



2nd International Conference on Space Elevator Climber and Tether Design – Pre-announcement

Venue: Luxembourg

Date: December 6-7, 2008

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1. Background

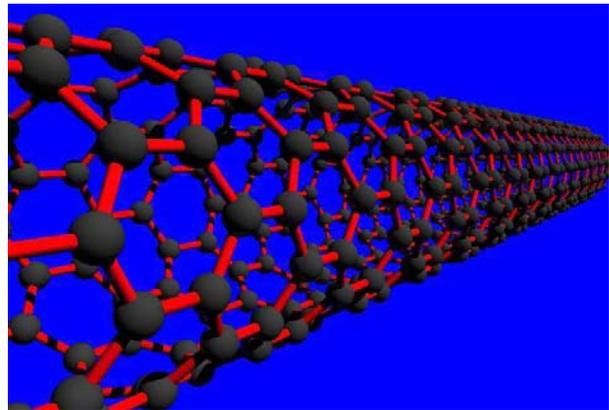
1.1 Introduction



The **Space Elevator** is a concept for inexpensive and safe travel from Earth to space that only recently has been considered viable. By utilizing current technology, a ribbon can be strung between an anchor on Earth and a satellite beyond geosynchronous orbit. This ribbon is ascended by mechanical cars, called **climbers**, thereby providing ready access to space without the use of rockets. Currently in the engineering stages this concept has attracted considerable interest internationally and has been the focus of international conferences and engineering

competitions in the United States to promote development of the required technologies. European researchers and engineers are now taking active roles in these activities.

Carbon nanotube fibres are expected to be the key to the realization of a space elevator **tether**. The single most difficult task in building the Space Elevator is achieving the required tether strength-to-weight ratio, in other words, developing a material that is both strong enough and light enough to support a 100.000 km long tether on which elevator climbers move up and down.



1.2 NASA Climber Competition

The NASA Beam Power Challenge is organized since 2005 by the Spaceward Foundation, the US partner organization of EuroSpaceward. It will be more challenging in 2008. Teams will be entering climbers designed to ascend a cable of 1 km length at an average speed of at least 2m/s utilizing only power beamed up from the ground. This is an important demonstration for the development of a space elevator. The NASA sponsored prize in 2008 is USD K900 for the fastest successful team. It will be doubled by Spaceward to USD 2M for the winning team achieving an average speed of at least 5m/s. The engineering challenges in this competition are serious and diverse – in the last three years none of the teams has won the prize.

In 2008 Triumph and DILAS, two multinational corporations founded in Germany, have stepped up to be the corporate sponsors of the competition providing kilowatt lasers and resources.

1.3 Climber Designs

To successfully compete in the 2008 and in future competitions teams will need to have highly optimized climbers with excellent engineering and the latest technology. This will include high-power lasers, high-performance photovoltaic arrays, microwave generators and receivers, low-mass drive engines, composite structures, vibration damping and innovative designs.



UBC climber at the 2007 contest near Salt Lake City

1.4 NASA Tether Challenge



Team Star Spider during their strong tether performance in 2007

In order to fuel the development of such super strong materials for the potential future use in a space elevator cable (or for other structural aerospace applications) the so-called Tether Challenge has been introduced by NASA. It is the second category of the Space Elevator competitions that are managed by the Spaceward Foundation. The competition requires a 50% improvement in breaking force from year to year. The challenge started in year 2005 with the strongest commercially available tether, Spectra, with a tensile strength of around 5GPa.

1.5 Space Elevator Tether Design

While theoretically carbon nanotubes can have tensile strengths beyond 200 GPa (some proposals predict strengths up to 1TPa), in practice the highest tensile strengths ever observed in single/multi-walled tubes range between 50 GPa and 150 GPa. However, even the strongest fibre made of nanotubes is likely to have notably less strength than its components. Improving tensile strength depends on further research on purity and different types of nanotubes.

Most designs call for single-walled carbon nanotubes. Due to the simplicity of use multiwalled nanotubes may also be viable if specific interlinking issues can be overcome. One potential material possibility is to take advantage of the high pressure interlinking properties of carbon nanotubes of a single variety.

2. The Conference and Its Focus

The *Second International Conference on Space Elevator Climber and Tether Design* in Luxembourg on December 6-7, 2008 follows the successful 1st European Workshop on Space Elevator Climber and Tether Design held in the city of Luxembourg on November 10-11, 2007. It will be organized by the European Spaceward Association in cooperation with the National Research Fund of Luxembourg, the US Spaceward Foundation, the Japan Space Elevator Association, the University of Luxembourg, the Institute Gabriel Lippmann, the Liège Space Centre, the University of Liège and the Université Catholique de Louvain.



Dr. Marcelo Motta, Cambridge University, announcing 9 GPa CNT fibers at the Luxembourg workshop in 2007.

The conference is scheduled to take place in the city of Luxembourg. It will bring together high level researchers and engineers on space elevator systems and carbon nanotube fibre production along with experts from the private elevator, laser, nanotechnology and space industries. The objective of the event is to advance the technology development by examining and discussing the status quo of designs of climbing systems and super strong CNT tethers that will have excelled at the 4th NASA Beam Power and Tether Challenge in autumn 2008. Among the speakers are the world leaders in this activities and the conference should result in a strong advancement in climber and tether design.

There will be again a special focus on attracting young university researchers to stimulate European team building and networking on the NASA Beam Power and Tether Challenges. The diverse nature of the Space Elevator infrastructure, e.g. from LASER systems to CNT fibres cables, and the exciting end goals make it an excellent proving ground for engineering universities, research institutes and private entities alike.

We will bring together the leaders in the relevant fields, teams set to compete and European private industry to push engineering designs of future climbers and allow participants to form partnerships that are beneficial to the teams, industry promoting their products and Europe in general.

2.1 Expected Participants and Speakers



Prof. Shanov presenting world record long CNT arrays

The participants that we will bring together include challenge teams from the US and Canada, from Europe and Japan, students and researchers from local universities, laser manufacturers, motor manufacturers, and experts in all aspects of the Space Elevator and engineering.

The workshop will combine presentations and group discussions on the best climbers to date and designs for future climbing systems, required CNT tethers and other components. No other conferences to date other than this one in Luxembourg have addressed climber and CNT tether designs in this detail and with

the growing interest in these activities and the overall space elevator development we expect increasing interest and attendance by various groups.

2.2 Expectations on the Current and Future Conferences

After the successful first workshop in November 2007 we intend to hold the conference annually as the pace making European technology gathering, presenting the state of the art on Space Elevator and CNT tether developments and building interest and support in advanced technology in Luxembourg.

In addition the Luxembourg workshop will serve as the key event in Europe to interchange and calibrate knowledge between US, European and Japanese scientists and engineers. This will greatly expand the access and resources available for European researchers and engineers and



will be in line with EuroSpaceward's goal to establish a centre of Space Elevator technology and expertise in Luxembourg.

With the growing Space Elevator outreach in the United States, Europe and Japan we expect this Luxembourg conference to become increasingly popular and we will work to accommodate a growing number of attendees in the future.

2.3 Organizing Committee

This workshop is being organized by the European Spaceward Association, short EuroSpaceward A.s.b.l. The organizers are:

- Dr. Bradley Edwards, President, EuroSpaceward
- Markus Klettner, Executive Director, EuroSpaceward
- John Winter, Director Public Relations, EuroSpaceward

2.4 Scientific Committee (preliminary)

Name / Institute / Country:

Dr. Bradley Edwards / EuroSpaceward / USA

Mr. Benoit Michel / Université Catholique de Louvain / Belgium

Dr. David Raitt / European Space Agency ESTEC / NL

Dr. Pierre Rochus / Directeur R&D Centre Spatial de Liège/ University of Liège / Belgium

Prof. Dr. Richard Sanctuary / University of Luxembourg / Luxembourg

Prof. Dr. Vesselin Shanov / University of Cincinnati / USA

Dr. Marcelo Motta / Dep. of Materials Science / University of Cambridge / UK

Mr. Akira Tsuchida / JAXA & JSEA / Japan

Prof. Dr. Cécile Zakri / Centre de Recherche Paul Pascal / France



2.5 Key-note speakers and lecturers (preliminary)

<p>Prof. Dr. Charles Cockell, Open University, UK, is currently Chair of Microbiology at the Open University in Milton Keynes and Chair of the Earth and Space Foundation, UK. Following his doctorate at the University of Oxford, Prof. Cockell has worked for NASA and the British Antarctic Survey. He is invited to talk about "How the exploration of space will provide new resources and skills for the protection of the Earth's environment".</p>
<p>Dr. Brad Edwards, Spaceward, USA, has been considered the father of the modern space elevator and is leading the global effort to develop and build a space elevator. He is President of EuroSpaceward and co-organizer of the NASA-sponsored Space Elevator Games. In addition Dr. Edwards is president of a start-up company to commercially produce CNT.</p>
<p>Dr. Marcelo Motta, Cambridge University, UK, is an expert on spinning high-performance continuous carbon nanotube fibers, the building blocks of a space elevator cable, at the Department of Materials Science of Cambridge University. Dr. Motta is also Chevening Technology Enterprise Fellow focused on commercialization of CNT fibers.</p>
<p>Prof. Dr. Vesselin Shanov , University of Cincinnati, USA, is associate professor at the University of Cincinnati. Dr. Shanov has international experience and engineering knowledge in the development of facilities and technologies for processing of nano-structured materials and thin films. He has also won several prestigious awards, including the Fulbright Award for Research and Teaching in USA.</p>
<p>Mr. Akira Tsuchida, JAXA & JSEA, Japan, is Founder and Director of the Japan Space Elevator Association. Mr. Tsuchida has been working for JAXA projects concerning the International Space Station. He is also leader of the Japanese team ETC that participated in the NASA Beam Power Challenge in 2007 and will compete again in 2008.</p>
<p>Prof. Dr. Cécile Zakri, Centre de Recherche Paul Pascal, France, is a leading expert on CNT fibres production at CRPP. She is an assistant professor at Bordeaux University and co-chair of chemontubes 2008.</p>
<p>Mr. Claude Beil, BEIL SARL, Luxembourg, is General Manager of a family owned elevator manufacturer near the town of Echternach. He is invited to speak about "Challenges of a space elevator and requirements from the perspective of an elevator manufacturer".</p>



<p>Mr. Jose Casas, Universidad Politecnica de Catalunya, has got an engineering degree in telecommunications from the Technical University of Catalunya, Barcelona. Currently he is a PhD student in the microelectronics and evolvable hardware field. He has knowledge of mechanics and practical assembly and use of PIC microcontrollers. José has been leader of Recens, the Spanish Space Elevator Climber Team.</p>
<p>Dr. Partick Choquet, CRP Gabriel Lippmann, Luxembourg, is a scientific researcher. He leads the functionalisation of CNT and carbon fibres by plasma surface treatment at the laboratories of Gabriel Lippmann.</p>
<p>Mr. Andreas Hein, Technical University Munich, Germany, has been leader of the Space Elevator team Tesla that constructs a micro wave powered climber with the aim to participate at the NASA challenge in year 2009. He is currently finishing his aerospace studies at TUM.</p>
<p>Mr. Markus Klettner, EuroSpaceward, Luxembourg, is Executive Director of EuroSpaceward. He received a MSc. degree in Space Management from the International Space University. In addition he owns a university degree in engineering and graduated in International Business Management</p>
<p>Dr. Martin Lades, KCSP, USA, is a senior research scientist. He has been working on image processing, information security and strategic planning. Since 2005 he is involved with the NASA Beam Power and Tether Challenge.</p>
<p>Dr. Bryan Laubscher, Black Line Ascension, USA, is Astrophysicist. He has been researcher for various years at Los Alamos National Laboratory. Currently he is raising Industrial Nano LLC a start-up company that focus on the commercialisation of CNT.</p>
<p>Mr. Benoit Michel, Université de Louvain, co-created one of the first 3D cartoon studios in Europe, "Neurones", in 1989. After 10 years of R&D in computer graphics he switched to research and project management in telecommunications, human-machine interaction, and digital cinema and space applications. Currently he serves at Université Catholique de Louvain in Belgium as the general manager of the SIMILAR network, a network of excellence in multimodal interface research and of EDCINE.</p>
<p>Mr. Bert Murray, National Space Society, USA, is leader of the National Space Society's Space Elevator Team. He is system staff engineer at Lockheed Martin and has 30 years experience with Aerospace and Transportation.</p>



Dr. David Raitt, ESA ESTEC, The Netherlands,

has worked for the European Space Agency since 1969 in France and Italy, as well as The Netherlands, in a variety of positions. He is now Senior Technology Transfer Officer in the European Space Agency's Technology Transfer and Promotion Office in The Netherlands where his activities involve managing the Technology Transfer Programme and National Technology Transfer Initiative, identifying and researching new breakthrough technological opportunities to ascertain their subsequent spin-off/spin-in possibilities in new markets and making the general public more aware of space technologies and concepts and the benefits that can result from technology spin-off.

Dr. Pierre Rochus, CSL, Université de Liège, Belgium,

is Deputy General Manager (R&D) at Centre Spatial de Liège. He is an expert in optical metrology, new space technologies and space environment testing. Dr. Rochus teaches also design of space instruments and celestial mechanics at the University of Liège.

Mr. Ben Shelef, Spaceward Foundation, USA,

is founder of the Spaceward Foundation that manages the NASA sponsored Space Elevator Games. In addition he is working as Director of Marketing at g2-engineering in Mountain View, CA.

Mr. John Winter, EuroSpaceward, Luxembourg,

has studied Political Science and Planetary Geology. He is Director Public Relations at EuroSpaceward.

2.6 Preliminary Conference Schedule

December 6, 2008: Space Elevator Climber Session

Time	Topic	Speaker
09:00	Introduction	Klettner / Winter
09:15	Keynote speech	Cockell
10:00	NASA PB&T Challenges 2008-2010 and beyond	Petro
10:30	Coffee break	
11:00	Progress on SE climber design	Edwards
12:00	Japanese & European efforts	Tsuchida/ Raitt/ Casas
13:00	Lunch	
14:00	Results/analysis of climber competition 2008	Shelef
14:45	Analysis of competition teams	Laubscher
15:30	Power systems	Lades / Michel
16:00	Coffee break	
16:30	Climber Workshop	Murray / Hein / Tsuchida
18:00	End of Session Day 1	

December 7, 2008: CNT Tether Session

Time	Topic	Speaker
09:00	Status of CNT fiber development - Keynote	Shanov
09:45	Advancement in CNT fiber production	Zakri
10:30	Coffee break	
11:00	CNT competition tether	Motta
11:45	Tether tests	Rochus / Choquet
12:30	Lunch	
14:00	Results/analysis of tether competition 2008	Laubscher
14:45	Tether workshop	Motta / Edwards
16:00	Coffee break	
16:30	Application of beam power systems	Shelef
17:00	Closing keynote address	Beil
17:45	Closing address	Klettner / Winter
18:00	End of Conference	