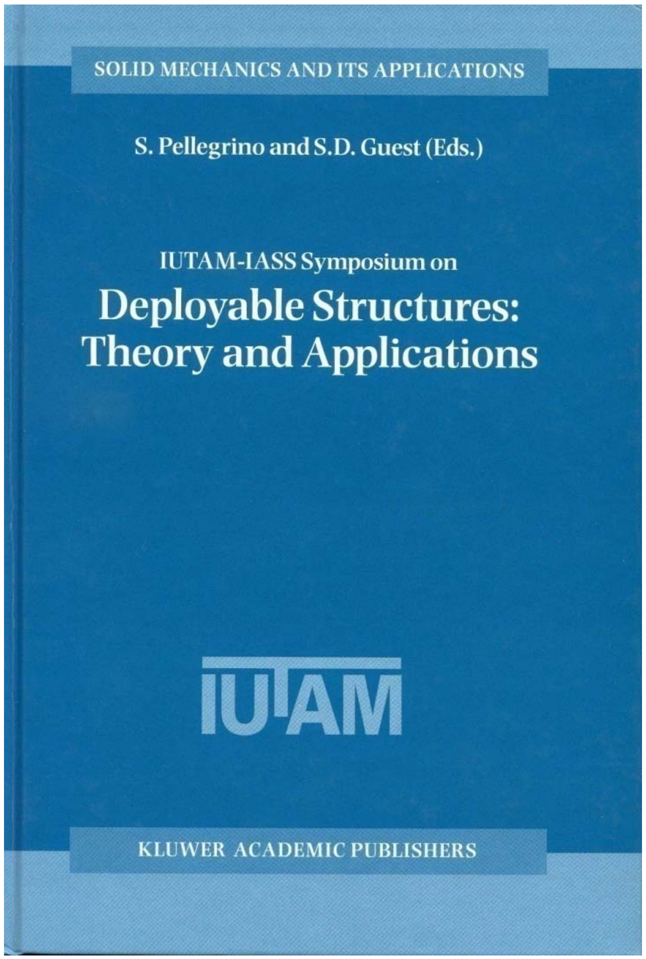
space structures laboratory

Professor Sergio Pellegrino
California Insititute of Technology

# Deployable Structures: What Have We Learnt During the Last 10 Years?

Sergio Pellegrino
sergiop@caltech.edu

# 10 Years Ago


SOLID MECHANICS AND ITS APPLICATIONS
S. Pellegrino and S.D. Guest (Eds.)
IUTAM-IASS Symposium on
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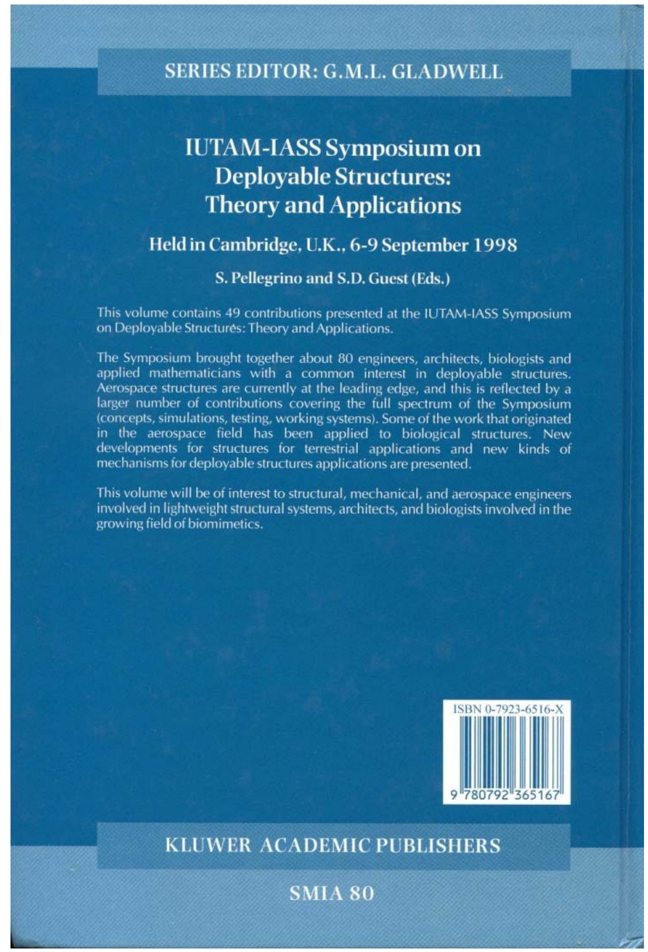
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S. Pellegrino and S.D. Guest (Eds.)
This volume contains 49 contributions presented at the IUTAM-IASS Symposium on Deployable Structures: Theory and Applications.
The Symposium brought together about 80 engineers, architects, biologists and applied mathematicians with a common interest in deployable structures. Aerospace structures are currently at the leading edge, and this is reflected by a larger number of contributions covering the full spectrum of the Symposium (concepts, simulations, testing, working systems). Some of the work that originated in the aerospace field has been applied to biological structures. New developments for structures for terrestrial applications and new kinds of mechanisms for deployable structures applications are presented.
This volume will be of interest to structural, mechanical, and aerospace engineers involved in lightweight structural systems, architects, and biologists involved in the growing field of biomimetics.
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# Excerpt from Discussion

**4. Size limits of mechanical vs. inflatable deployable structures**

*Professor Steele*: I attended a workshop on inflatable structures at JPL last spring, and I was totally amazed by the plans that people have for very large space structures. It seems to me that the only way to go is inflatables. So there must be a transition between the mechanical systems that people have talked about here, extending the size of these, and if we can work down the list that Dr Lou has made for us, the smallest inflatable structures that make sense. Or do the mechanical people think that they can build 100 m or a 1 km size solar sails —can you imagine being able to do this with mechanical devices?

# Excerpt from Discussion

*Dr Lou*: I think that this is a very good question, but there is no simple answer. First, let's consider it from the standpoint of accuracy and let's talk about space reflectors; inflatable technology at this point cannot deliver sub-millimetre accuracy. To go into sub-millimetre or visible wavelengths the only option currently is to use to mechanical systems, no matter what the size is. Because of this constraint, when we talk about the Next Generation Space Telescope, to replace Hubble, we talk about an 8 m primary reflector. This constraint on mechanical systems is imposed by the fairing of the launch vehicle. Scientists would like to have 20-25 m primary reflectors, but this cannot be realised with the given precision requirement. Second, let's consider size and mechanical requirements. If the fairing of the launch vehicle is large enough and mass is no problem, going for an inflatable structure may not be the best choice. A trade-off between mechanical and inflatable systems is required.

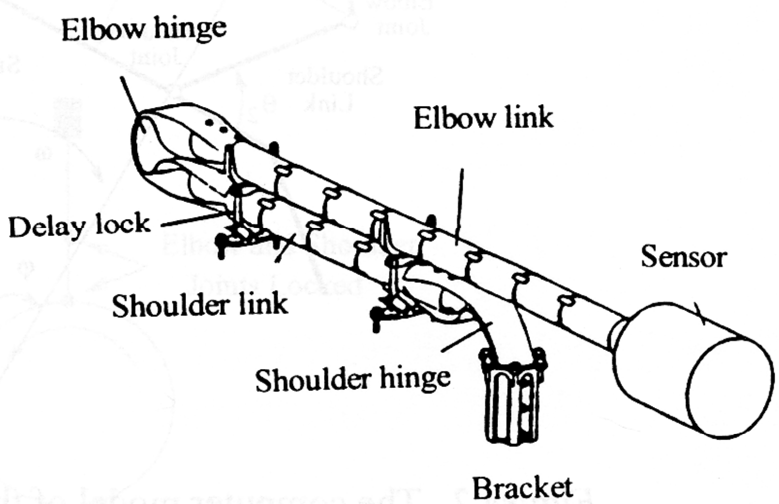
# What has happened during these 10 years?

- Inflatables have not become main stream
- Mechanical deployables still going strong and continuing to get better (e.g. extended versions of Astromesh, optimized coilable booms)
- Ambitious demonstrations of innovative technologies have failed to secure flight opportunities
- Opportunities for novel low-cost structures have come mainly from small satellite missions

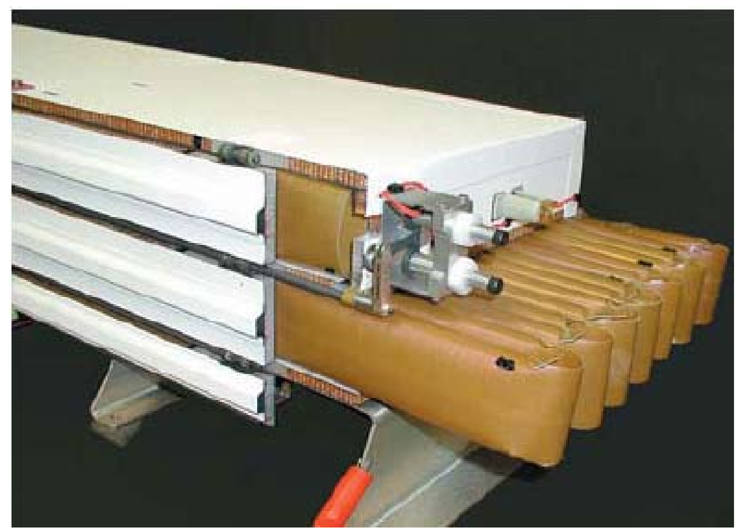
# Deployable booms with integral hinges

**CONTROLLING THE PERFORMANCE AND THE DEPLOYMENT PARAMETERS OF A SELF-LOCKING SATELLITE BOOM**

W. SZYSZKOWSKI and K. FIELDEN
*University of Saskatchewan, Department of Mechanical Engineering, Saskatoon SK, Canada, S7N 0W0*




Qinetiq boom

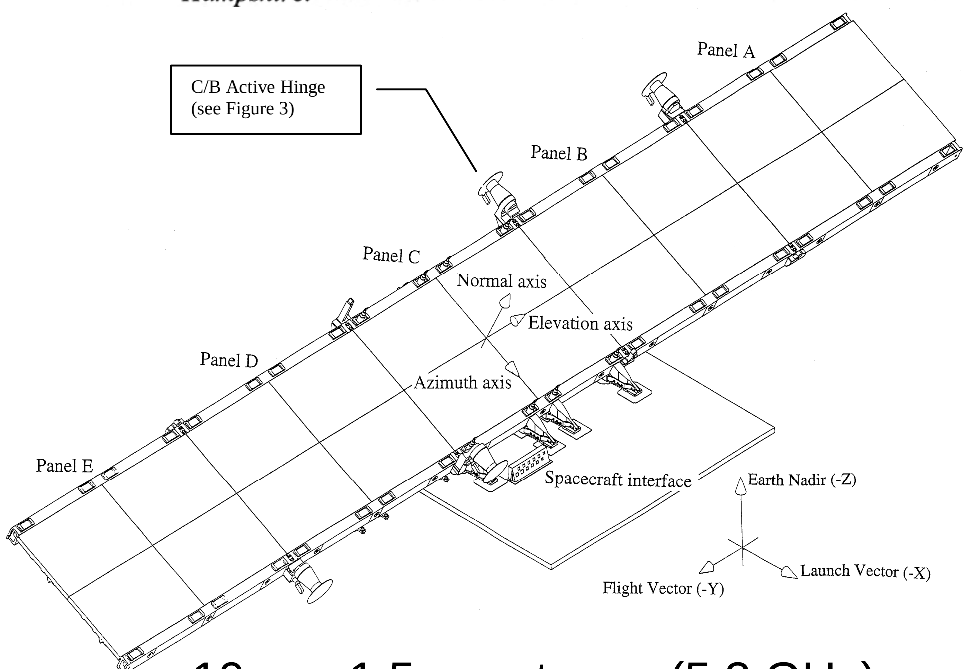


NGST Astro Aerospace MARSIS antenna

# Synthetic Aperture Radar Structures

**DESIGN, INTEGRATION AND TESTING OF AN ADVANCED SYNTHETIC APERTURE RADAR**


D. WRIGHT
*Matra Marconi Space Systems Limited*
*Gunnels Wood Road,*
*Stevenage,*
*Hampshire.*

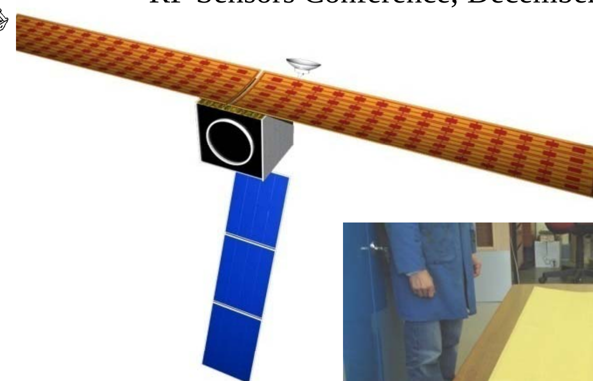



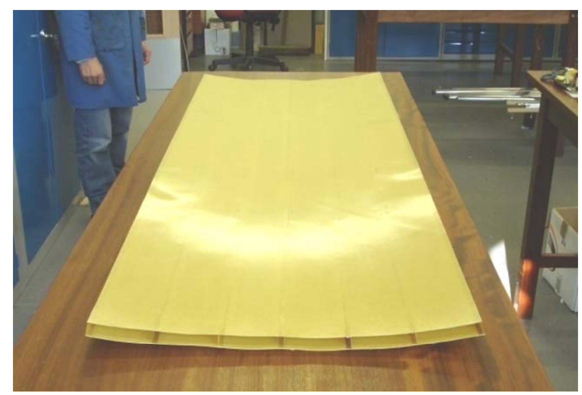

10 m x 1.5 m antenna (5.3 GHz)
structural mass 15 kg/m$^2$

**A Space Based Radar Antenna Concept for Global Biomass Measurement**


**P. Howard, M. Notter and C. D. Hall**
EADS Astrium Ltd, Anchorage Road, Portsmouth, PO3 5PU, U.K.
**S. Pellegrino**
Department of Engineering, University of Cambridge, Cambridge, CB2 1PZ, UK


RF Sensors Conference, December 2006, ESA





17.3 m x 2. 9 m antenna (0.4 GHz)
structural mass 1 kg/m$^2$

# Role of Simulation

- Interest in inflatables and other membrane structures has resulted in very significant advances
- Transition from design tool to high-fidelity, non-linear finite element simulation techniques
- User-defined subroutines implementing more accurate constitutive material models
- Detailed experimental validation and verification of predictions

# Emergence of Alternative Approaches

- Active shape adjustment
- Active materials (e.g. memory matrix composites)
- Modular structures
- Formation flying

# Making it to Space

- Novel structures perceived as risky. Flight testing needed to establish a new technology
- Techniques for Earth-based testing of large structures continue to be needed
- Validation by simulation: will project managers be prepared to fly structures whose performance has not been verified on the ground?