.

During his period at Cambridge and then UCL, Michael published a series of papers on general theory of elastic stability [3–22] and developed—largely independently of another giant of modern mechanics, Warner Tjardus Koiter (1914–1997)—the theory of imperfection sensitivity of structures. Michael had been unaware of Koiter’s PhD thesis [23], published in Dutch in 1945. In his ‘Advice to a young researcher’ [24], he reminisces: ‘it was, in fact, when I submitted my paper on the basic principles of elastic stability [7] in 1963 to Rodney Hill at Nottingham that he drew my attention, for the first time, to the work of Koiter…’. These researches, both in solo papers and in collaboration with associates, culminated in a monograph [25] together with his former student Giles Hunt, who later became a long-term collaborator. In its preface Michael wrote

For several years the first author was blissfully unaware of the classic dissertation of Prof. W. T. Koiter which had surprisingly lain largely unknown since 1945 and has in fact only recently been translated into English by the National Aeronautics and Space Administration of America. This was indeed most fortunate since the weight of Prof. Koiter’s contribution could well have discouraged him from proceeding with his own development of the subject. As it transpired, the full significance of Prof. Koiter’s work has filtered slowly into our consciousness in a gentle stream, moderated by the Dutch language and by our temperaments which have invariably preferred to explore the field for ourselves. This having been said, we must nevertheless hasten to admit our deep indebtedness to Prof. Koiter’s work, which we hope is adequately acknowledged in the text.

Later, in his own reminiscences, Koiter [26] referred to this quote as ‘eloquent’ and concurred that the researches at UCL were done ‘… independently’.

Chilver [2] characterized A General Theory of Elastic Stability [25] as the ‘treatise… as a definitive one… we see a bringing in together of the new concepts that Michael and Giles had developed
during their researches, leading to a unified conceptual framework for stability theory’. As against the perspective of the department’s head, occupied by Chilver at that time, it is most interesting to have an input from the then-student Hunt [27] about this period:

There’s nothing like being in the right place at the right time, and in the late 1960s there was probably no better place for a research student with a structural bent than the Stability Research Group at University College London. Henry Chilver, as head of the Department, was establishing a world class group in the theory and analysis of buckling, set to rival that of Budiansky and Hutchinson at Harvard. Alastair Walker and Jim Croll had arrived from Scotland and New Zealand respectively, and John Roorda had left a legacy of elegant experimental and comparative theoretical work on the nature of imperfections. Most importantly from this writer’s perspective, Michael Thompson just had been appointed from Cambridge. The emphasis was on the phenomenology of buckling, with a distinctly nonlinear flavour. So, having been indoctrinated, soon after completing my PhD, I was fortunate to be asked by Michael to join him as coauthor of *A General Theory of Elastic Stability* [25].

On another occasion, specifically in a paper included in the special issue [28] dedicated to his own 65th birthday and formal retirement from the University of Bath, Hunt [29] mentions interconnection with Harvard University, while

briefly describing two conferences that on reflection, appeared to be pivotal in the development of my own discipline. Although I was unable to attend the first meeting in Harvard in 1974, the proceedings edited by Budiansky [30] instantly became my bible. For the second in London in 1982, I was fully involved and helped edit the proceedings [31].

I participated at this latter, magnificently organized conference attended by many luminaries in the field, and witnessed the breadth of interests of Michael Thompson, at that time actively engaged with catastrophe theory. I would like to stress that Michael does not only heavily propagate his ideas but stops from time to time to ask big questions. In this regard, I would like to mention two of his papers [32,33]. In the former one, he examined catastrophe theory and its philosophical base. In the latter, he essentially posed a question: ‘Catastrophe theory in mechanics: progress or digression?’ The interested reader may also consult an article on René Thom [34] and a paper by Boutot [35]. Whereas the anonymous author of the former is quite sceptical of the catastrophe theory (‘great things were expected from René Thom’s catastrophe theory when it first emerged in 1970s from the arcane deliberations of mathematicians into the everyday world of people who just hope for a more ordered life’), the latter, not unlike Thompson [33], wants ‘to “rehabilitate” the theory by forgoing the controversy raised by scientists about its practical efficiency’.

Likewise, optimization or ‘making things the best’ (in the terminology of Ashley [36]) was vividly shown by Michael and his collaborators to be a risky process [37–40]. Specifically, one paper [37] was written with the intention

... to demonstrate how a process of structural optimization leads to designs which are liable to exhibit the dangerous failure characteristics well known in buckling of thin shells... Optimization thus leads to buckling instabilities, but worse is to come... In a structure of any appreciable complexity optimization seems to call for simultaneity of failure loads, and this is becoming a significant feature in the design of large composite structures. Unfortunately the coupling of even apparently unrelated and harmless failures can give rise to severe shell-type instability...

Besides, Thompson & Hunt [40] observe ‘that an optimum design is by its very nature imperfection-sensitive, since any deviation from the idealized optimum design must yield a lower failure bound’.
Thus, despite the fact that ‘the ethics of our profession today does not allow any design for a structure without optimization’ [41], one should proceed with extreme caution, as Michael and his co-workers showed. The answer to the extreme question [42], ‘Shall we abandon optimization theory?’ should be in the negative, as was substantiated by Ohsaki & Ikeda [43]. These authors specifically showed that ‘imperfection sensitivity law varies according to the type of a critical point, and coincident critical points are not always imperfection-sensitive. The sensitivity is severe for semi-symmetric and completely symmetric bifurcation points, but is less severe for a hilltop branching point’. In the book by Elishakoff & Ohsaki [44], the authors advocate the idea that for uncertainty and optimization not to remain purely academic concepts, they ought to be combined with anti-optimization, or with a search procedure for worst scenarios under uncertainty.

And as uncertainty has been mentioned, I would like to quote from Hunt & Virgin [45]:

... we take great pride in the genealogy of our research supervision. We were both supervised by Michael, himself the student of Henry Chilver, who got his PhD from the University of Bristol under the supervision of Alfred Pugsley (1903–1998), the father of structural safety to engineering in the UK over most of the last century.

Myself, I take great pride by my own research supervision, by Academician Vladimir Vasilievich Bolotin (1926–2008), who was the father of structural safety in Russia over most of the second half of the last century and the beginning of the present one. The classic books of Sir Alfred Pugsley (1903–1998) [46] (with whom I had a chance to correspond on matters of structural safety) and Bolotin [47] strongly influenced uncertainty analysis, worldwide. This above ‘genealogy’ of Michael perhaps explains the fact that he embraced the probabilistic approach—unlike many contemporaries—and proposed the probabilistic theory of imperfection sensitivity [48], independently of Bolotin. I am pleased to share this statistical ‘ancestry’ with Michael, in addition to the broad themes of stability and nonlinear dynamics, albeit in different directions. Some four decades later Michael returned to the probabilistic concepts in a paper with Jan Sieber [49].

Michael found very interesting applications of instability phenomena that extend to bifurcational instability of an atomic lattice, identifying a small symmetry-breaking shearing stress as an imperfection [50]. The results of his numerous pursuits appeared in the book *Instabilities and Catastrophes in Science and Engineering* [51]. In his Foreword Sir James Lighthill (1924–1998) wrote

Nobody could have been better qualified than Professor J.M.T. Thompson to prepare the present splendidly clear account of the entire subject.

Smith [52] in the review published in the *International Journal for Numerical Methods in Geomechanics* characterized it as a ‘good introduction to the literature... entertaining bedtime reading’. Rabitz [53] in his review in *American Scientist* noted: ‘The subject is a timely one, and the author has indeed given us a survey encompassing applications to engineering, chemistry, biology, and physics... the survey clearly elucidates the common mathematical structure underlying the rather diverse applications’. Leipholz [54] in his review in the *Journal of Applied Mechanics* characterized it as ‘most impressive, and stimulating survey of modern stability theory... fascinating introduction into the state of the art... highly recommended’. Indeed, the vast amount of diverse topics—from astrophysics and gravitational collapse to dynamical field theories to neural activity in the brain—testify to Michael’s unbounded interest in and command of anything that may lose stability.

That book was followed by another one, *Elastic Instability Phenomena*, co-authored with Hunt [55]. Nachman [56] reviewed it for *Applied Mechanics Reviews* using the adjectives ‘very clever’ and ‘very nice’. Tvergaard [57] in *Journal of Applied Mechanics* called it a ‘good, broad introduction to the area’.

He then immersed himself in the theory and applications of chaos theory with a stream of beautiful papers and a book *Nonlinear Dynamics and Chaos* [58] co-authored with Bruce Stewart.
I was gratified by his kind acceptance of my invitation to contribute a review paper on chaotic
dynamics and Newtonian legacy to *Applied Mechanics Reviews* [59].

At this juncture, I would like to mention that I approached Michael to share his experiences
with some of his books. Here is his testimony:

When Isaac Elishakoff asked me to describe a period in my early research activities at
University College London that was singularly stimulating and exciting, it didn’t take me
long to realise that 1974 was quite a pivotal year. My book with Giles Hunt on the general
theory of elastic stability had appeared in late 1973, and I couldn’t resist taking a copy with
me to show to various colleagues at the Harvard IUTAM Symposium on the *Buckling of

Then, out of the blue on the 4th of September, I received an exciting and energizing letter
from David Chillingworth, a pure mathematician at Southampton University, who had
noticed our book as a recent acquisition of his university library. In it, he pointing out the
great similarities between what Giles and I were doing and the catastrophe theory of René
Thom that was being publicised at the time by Christopher Zeeman and his colleagues at
Warwick University. Extracts from David’s letter are reproduced [in figure 2], and in the
body of the letter, he recounted in his elegant script and with his usual clarity of expression
the essentials of catastrophe theory, and how they related to our work at UCL on the
buckling of elastic structures.

I immediately invited David to come to UCL for a chat about this seminal collision of ideas.
Quite remarkably, Giles had just computed the imperfection sensitivity characteristics for
a stiffened elastic plate and drawn a beautiful three-dimensional representation of the
singularity (see fig. 6 of my ‘advice article’ in this Theme Issue). David immediately
identified this as a hyperbolic umbilic catastrophe, seemingly the first known practical
example of this important interactive phenomenon.

The galvanizing impact of this meeting is well testified by the fact that within two months
Giles and I had submitted a major article to the *Journal of Applied Mathematics and Physics
(ZAMP)* [60] entitled *Towards a unified bifurcation theory*, in which we laid out in full the
relationships between the two lines of research, and including, of course, Giles’ hyperbolic
umbilic picture. This turned out to be an influential and highly cited paper. It appeared
in 1975, as did David’s insightful introduction to catastrophe theory in the *IMA Bulletin*
[61], which served as an excellent and accessible guide to many of my subsequent research
students.

The close working relationships that catastrophe theory triggered with the Warwick group,
including Ian Stewart and David Rand, served me well in later years when I encountered
the perplexing chaotic motions of articulated mooring towers.

Let us give the podium to Lord Chilver:

Throughout his career, Michael has always been concerned to achieve communication of
his ideas to the widest possible audiences of engineers, applied scientists and others. The
elegance and clarity of his many hand-drawn diagrams have long been recognized by
international readers of his work. Eight figures from his book on *Nonlinear Dynamics and
Chaos* [58] were reproduced by Ian Stewart in his popular book *Does God Play Dice? The
Mathematics of Chaos* [62].

Chilver also puts it very fittingly when he writes that

Michael’s progress from a student in mechanical sciences to the founder and director of an
international scientific centre is a remarkable history. His work has opened up many new
vistas of research, and has inspired all those who have worked with him [and not only those
who have worked for him!]. We are deeply honoured to have been able to work with him,
in one way or another, during his scintillating career, and have learnt so much from him.
Dowell [63] in his review in the AIAA journal had the following to say:

This book will be welcomed by all those readers who have sought an introduction to the recent developments to nonlinear dynamics and chaos. The recent discovery (or a rediscovery some would say, giving Poincare his due) of random-like, broad-band oscillations in the response of simple mechanical systems whose parameters are entirely deterministic, has led to one of the most exciting periods in the development of nonlinear dynamics since the days of Poincare… might be the best place to start…

At one point in my career, I was invited to the University of Cambridge as an Overseas Fellow. I was looking forward to this opportunity for possible collaboration with several scientists in the UK, and first and foremost with Michael. However, my wife Esther, who is a medical doctor, had an accident on a ladder, while looking for a book in which a condition similar to her patient’s was supposedly described. This prevented me then from going to Cambridge, and there has been no
other opportunity since then. However, I—since I am one of the 14 000 people owning his books—and many others, had a chance to continue to learn from Michael’s papers and books, inspired by his keen pursuit of truth, elegance and simplicity.

To digress, I would like to answer in advance a possible sceptic who may claim that the extensive quotes from reviews on Michael’s books are superfluous. I personally believe that books which present not only strictly original material but also the links between the different elements are most important vehicles for propagation of knowledge and attraction of the reading public. Far too many prominent scientists appear to be ‘lazy’ when it comes to book writing. Instead, the h-index, the number of papers cited by an at least equal number of authors, is king in the realm of assessing others and oneself. This leads people to deal with hot topics alone instead of trying to find solutions to older problems which often remain unresolved and abandoned. I am not against the h-index, but it ought to be supplemented by another index—let us call it the e-index—which would list the number of papers or books that cite the books of a particular author and also the characteristic adjectives used in the reviews.

I am pleased that Michael responded positively to my invitation to contribute to this issue. His beautiful piece on the advice to a young scientist [24] alone would have been a sufficient reason for launching it. In his case, both the h-index and the e-index would have been high.

In recent years, Michael devoted much energy to promotion of public understanding of science (figure 3), producing several DVDs, including (i) Instabilities and Catastrophes; (ii) Predicting the Unpredictable: seeing Order within Chaos; and (iii) Twisting, Coiling and Knotting in DNA Replication. Much additional information can be found on his personal website: www.homepages.ucl.ac.uk/~ucess21/.

In my humble opinion, Michael’s most notable public service is the 10-year editorship of this very journal Philosophical Transactions of the Royal Society A. For a detailed review of the changes that took place, one can read his article [64]. I will mention only the Millennium and Triennial issues, subject clusters, as well as phasing out of the publication of individually submitted manuscripts, making each issue a collection of papers devoted to a single topic. Each issue is, in Michael’s terminology, ‘creating a “symposium” in print’.

The recent book in Russian—in the process of being translated into English—by Perelmutter & Slivker [65] contains a gallery of photos of 44 scientist mechanicians, who contributed most

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Figure 3. Michael giving a public understanding of science lecture at Cambridge in 2004. (Online version in colour.)
in development of stability theory of structures. There are two living scientists listed: Michael Thompson of the UK and Alexander Guz of Ukraine.

Let me conclude on a note which to some may sound frivolous. Still, I feel that a few words in Latin would not be inappropriate in this setting—seeing that it was the vehicle of European science when the Royal Society was founded, and it graces the society’s motto to this very day. So—*Feci quod potui faciant meliora potentes*—meaning the following: ‘I did all that I could. Let those who can, do better’. This phrase was used by painters of the Renaissance era, while they were signing their creations. It was also used by Roman consuls when they were transferring power. I mean it literally: may there be, in 5 or 10 or more years, yet another celebration of Michael’s achievements and someone surpass the present introduction in terms of both content and eloquence!

We look forward to many more years of being constantly amazed by Michael’s energy, intellectual vigour, creative dynamism and generous and exciting personality.

2. Description of the issue

Owing to the Renaissance-type interests and contributions of Michael, it was felt fitting to celebrate this event with mechanics—from the nano-scale to the macro-scale. The Theme Issue opens with the personal salute to Michael by his former students, Hunt & Virgin [45]. I was delighted to see, on the one hand, Lord Chilver’s [2] tribute to his former student, and now the essay on Michael’s teaching style by two of his own former students and now colleagues. As a Chinese proverb maintains, ‘Teachers open the door, but you must make the entry yourself’. It must be a rather unique personal and scientific quality of Michael that both his advisor and his advisees are eager to testify about him, in exponential terms.

Michael’s own piece [24] is a continuation of his work as an educator. He offers advice to young researchers, which will prove no less useful for not so young ones; specifically, he outlines—based upon his own rich experience—the nitty-gritty of how to enter the doors opened by the teachers and advisers. I hope that Michael will maintain his impetus and enlarge his contribution to a book.

The other papers are divided into following sections. Papers in the first section, Nonlinear Continuum Mechanics, deal with modern nonlinear aspects in mechanics. Specifically, Hutchinson [66] studies the role of substrate nonlinearity in the stability of wrinkling of thin films bonded to compliant substrates; the initial post-bifurcational range is investigated. He shows that the substrate pre-stretch has a significant effect on the nonlinearity, relevant to wrinkling. This investigation was motivated by the fact that in many film–substrate systems, compressive buckling of the film into wrinkling mode is undesirable. For the neo-Hookean elasticity, the author uncovers fold-like or ridge-like wrinkle shapes. Substrate nonlinearity leads also to a transition of a periodic wrinkle pattern to one alternating between highly localized undulations and relatively flat regions. It turned out that the ‘localization phenomena usually set in at compressive strains well above the bifurcation strain and are not captured by the initial post-bifurcational approach’. In the paper by Di Paola *et al.* [67], the authors deal with non-local effects, such as additional body forces acting on material volumes and depending on relative displacements. As they mention, their ‘theory basically aims to introduce non-local interactions among different locations of the body, in terms of elastic, central long-range body forces proportional to the interacting volumes or masses’. They demonstrate that the elastic equilibrium problem is ruled by a set of integral-differential equations in terms of displacements. This theory appears to be applicable to soft biological tissues, modern bio-mimetic materials and carbon/epoxy nanocomposites as well as to small-scale cases where classical mechanics is not supported by experimental results.

The next section is titled Nanomechanics. The paper by Spanos *et al.* [68] deals with stochastic estimation of physical properties of nanocomposites via finite-element discretization, for predicting nonlinear elastic and thermal properties of single-walled carbon nanotube-reinforced composites. The paper by Lenci *et al.* [69] is devoted to the dynamic integrity concept
proposed by Michael and developed further by these authors, with a view to interpretation of experimental results. Two specific experiments are considered in detail, a microelectromechanical system and a rotating pendulum, the former simulating a micro-scale phenomenon and the latter dealing with macro-scale behaviour. The authors succeed in showing that ‘the dynamic integrity concept is able to justify, or even possibly predict the experimental results’. The study by Elishakoff et al. [70] is devoted to identification of a bacterium or virus attached to a double-walled carbon nanotube by vibrational means with the frequency shift serving as indicator.

In the section titled Micromechanics, the paper by Aboudi & Ryvkin [71] presents several methods of analysis of composite materials with periodic microstructures subjected to localized effects, such as concentrated loads, cracking or stationary/progressive damage. The study by Melcher et al. [72] is devoted to mechanical systems subjected to repeated impacts. The specific motivation of this paper is an attempt to understand the complex dynamical properties of the tapping mode in atomic force microscopy, as observed in several previous studies. The authors consider a flexible micro-scale cantilever excited at its clamped end, so that the narrow tip at the free end repeatedly impacts with a sample in order to capture surface properties.

In the section titled Biomechanics, the paper by Pratab et al. [73] shows that Crick’s idea of knobs-into-holes packing of hydrophobic residues, with a stabilizing interface thus formed between two $\alpha$-helics in a coiled coil, may be generalized to three species of a four-helix bundle. One motivation of this study was the possible role of $\alpha$-helical bundles in providing confrontational ‘switches’ for various kinds of molecular machinery.

The section Mechanics of Instability opens with the research by Hunt et al. [74], the central issue being the kink or shear banding that takes place in many structural and material systems, on scales ranging from micro to macro. The authors mention that on this topic ‘everyone has his or her favourite view’ stressing that in the past authors resorted to either finite-element analysis or the discrete-elements method. Although, here, they deal with linear elastic behaviour, the geometry is nonlinear. Simple models are introduced for either kink banding or shear banding. The topic of the paper by Virgin & Wiebe [75] is the notion of critical slowing down which serves as an indicator of approaching bifurcation with sluggish response of the system to external perturbations. This phenomenon has been observed in biological systems as an early warning sign of extinction of species and has been used for forecasting climate shifts and predicting phase transitions in statistical mechanics. The paper by Liu et al. [76] is devoted to a new control method applicable for a class of non-autonomous dynamical systems that exhibit stable coexisting solutions. The authors demonstrate that increase in the duration of the control action and/or the number of control actuators permits successful switching between the stable solutions using a lower control force.

The final section, Macromechanics of Vibrations, comprises three papers. That of McRobie et al. [77] establishes parallels between the dynamic responses of flexible bridges under the action of wind and the forces generated by crowd loading. This phenomenon permits application of conclusions drawn in one field to another. The authors also stress that there are ‘additional complications of randomness inherent in wind engineering (be it buffeting by incident turbulence or spanwise decorrelation of vortices’s shed) and the inter- and intra-personal variability inherent in human walking’. Amabili’s paper [78] notes that ‘reduced-order models are essential to study nonlinear vibrations of structures and structural components. In fact, large models with many thousands or more degrees of freedom obtained by commercial finite-element codes cannot be used to obtain all the branches of the forced vibration response around a resonance of the structure. This limitation is mainly due to the huge computational problem involved and to the fact that stiff systems of equations are obtained due to the very different time scales associated with different degrees of freedom’. The author offers suggestions for selection of the modes to facilitate reduction of the number of degrees of freedom. In the study by Takács & Stépán [79], the authors deal with the delay differential equation for ‘mystical’ low probability large damage phenomena taking place in shimmy. They calculate the instantaneous lateral tyre deformations in thin contact patches, using a simple bicycle model of a passenger car.

It is hoped that the readers will enjoy their stroll through this issue.
Michael, many happy returns! May the authors and readers of this issue exhibit fairness, justice and tolerance to others’ ideas, being aware that good interrelations among us are a major prerequisite to better science.

As a postscript, it is pleasing to report that Michael recently was awarded the prestigious 2013 Lyapunov Award by the American Society of Mechanical Engineers.

References