Flexible Thread Technology

Meeting Objectives

- Introductions
- Flexible Thread Technology Development and History
- Features and Benefits of Flexible Thread Technology
- Applications Utilizing Flexible Thread Technology
- Business Model
- Conclusion

Introductions

- ***Bob Fullerton:*** Chief Innovator and inventor of the Flexible Thread Technology
- ***ANI Solutions:*** Manufacturing, sales, and marketing strategists

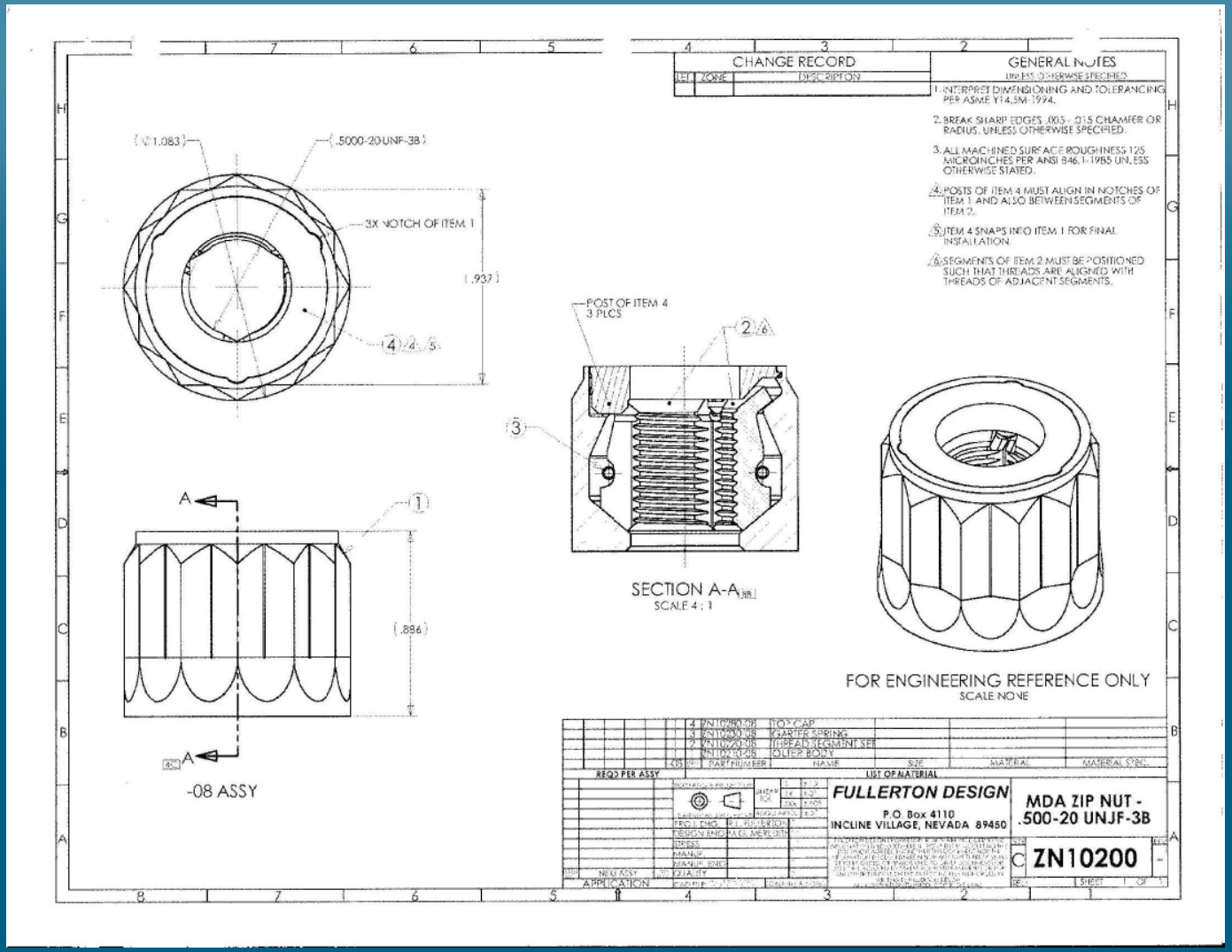
History of the Flexible Thread Technology

- Development stages of a successful invention:
  - Typical “development timeline” is measured in trimesters
    - ***1st trimester:*** develop a functioning product (to solve a problem or fill a need)
    - ***2nd trimester:*** design for economical repeatability
    - ***3rd trimester:*** design for the intended market economics

History (cont.)

- 1979
  - Fullerton perceives a need when watching auto racing
  - patents applied for
- 1993
  - first iteration patents issued (ZipNut®)
  - successful completion of 1st trimester (develop a functioning product)

History (cont.)



History (and Disclosure) - *Two Diverging Paths*

- 1991: ZipNut®
  - patents/intellectual property taken from Fullerton in a lawsuit filed by the State of Nevada (filing was in response to actions taken by Fullerton's attorney)
- 1991 - current
  - ZipNut® was taken over by the attorney
  - product was brought to market, but with quality and manufacturing issues

Two Diverging Paths (cont.)

- 1991 – 2009: Bob Fullerton
  - defends his rights to patents and intellectual property
- 2009
  - case is finally settled as a single “no contest” misdemeanor count - misfiling of documents
  - original ZipNut® remains with attorney
- 2009 - current
  - third design iteration of the Flexible Thread Technology completed with enhanced performance benefits (not in conflict with any existing patents; patents pending)

Differences in Design

- Differences of original ZipNut® and the new generation Flexible Thread Technology are as follows:
  - Original ZipNut®, functioned fairly well, but proved difficult to maintain quality control of critical internal dimensions and challenging in providing repeatability
  - Resulting product was very expensive to manufacture

Differences in Design (cont.)

- New generation Flexible Thread Technology maintains the centerline of the thread segments, with respect to the internal dimensions of the outer body
- Critical to both quality and repeatability
- Resulting product is cost-effective to manufacture

Differences in Design (cont.)

- New generation Flexible Thread Technology will also:
  - eliminate three troublesome components for assembly; (a) torque pins, (b) springs, and (c) cap
  - provide a mechanical locking effect when the fastener/coupler is tightened
  - reduce manufacturing costs by up to 30%
  - most importantly, be able to be completely manufactured by automation which reduces cost and increases quality further

Features and Benefits of the New Flexible Thread Technology

- Assembly Speed
  - works with existing equipment; male only needs matching thread and diameter
  - fully connects with only an axial push and twist of up to one full turn
  - engage or disengage* quickly
  - permits rapid assembly without the need of starting the thread lead or rotating the male and female multiple times

*(Requires “Double” Flexible Thread Technology which is designed to retract the threads when activated. This feature doubles the product benefit without doubling the cost.)

Features and Benefits (cont.)

- Eliminates Cross-Threading
  - independent thread segments slide over the opposing threads until either the axial force terminates or a stop is reached
  - once stop is reached, thread segments seat on to the opposing threads
  - allows for misalignment, as axial push can be performed with the thread leads at any orientation
  - engages securely over stripped or damaged threads, and can be removed without further damage to either component

Features and Benefits (cont.)

- High Strengh/Size Ratio
  - threads are mechanically drawn against the opposing threads, a function of disengagement pressure and 100% peak-to-valley thread engagement
  - provides an axial load bearing capability similar to any other fastener that can be designed to meet any load requirements

Features and Benefits (cont.)

- **Resists Movement under Vibration**
  - mechanical interlock design operates to lock the threads in place and prevents movement during vibration

Features and Benefits (cont.)

- **Flexibility in Fabrication**
  - can be made in stainless, aluminum, titanium, brass, non-metallics, composites, and other materials
  - thread segment material can be different from housing material
  - no limitations as long as the material has sufficient properties to bear the specified load and environment
  - can be manufactured in a wide range of sizes

Features and Benefits (cont.)

- **Other Essential Benefits for Use:**
  - in harsh environmental conditions (outer space, weather, etc.)
  - in difficult physical circumstances (confined space, awkward load or configuration, etc.)
  - where reliability of connection is required under high loads or pressure
  - where threads are otherwise unavailable (robotics)
  - where damaged threads are a problem

Applications where Flexible Thread Technology is in Use

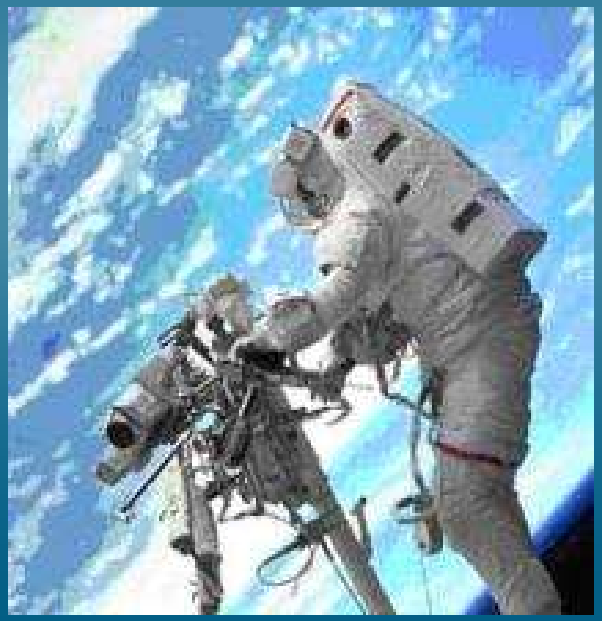
- The International Space Station
  - Boeing
    - Main Truss Structural Joints
    - EVA Soft/Hard Dock and Airlock Orbital Replacement Units
    - Universal Trunnion Attachment System
    - Robotic Assembly Deployment of UHF Antenna Booms
  - Honeywell
    - Alpha & Beta Solar Panel Gimbals
  - Rocketdyne
    - Solar Array Mast Canister

Applications (cont.)

- NASA Shuttle Repair Missions
  - Swales Aerospace
    - Hubble Space Telescope Repair Mission for Goddard Space Flight Center
    - Repair and Servicing Missions in 1993, 1997, 1999, and 2009 which included:
      - Wide Field and Planetary Camera
      - Fine Guidance Sensor
      - Solar Array Drive
      - Data Interface Unit
      - S-Band Single Access Transmitter

Applications (cont.)

ZipNuts® have been used in the servicing of the Hubble Space Telescope
[Dec. 1999 mission - right]
Image credit: NASA



Highlights of NASA Applications

- NASA has incorporated Flexible Thread Technology as a “Recommended Technique for Effective Maintainability in Selection of Robotically Compatible Fasteners and Handling Mechanisms” (Technique DFE-l) in its official Policy for Safety and Mission Success (NPD 8700. 1)
- Official Design Factors for all future NASA projects specifically recommend the Flexible Thread technology to “avoid jamming and binding” and as an “excellent soft dock attachment”

Applications (cont.)

- Power and Energy
  - Carolina Power & Light / Tennessee Valley Authority
    - to seal the heat exchanger, preventing reactor water from entering during scheduled power outages
  - U.S. Department of Energy
    - to permanently attach circulation fans at the Savannah River Project
  - Florida Power & Light
    - to attach ducting during nuclear power outages

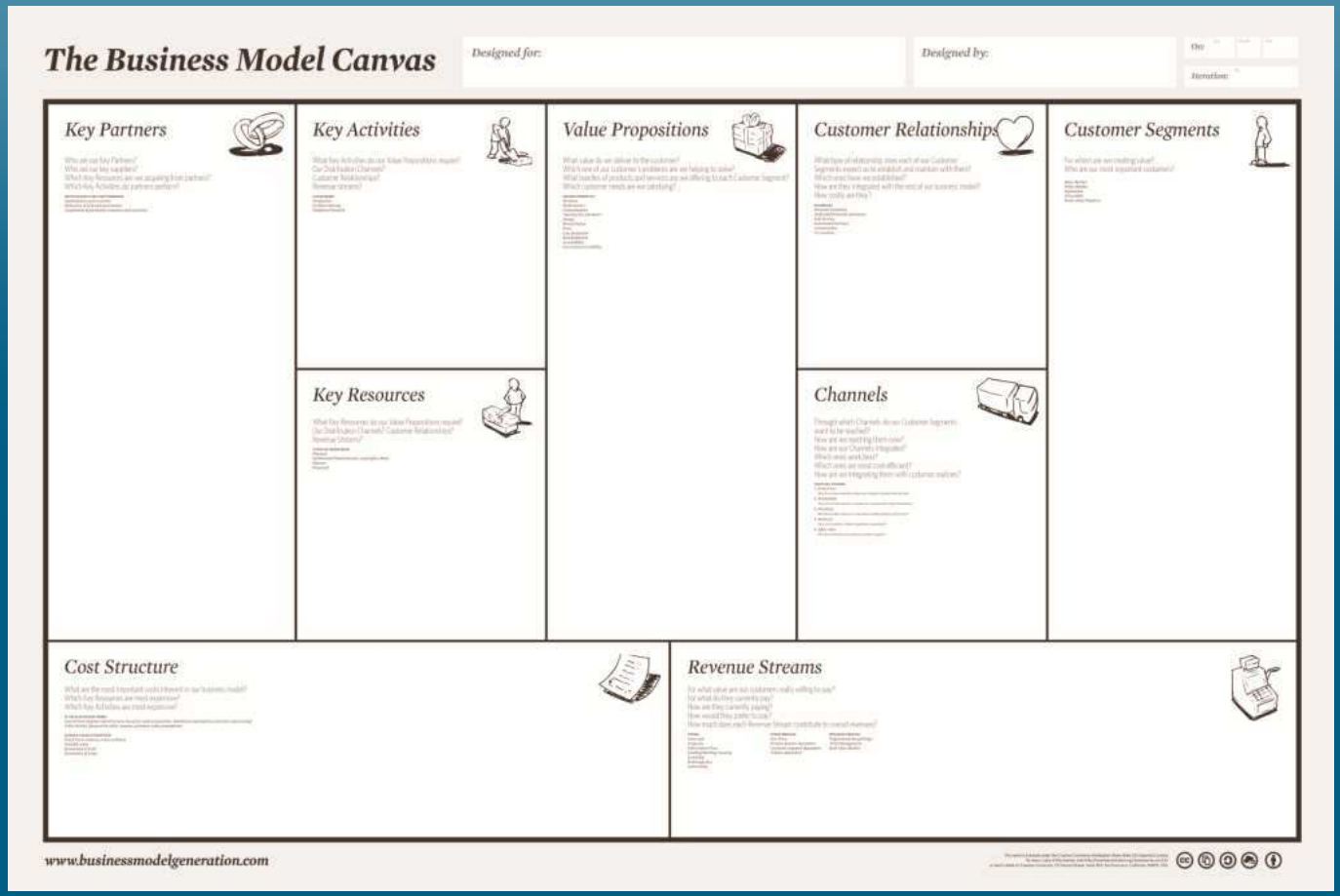
Applications (cont.)

- Deep-Water Construction
  - FMC
    - used on a deep-water pipe-laying machine
  - Sonsub
    - used on a deep-water pipe-laying remote operated vehicle (ROV), “BRUTUS”
- Manufacturing
  - Goodyear
    - used to attach molds to tire manufacturing equipment
  - Jergens
    - used to automatically proof load ever swivel bolt they sell

Applications (cont.)

- Other Uses Include:
  - Production of high-pressure gas cylinders
    - Air Products, AGA, Airgas, Holox (Linde) and BOC (Linde)
  - Fire and Rescue equipment
    - Curtiss- Wright and Power Hawk Technologies
  - Medical equipment
    - Nellcor Puritan Bennett

Business Model



-Business Model Canvas - provided at www.businessmodelgeneration.com

Conclusions

- Flexible Thread Technology
  - is the first fast, reliable and easy method of connecting threaded joints
  - has a reputation in the aerospace, power/energy, manufacturing, fire/rescue, and compressed gas industries as the first “instant thread” technology
  - is being used in a wide range of different applications, and new possible applications can be developed regularly
  - has a record of creative, innovative, and robust solutions to the world’s, and outer space’s, most challenging fastener problems

Thank you for your interest!