Conference Program

Microsoft Conference Center, Redmond, Washington

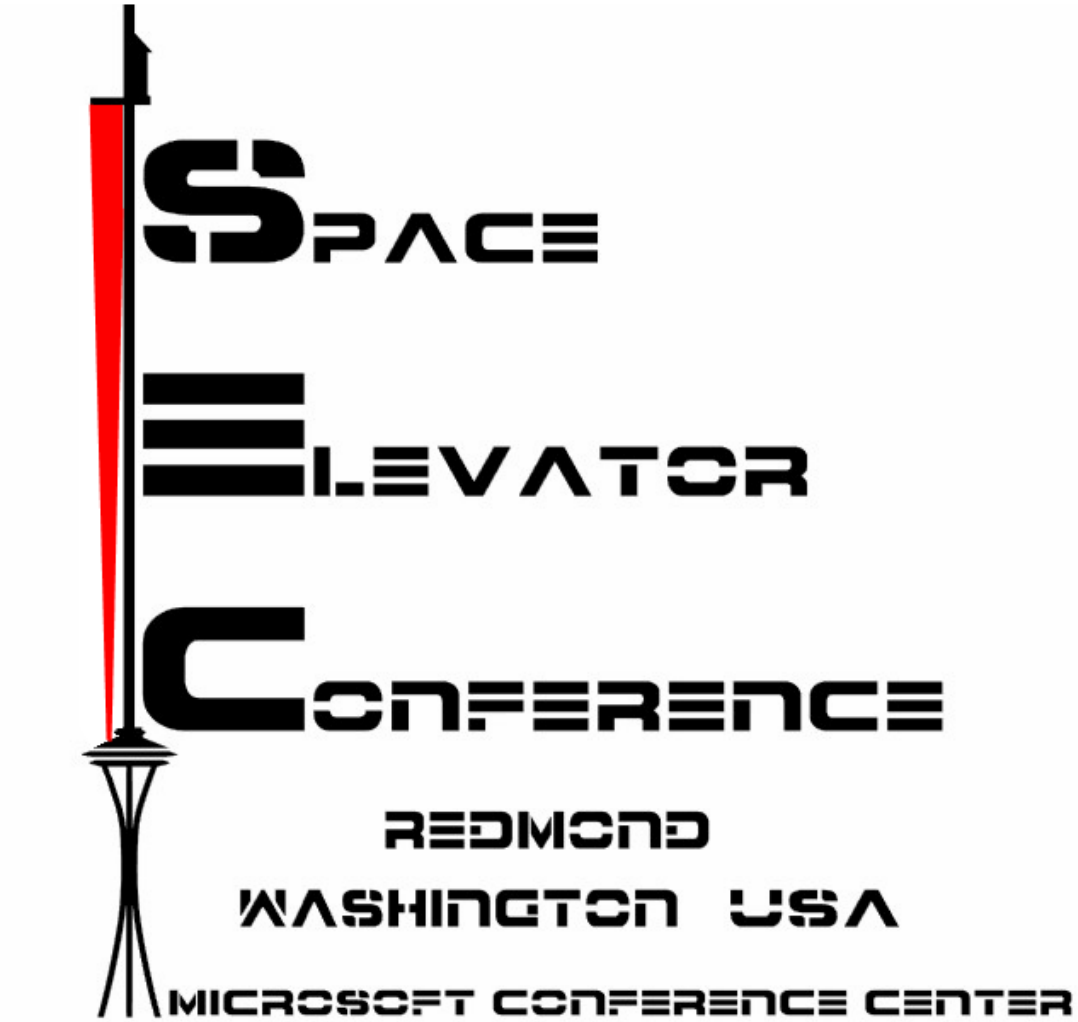
Presented by

The Space Engineering and Science Institute

Sponsored by

Microsoft ISEC

LEEWARD SPACE FOUNDATION



August 12 – 14, 2011

Presented by

The Space Engineering and Science Institute

Sponsored by

Microsoft

ISEC

LEEWARD SPACE FOUNDATION

2011 Space Elevator Conference

August 12-14 | Microsoft Conference Center | Redmond, Washington, USA

2011 Space Elevator Conference Technical Program

Presentations may shift order and start times, though the general themes for each day will remain as listed here. Paid registration includes breakfast 7am-8am and lunch 12pm-1pm each day.

Day 1 - Friday, August 12, 2011

7:00 am - Check in, registration, and ***Breakfast*** (provided)
8:15 am - **Conference Welcome and Introduction** - David Horn
8:30 am - **Space Elevator Concept Overview** - Dr. Bryan Laubscher

Tethers Session: 30 MegaYuris or Bust
9:30 am - **Making and breaking graphitic nanocarbon: insights from computer simulations** - Dr. Vasilii Artyukhov (Rice University)
10:00 am - 15-minute break
10:15 am - **A few answers to Rajasinghe: Carbon bonds, limits of growth, bounds of strength** - Dr. Boris Yakobson (Rice University)
11:15 am - **Contrasting Carbon Fiber and Carbon Nanotube Development** - Dr.
Bryan Laubscher

12:00 pm - ***Lunch*** (provided) with a "book signing" of ***Space Elevator Survivability, Space Debris Mitigation***. Pete Swan and Skip Penny will be in the lunch room ready to sign your copy.

Tethers Session: 30 MegaYuris or Bust *(continued)*
1:00 pm - **Recent Progress in Synthesis, Processing, And Application of Carbon Nanotube Materials** - Dr. Vesselin Shanov (University of Cincinnati)
2:00 pm - **Limitations in Macroscale Carbon Nanotube Materials** - Mark Haase (University of Cincinnati)
3:00 pm - 15-minute break

3:15 pm - **NASA Centennial Challenges Report** - Dr. Larry Cooper, NASA Centennial Challenges Program Executive
4:00 pm - ***NASA Centennial Challenges Strong Tether Competition***

Day 2 - Saturday, August 13, 2011

7:00 am - Check in, registration, ***Breakfast*** (provided)

Science and Technical Session
8:00 am - **Space Elevator Operations Concept** - Skip Penny
9:00 am - **Numerical Analysis on Dynamics of Space Elevator System – Vibration/ Length/ Elevator** - Hironori Fujii
10:00 am - 15-minute break
10:15 am - **Space Elevator Stage I** - John Knapman and Keith Lofstrom
11:15 am - **Solar reinforced space elevator, space pump and near-Earth space solar farming** - Adam Purkrt

12:00 pm - ***Lunch*** (provided)
1:00 pm - One hour to attend **Family Science Fest Events**

Science and Technical Session *(continued)*
2:00 pm - **Artsutanov Prize Winner Presentation** or **Space Elevator Applications Brainstorming Session**
3:00 pm - 15-minute break

Economic and Legal Session
3:15 pm - **Legal issues related to space debris** - Sunao Kai

4:15 pm - **RoboQuest - Robotics Competition Finals**

6:00 pm - ***Evening Banquet*** (at the conference center)

Day 3 - Sunday, August 14, 2011

7:00 am - Check in, registration, ***Breakfast*** (provided)

ISEC Studies Session
8:00 am - **The International Space Elevator Consortium (ISEC)** - Ted Semon
8:30 am - **Participation in a Cosmic Study - Feasibility of a Space Elevator** - Dr. Peter Swan
10:00 am - 15-minute break
10:15 am - **Space Elevator Survivability, Space Debris Mitigation** - Dr. Peter Swan

Political and Social Session
11:00 am - **Bootstrap the Space Elevator via Solar Driven Railroad** - Brandon Sanders

12:00 pm - ***Lunch*** (provided)

1:00 pm - **History of Materials** - Dr. Bryan Laubscher
1:30 pm - **The Making of the High Lift Screenplay** - Dr. Bryan Laubscher

2:00 pm - **Shotgun Science Session**
3:00 pm - **SE Roadmap Workshops** (break-out sessions by pillar)
4:30 pm - **Conference Wrap Up and Next Steps** - David Horn
5:30 pm - End of 2011 conference

5:00 pm - ***Evening Mixer*** (at the conference center)

This page was last modified on 12-Aug-2011

Microsoft®

welcomes you to the

2011 Space Elevator Conference

Conference Center Logistics

- Wireless Internet available through the **MSFTINET** connection
- Breakfast, lunch, afternoon snacks, and the Saturday dinner banquet will be in the St. Helens room (across the hall)
- Restrooms are at the end of the hall (turn left when leaving the Cascade auditorium)
- Sodas and flavored waters available down the hall toward the restrooms

Conference Events

- 3-day technical program
- Friday focus on CNT research
- NASA Tether Strength Challenge
- Friday Evening Mixer
- Family Science Fest
- Saturday Evening Banquet
- Sunday workshops

Sunday Schedule Shift

Highlighted items have changed times

11:00 am – **Space Elevator Operations Discussion** – Skip Penny (replaces SE Roadmap workshops)

12:00 pm - ***Lunch*** (provided)

1:00 pm - **Bootstrap the Space Elevator via Solar Driven Railroad** - Brandon Sanders

2:00 pm - **Shotgun Science Session**

3:15 pm - *Break*

3:30 pm - **History of Materials** - Dr. Bryan Laubscher

4:00 pm - **The Making of the High Lift Screenplay** - Dr. Bryan Laubscher

4:30 pm - **Conference Wrap Up and Next Steps** - David Horn

5:00 pm - End of 2011 conference

Shotgun Science Session Schedule

- 2:00pm **Sean McClain** – The Military Perspective
- 2:05pm **Maurice Franklin** – SE Analysis Spreadsheet
- 2:10pm **Paul Roubekas** – Software Model & Simulator Framework
- 2:15pm **Dave Rajczewski** – Demonstrator Models
- 2:20pm **Dave Rajczewski** – Atmosphere Threat Avoidance
- 2:25pm **Peter Ness** – Baby Steps – Segments to Space
- 2:30pm **Ben Sibelman** – JP-Aerospace-style balloon platform as “base station” for Space Elevator
- 2:35pm **Garland Brinkley** – Climbers Move Up and Down Tether
- 2:45pm **Keith Lofstrum** – Capture Tether
- 2:50pm **Alejandro Lamothe** – How to Create and Promote Space Elevator Awareness
- 2:55pm **Phil Richter** – Structural Engineering Models - Systematic Approach
- 3:00pm **Phil Richter** – Developing a Ribbon Structure for Deployment of Permanent Assets
- 3:05pm **Bryan Laubscher** – Retreat Workshop

Conference Wrap-Up

- Conference Staff
- What Went Well
- Join the Planning Committee
- How You Can Help
- A Bigger, Better Conference

Conference Planning Committee and Staff

Thank You!

These volunteers made this conference a success.

General Chair – Dr. Bryan Laubscher

Technical Chair – Dr. Peter Swan

NASA Centennial Challenge Strong Tether Competition - Ben Shelef (Spaceward Foundation)

Family Science Fest/RoboQuest – **Carolyn Davids, David Schilling,** Maurice Franklin

Publicity – Peggy Alonso

Marketing – Josh Halfon

Registration and Check-In – Ruth Richter, Phil Richter

Poster Design – Krishna Prasad Mayadi Nagesh Rao

Logo Design – Peggy Alonso & Greg Thorburn

Email Announcements – John Lee

Conference Planning Committee – David Horn (chair), Bryan Laubscher, Hugh Kelso, Ted Semon, Maurice Franklin, Peggy Alonso, Josh Halfon, Phil Richter, Ruth Richter

Conference Sponsors

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What Do You Think Went Well in These Areas?

- Presentation Content
- Presentation Logistics (display, audio, Q & A, etc)
- Family Science Fest Events
- Tether Strength Competition
- Shotgun science session
- Meals (breakfast, lunch, mixer, banquet)
- Time of the year the conference is held
- Daily start time

Join the Conference Committee

- We can use your help
- The conference can be much better with your help
- Contribute only to what you can commit
- You don’t have to live in the Seattle area
- You get the conference staff rate
- Monthly planning meetings/conference calls start in October

How You Can Help

- New ideas
- Paper Reviews
- Program and Agenda
- Public Relations
- **Advertising**
- Artwork
- Web site
- Newsletters
- **Sponsorship**
- Partnerships
- Registration and Check-In
- Assembling the Conference Program / Badges
- SWAG
- Committee Meeting Secretary
- Publishing Proceedings
- SE 101
- SE 202
- Family Science Fest Planning and Execution
- Tether Strength Competition Video Streaming
- Presentations to your community
- Your Endorsements of this Conference
- Q/A Facilitation

A Bigger, Better Conference

- 100-150 attendees
  - The conference would break even financially in this range, this ensures we can continue annual conferences
  - Leverage for hotel discounts
  - Better lunches
  - Cool swag (t-shirts, pens, hats, etc.)
- 200+ attendees
  - All of the above, plus…
  - We could provide travel assistance to selected presenters and keynote speakers (if not sponsored)
  - Multiple track conference, focus on the topics of interest to you
  - And more!

Next Steps

- Publish the Proceedings (2009, 2010, 2011)
  - 2009 and 2010 now in progress
  - 2011 by the end of the year
  - Papers due the end of August
- A general overview slide deck we all can use
- 1st Planning Meeting for Next Conference
  - October 2011, time and location TBD
  - Can dial in to the meetings
- Get another big sponsor
- Monthly Newsletters (sign up on the Contacts page http://spaceelevatorconference.org/contacts.aspx)

Presentation Abstracts and Summaries

In program order

FRIDAY:

Tethers Session: 30 MegaYuris or Bust

03. Making and Breaking Graphitic Nanocarbon: Insights from Computer Simulations

Vasilii Artyukhov (Rice University) artyukhov@rice.edu
Boris Yakobson (Rice University) biy@rice.edu

Carbon nanotubes – cylinders of sp2 carbon, or graphene, – possess the greatest tensile strength of all materials known so far. With the nominal sheet thickness of 0.334 nm, the theoretical breaking strength of carbon nanotubes in first-principles computations comes out at ~100–120 GPa, which, divided by the density of graphite of ~2 g/cm3, gives a specific strength of ~50–60 MYuris, or roughly twice the minimum requirement for space elevator tether. This makes graphitic nanocarbon (and its close relative, h-BN) the only known material that can make the vision of space elevator come true. Due to the simplistic nature of typical such simulations, this cited value appears a reliable lower estimate of what cannot be surpassed using known materials. However, the engineering feasibility of the space elevator project depends instead on upper estimates of what can be achieved with real materials, and this calls for much more elaborate simulations and theory. This talk will describe research into the atomistic details of fracture of graphene and nanotubes, including not only strength but also toughness in the picture, as well as touch upon our efforts to better theoretically understand the growth of these materials, with the aim to get real materials as close as possible to the fundamental limits.

04. A Few Answers to Rajasinghe: Carbon Bonds, Limits of Growth, Bounds of Strength…

Boris Yakobson (Rice University) biy@rice.edu

Early promise of nanotubes strength has also posed a challenging question: What are the initial steps of carbon network failure, under the high tension, and what is the breaking strain limit, at least theoretically? Two mechanisms appear to be leading, at low temperature a brittle failure and at high temperature plastic relaxation. In the course of these studies, several fascinating and conceptually important things have emerged. One was the possibility of super-plasticity in nanotubes, and of their self-healing in evaporation, both due to particular pentagon-heptagon 5|7 defects, able to glide or climb across the nanotube as edge dislocation. Recognition of these dislocations led us further to appreciate the chirality as key factor in growth, thus bridging the seemingly disconnected fields, fracture and synthesis. Most recently, we discovered profound connection between the graphene-edge makeup and the ways nature chooses which chiral tube to create. As this understanding deepens, it should offer a control in nanotube production, for strong cable designs and other far-reaching applications.

05. Contrasting Carbon Fiber and Carbon Nanotube Development

Bryan Laubscher (Odysseus Technologies, LLC) skyhookbel@hotmail.com

What can the history of carbon fiber tell us about the possible development of carbon nanotube materials? Carbon fiber was discovered in 1957 at a Union Carbide laboratory in Parma, Ohio. Fifty years later it was being used as the fuselage of a commercial jet, the Boeing 787. Is this what we can expect in carbon nanotube development progress?

In this presentation, the hurdles encountered in carbon fiber development will be discussed. Current problems with carbon nanotube development will be discussed within the context of the carbon fiber development history. Finally, speculation will be offered concerning the future of carbon nanotube development.

06. Recent Progress in Synthesis, Processing And Application of Carbon Nanotube Materials

Vesselin Shanov (University of Cincinnati) vesselin.shanov@uc.edu

Recent results in catalytic synthesis of 2 centimeter long CNT arrays by CVD will be presented. Current scale up efforts to develop methods that industry needs to "mass produce" aligned CNTs and to process them into fibrous products will be reported. Nanotechnology innovations under development in our Nanoworld laboratories include: big area synthesis of Black CottonTM and processing this highly aligned and pure CNT material into light, strong and electrically conductive fibers.

Our team has developed techniques for spinning long CNTs directly from the array into thread, yarn, ribbons and sheets. These techniques have produced CNT thread with strength above 1 GPa and electrical conductivity of 0.8x104 (ohm. cm)-1. Efforts for post processing the CNT based materials in order to improve their strength and conductivity will be reported. The talk will also illustrate novel applications of the CNT arrays, threads, yarns ribbons, and sheets for fabrication of electronic, aerospace, and biomedical devices.

07. Limitations in Macroscale Carbon Nanotube Materials

Mark Haase (University of Cincinnati) haasemr@mail.uc.edu

The unique, and often impressive, physical properties of carbon nanotubes are widely known and well documented in the literature; it is these properties, especially strength and conductivity, that have driven research in this area for the last two decades. Despite this effort, it has proven difficult to realize these nanoscale properties in macroscale materials and devices. As part of our efforts to improve the properties of carbon nanotube macro-materials—including threads, ribbons, and sheets—we have sought to identify the bottlenecks in making those improvements.

The key bottlenecks to high strength materials seem to lie in the strength of the tubes themselves, and the strength of the interactions between them. The strength of the tubes is dependent principally on the number of defects in their structure. The strength of the interactions is related to the length of carbon nanotubes, and to the density of the tubes made from them. The amount of amorphous carbon also plays a role in determining the strength of intermolecular interactions.
Having comprised a list of the bottlenecks to developing high strength materials, we investigated techniques to work through them, outlining three areas for improvement: synthesis, spinning process, and post treatment. Research into synthesis can be used to improve the length of the tubes, and the amount of amorphous carbon contained in the arrays. Post treatment techniques can be used to increase the density of the carbon nanotube arrays, and to improve the quality of the nanotubes. Spinning techniques can be used to optimize the threads drawn from these arrays, and will be a vital part of any large scale techniques. We maintain that carbon nanotube macromaterials of high strength can be developed by focusing effort into understanding and improving these areas.

08. NASA Centennial Challenges Report

Larry Cooper (NASA) Larry.P.Cooper@nasa.gov

This presentation will provide an update on NASA's Centennial Challenges, which focus on unique and difficult problems across space and aviation technologies, as well as relevant disciplines such as robotics and materials science. Following the presentation the 2011 Strong Tether competition will take place – will this be the year of the CNT tether?

SATURDAY:

Science and Technical Session

09. Space Elevator Operations Concept

Skip Penny (Cholla Space Systems) skipnjane@hotmail.com

This presentation will describe the approach to creating and maintaining a Concept of Operations for the Space Elevator. An “Operations View” will be presented and each element will be addressed at a high level. The presentation will describe current thinking on how a satellite will be delivered to an orbit for deployment. A first cut at what the Space Elevator organization might be will also be presented.

10. Numerical Analysis on Dynamics of Space Elevator System: Vibration / Length / Elevator

Hironori Fujii (Kanagawa Institute of Technology) flyhigher4000@yahoo.co.jp

This paper is to survey the several aspects of numerical analysis on the dynamic features of the space elevator system. The space elevator system is an extension of very long tether equipped with the moving mass, elevator, and the dynamics is very complex concerning to its much flexible dynamic features of very long length reaching to 100,000km. The aspects are summarized based on the author’s works over 20 years including:
1) Concept on the numerical simulation to describe extraordinary long flexible tether,
2) Vibration features in lateral and also in longitudinal motion of long tether system,
3) Equipment of the counter mass at the free end of tether in order to reduce the length of tether and the resulting mass of the whole system,
4) Effect of moving mass, the elevator, as the disturbances on the long flexible tether.
Results of the numerical simulation are summarized based on the recent works of the author and the validity of the numerical scheme is discussed. The discussion leads to the overview of the present status of the dynamic behavior of the space elevator system.
One attempt is also shown to verify the result of numerical analysis in laboratory from the experimental scheme and the vilification is discussed on the analysis of the space elevator system on the very important process of preliminary design.

11. Space Elevator Stage I

John Knapman (Knapman Research) JMKnapman@aol.com
Keith Lofstrom (KLIC) keithl@keithl.com

One of the challenges of building the space elevator is to deal with the effects of Earth's turbulent atmosphere without adding substantially to the weight that has to be supported by the rest of the structure. A solution is to adapt one of the related concepts outlined in a paper by Jerome Pearson, namely the Launch Loop, which is capable of propelling a vehicle into orbit electromagnetically. A family of variations of this concept has been described and is known collectively as the space cable. A version is proposed as the space elevator stage I. It can stand on the ground or at sea and is held aloft by several fast-moving flexible belts, known as rotors, using magnetic levitation.

A platform at the top is used as an anchor and transfer station for the main space-elevator ribbon. The height can be as great as 140 km, but 50 km is sufficient to place the transfer station above 99.9% of the atmosphere. The transfer station can weigh several thousand tons if required, and it can support the weight of a laser power beamer together with associated cooling structures. A high-altitude workshop is also envisioned. An observation platform will be provided for travelers to enjoy the sensational view before transferring to a ribbon climber. Climbers can be hauled up from the Earth's surface to the transfer station. Alternatively, specialized stage I climbers can be provided for this part of the journey.

To minimize friction and energy consumption, the rotors travel in evacuated tubes. The levitation force is created by changing the direction of the rotors' momentum vector using permanent magnets stabilized by electromagnets. The only loss of kinetic energy is caused by residual friction and losses in the electromagnets. Gravity removes some kinetic energy from a rotor as it rises, but this is restored when it descends.

At each end of the space elevator stage I, there is a surface station that turns the rotors around using powerful magnets. A reasonable separation between the surface stations is 150 km, but there is considerable flexibility. The structure is tethered to the Earth's surface to maintain stability in the presence of gusting cross winds. There is some stiffness in the rotors and tubes that is sufficient to maintain the required shape between the tethers. There is a technique called active curvature control that dispenses with most of the tethers, but there remain some engineering challenges in implementing it.

Previous work has shown that similar structures are feasible using Kevlar as the main load-bearing material and Neodymium Iron Boron (NIB) in the magnets. Because these materials are available today, the space elevator stage I can be built now and so provide valuable experience of reaching space using a fixed infrastructure. Hence it can be stage I chronologically as well as the lowest stage physically.

Key words: base station, transfer platform, magnetic levitation, Kevlar

12. Solar Reinforced Space Elevator, Space Pump and Near-Earth Space Solar Farming

Adam Purkrt (Institute of Physics Prague) adam@purkrt.net

For space elevator and space based solar power to ever come to life, the importance of incorporating solar cells along the (helically wound) tether, is imminent. Generated power can be utilized for powering the climber through microwave transmission, alleviating the need for long-range laser power transfer. More importantly, excess power could be sent as X-rays through the CNTs acting as waveguides, improving both their tensile and compressive strength, benefiting a range of elevator designs, and providing certain degree of active protection against impacting debris at the same time.

Polymer materials, in natural connection with carbon nanotubes, may turn out to be a viable way how to create such cells. The most prominent CNT/polymer complexes will be discussed, focusing primarily on weight/power generation ratio. Furthermore, estimates regarding CNTs acting as X-ray waveguides and implications for mechanical properties will be summarized.

In the end, some basic ideas about alleviating the climber completely and just using induced convulsive CNT motion for transporting liquid materials to/from space ("space pump"), with possible implications for near-Earth space solar farming, will be presented.

Keywords: space elevator, space pump, space based solar power, X-ray waveguide, carbon nanotubes

Legal Session

14. Legal Issues Related to Space Debris

Sunao Kai (Nihon University) kaisunao@law.nihon-u.ac.jp

Until now, there is no international space debris treaty, and we cannot expect such a special treaty in the near future. So, we must consider these legal issues under the current law situation.

At first we must consider about the concept of space debris.

The man-made object which has launched to the earth orbit or other outer space shall easily be the space debris when it has been out of control because its thruster's fuel has out or its batteries have run out, or only a small trouble of its mechanism has happened. Here we shall call this type of object as a "non-controllable Satellite".

In contrast, the Satellites under the control of launched countries are not space debris under the normal concept. We shall call this type of object as a "controllable Satellite".

But, this classification is not based on a legal perspective. From the legal view point, debris (garbage) is what the owner has abandoned its original ownership. Abandoned its ownership must be recognized objectively. But non controllable Satellites are not such a thing. The owner has only lost its possession. In normal case, owner has still its property rights. So, people cannot clean up satellites without permission of owners, whether they are controllable or non-controllable.

From the viewpoint of safety of space elevator, there is also no deference between controllable satellites and non-controllable satellites. It is equally dangerous when satellites come into collision with space elevator. And under the current Convention on International Liability for Damage Caused by Space Objects, the launched country must pay damages, whether it is controllable or non-controllable.

Because of these reasons, we must consider the legal issues of space debris, not only about non-controllable satellite but also controllable Satellite as well.

Now, I would like to report how we can resolve the legal issues.

SUNDAY:

ISEC Studies Session

16. The International Space Elevator Consortium (ISEC)

Ted Semon (ISEC) ted@isec.info

ISEC is now approaching its third birthday. How did it come about? What has it accomplished, especially in the past 12 months? How is it promoting the idea of a Space Elevator? What are its future plans?

ISEC operates according to a Strategic Plan, created by the President and approved by the Board of Directors. This plan includes the following:

• Defining a theme that all major activities of ISEC revolve around – for 2011, this theme is Developing stronger, lighter tethers – 30MYuri or bust!

• Establish and award the Pearson and Artsutanov prizes for papers that 'increase our understanding' of the Space Elevator.

• Create the ISEC 2011 Journal.

• Create the ISEC Report – a detailed study on the Yearly Theme.

• Create the 2011 ISEC Poster.

This presentation will give a brief history of ISEC, will explain the rationale and progress for each of its goals and will explain to the audience why they should consider joining ISEC (or renewing their membership if already a member).

17. Participation in a Cosmic Study - Feasibility of a Space Elevator

Peter Swan (ISEC) peter@isec.info

The ISEC is supporting (co-sponsoring) a major study with the International Academy of Astronautics on the feasibility of Space Elevators. We will present the layout and progress of "A Cosmic Study for the International Academy of Astronautics" [Editors: Cathy Swan, David Raitt, Skip Penny, Peter Swan] that is being conducted. Please see the section of your conference program titled "Assessment of the Technological Feasibility and Challenges of the Space Elevator Concept" during this presentation.

18. Space Elevator Survivability: Space Debris Mitigation

Peter Swan (ISEC) peter@isec.info

This talk will assess the threat of space debris to a space elevator with the latest information of densities from NASA. The approach for calculations of the probability of collision from debris with the space elevator has been utilized for years for space debris collisions, and is now leveraged to show the probabilities of impact with a space elevator. In addition, the lecture will address mitigation approaches and policy issues that should be initiated in the near future. The topics are: Description of the Threat, Probability of Collision calculation and results, and Mitigation approaches.

To see the details of this study that was conducted by the International Space Elevator Consortium, please pick up a copy of the book *Space Elevator Survivability: Space Debris Mitigation* through www.Lulu.com or through Amazon.com for a Kindle with option also on the Ipad.

Political and Social Session

19. Bootstrap the Space Elevator via Solar Driven Railroad

Brandon Sanders (Awakening Science Foundation) brandon@thesanders.us

2012 is the 150 year anniversary of the legislation that launched the transcontinental railroad in the United States. This anniversary provides an emotionally potent opportunity to rally broad public support for an equally significant infrastructure project to ignite our development into space.

In the Pacific Railway Act of 1862, the United States government guaranteed loans for private enterprise to construct a $50 million transcontinental railroad linking the Atlantic and Pacific coasts of the United States and shaping its economy and culture for the last 150 years. As a percentage of GDP, an equivalent investment by the United States today represents a $90 billion infrastructure commitment and could shape who we become in the next 150 years.

In the first part of this talk I share lessons from the intercontinental railroad that apply directly to our present day efforts to develop a space elevator. These lessons include relating directly to the political landscape, finding immediate connections to financial drivers, and capitalizing on our innate desire to leave a legacy.

The middle portion of the talk examines three space infrastructure projects, the space elevator, a solar power satellite network, and the orbital railway. We outline how these three projects can work together to capitalize on the sesquicentennial of the intercontinental railroad legislation.

I conclude the talk by presenting a plan to bootstrap the space elevator via solar driven railroad. This plan introduces the orbital railway act of 2012 and situates it within a strategic rollout that starts with solar power satellites and culminates in the deployment of a space elevator.

Keywords: Space Elevator, Solar Power Satellites, Orbital Railway Act

20. History of Materials

Bryan Laubscher (Odysseus Technologies, LLC) skyhookbel@hotmail.com

The history of human civilization is punctuated by the development of materials. Indeed many of the “ages” of our past are named for materials. New materials enabled the development of new technologies and civilization progressed from stone tools to steel and huts to skyscrapers. In this presentation, I will discuss many of the past ages of mankind such as the Stone Age, Iron Age and Bronze Age, etc. including the advances in technology these materials enabled. From this historical perspective I will speculate on the type of technologies that will be enabled by carbon nanotube materials.

21. The Making of the High Lift Screenplay

Bryan Laubscher (Odysseus Technologies, LLC) skyhookbel@hotmail.com
Victor Cummings victorcummings@gmail.com

Logline: In the year 2120, elevators lift man and materials high into space and a protective shield surrounds the earth to save it from catastrophic global warming. When the operation of this shield is disrupted setting off a chain reaction of mass destruction, Space Elevator engineer, Gordon Welkin, leads a team of unlikely heroes in time to save the earth from complete annihilation.

Run time: 106 minutes.

High Lift is an original screenplay that uses space elevators as its setting, and the need for them in recovery from issues of energy depletion, continued space exploration, and the health of our ecosystem as its theme.

This paper and presentation will cover the history of, motivation for writing, and a brief synopsis of the screenplay. There will also be a call to readers who may be able to assist in efforts to get the screenplay produced.

2011 Space Elevator Conference Summary

By David Horn, Maurice Franklin, and Carolyn Davids

For the fourth consecutive year, Microsoft hosted the Space Elevator Conference August 12-14, 2011, at the conference center on the Redmond main campus. The technical conference theme was "Developing Stronger, Lighter Tethers – 30 MegaYuris or Bust!" The main goals of the technical conference were to:

a. Review the current state of the carbon nanotube (CNT) materials technologies required to make a space elevator a reality, and
b. Review and understand the issues and risks of building and operating space elevators.

The 2011 conference also added a public Family Science Fest on Saturday of the conference to attract families and kids to science, technology, engineering, and math (STEM).

Family Science Fest Events and Exhibits

- Space elevator robotics competition (RoboQuest) for middle and high school kids featuring various classes of climbing robots and prizes. Robots had to climb a 15' ribbon as quickly as possible while carrying and deploying weights simulating satellite payloads.
- Pacific Science Center exhibits on engineering, space exploration, and nanotechnology
- Museum of Flight "Robot Garage" where kids can build and operate a rover
- WA NASA Space Grant Consortium "Mars Rover" activity and booth
- Three Space Elevator 101 public presentations
- "Drive a Bot" activity for kids to test their robot driving skills
- LEGO Build Zone for kids to build their own spacefaring creations
- Robot Alley displaying robots from local robotics teams and clubs, including UW Robotics Team, *FIRST* WA robotics (www.firstwa.org), and Girl Scouts of Western Washington Robotics
- Photo opportunities with a hand-built, life-size working replica of R2-D2 from Star Wars
- Exhibits from Museum of Flight, Khan Academy, Washington State Science and Engineering Fair (http://www.wssef.org/), DigiPen Institute of Technology, Student RnD (http://studentrnd.org/), and Civil Air Patrol youth squadron

Fast Facts

- 300-400 attendees at the Family Science Fest
- 14 student teams competing in the RoboQuest robotics challenge
- A large, full room of Pacific Science Center "Science on Wheels" engineering and science exhibits
- ~60 participants at the technical conference
- 21 technical conference talks and workshops over three days
- One full day dedicated to CNT research presentations
- The NASA Strong Tether Challenge
- Multiple news items mentioning Microsoft as the sponsor and host (details below)

Conference Summary

The technical conference and family science fest were a huge success in 2011. CNT researchers from Rice University and the University of Cincinnati presented the progress being made towards producing such a material. When these researchers attended the NASA Tether Strength Challenge competition, they were excited to enter the competition next year, even though there was only one entry to the competition and that entry was not close to winning a prize.

On Saturday afternoon, the conference attendees took a break from the technical talks to watch the RoboQuest finals. Many commented positively on the design solutions the youth teams had used to tackle the very same problems that would face engineers developing an actual space elevator climber. Fueled by Space Elevator 101 talks and the excitement of robotics, many conference attendees, especially students on the robotics teams, are already planning to attend next year's conference.

Press Coverage

There was some press coverage of the conference, subject matter, and Microsoft which included:

- Space Elevator and Conference Coverage on the New Day Northwest show on Seattle's King 5: http://www.king5.com/new-day-northwest/Space-Elevator-Conference-headed-to-Redmond-125775943.html
- Space Elevator and Conference Coverage in RedmondReporter.COM: http://www.redmond-reporter.com/community/126595528.html
- Space Elevator Robotics Competition coverage in Woodinville Patch (online news: http://woodinville.patch.com/articles/woodinville-robotics-team-places-at-space-elevator-conference-competition
- Space Elevator Robotics Competition coverage in the Sammamish Patch:
- http://sammamish.patch.com/articles/sammamish-robotics-team-places-second-at-microsoft-conference
- Space Elevator Coverage in July 2011 Issue of National Geographic Magazine: http://ngm.nationalgeographic.com/2011/07/visions-now-next#/next
- "Stairway to the Heavens" by David Appell published in the December 2012 Physics World (not available online) – Article covering space elevators and the 2011 conference
- Pioneer Robotics, Shelton, WA, features Robotics Competition and conference on their website: http://pioneerfirstrobotics.blogspot.com/2011_08_01_archive.html
- FTC Team 417 features photo galley of Family Science Fest on their website: http://www.ftc417.org/?q=flickr/set/72157627953757687