Electronic Rope

Load and Wear Monitoring

Dan Goldwater
Saul Griffith

SQUID:Labs LLC

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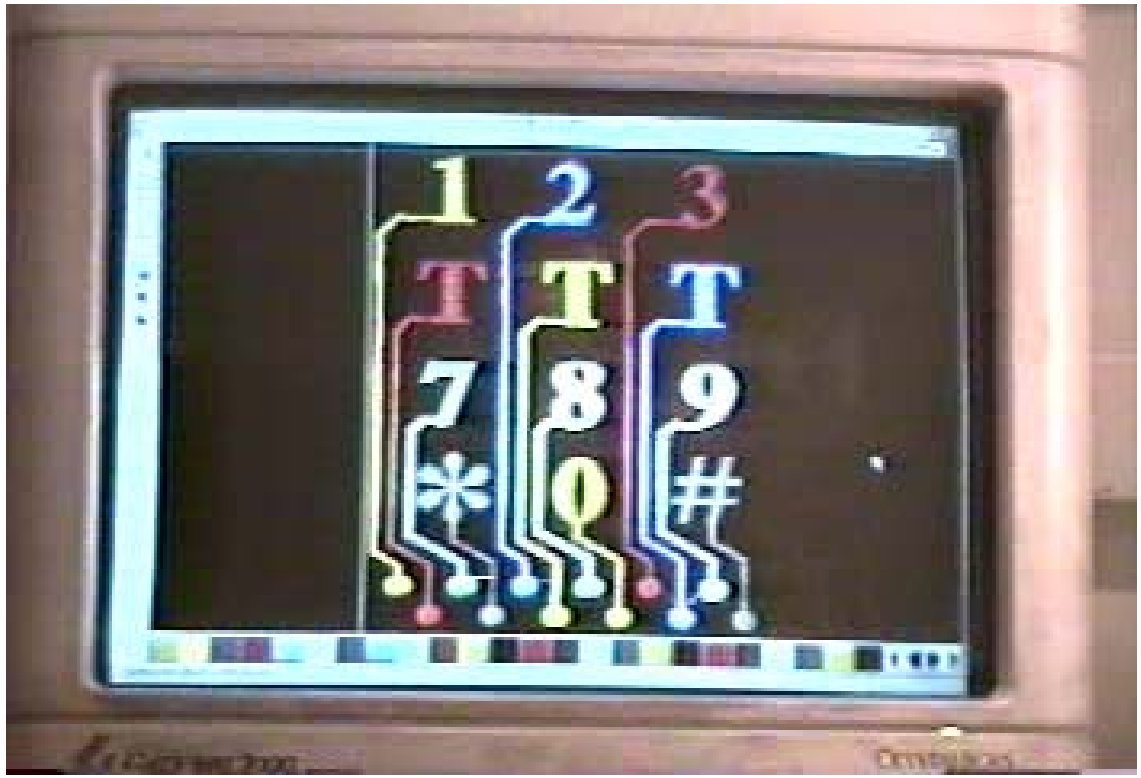
Electronic Rope – The Idea

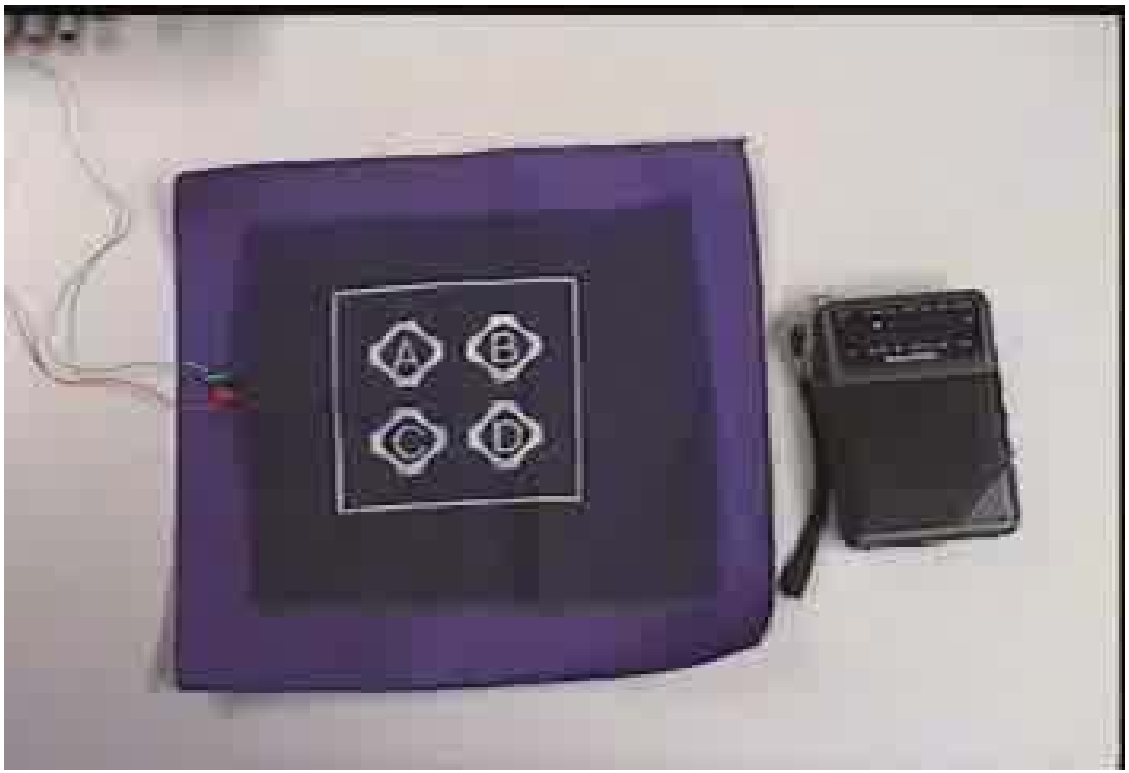
- MIT Media Lab: garments and wearable computing
- Embroidered electrically active patches

Color (13)

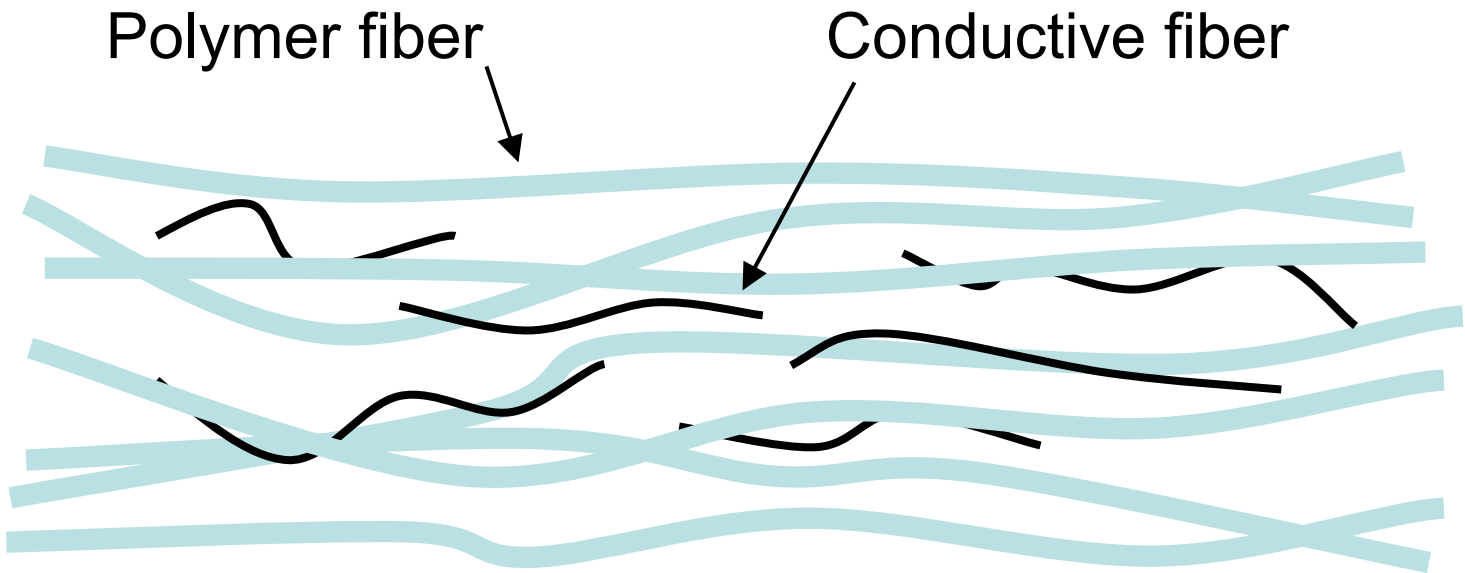


Electronic Rope – The Idea

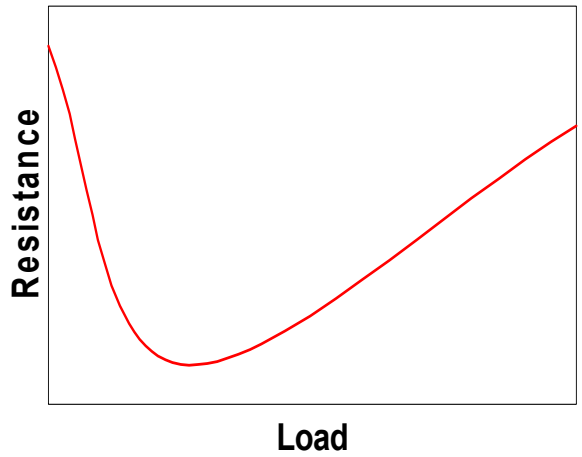
- Embroidered patches: electronic data collection via capacitive and resistive sensing
- Data wires via conductive thread



Active Thread – What is it?



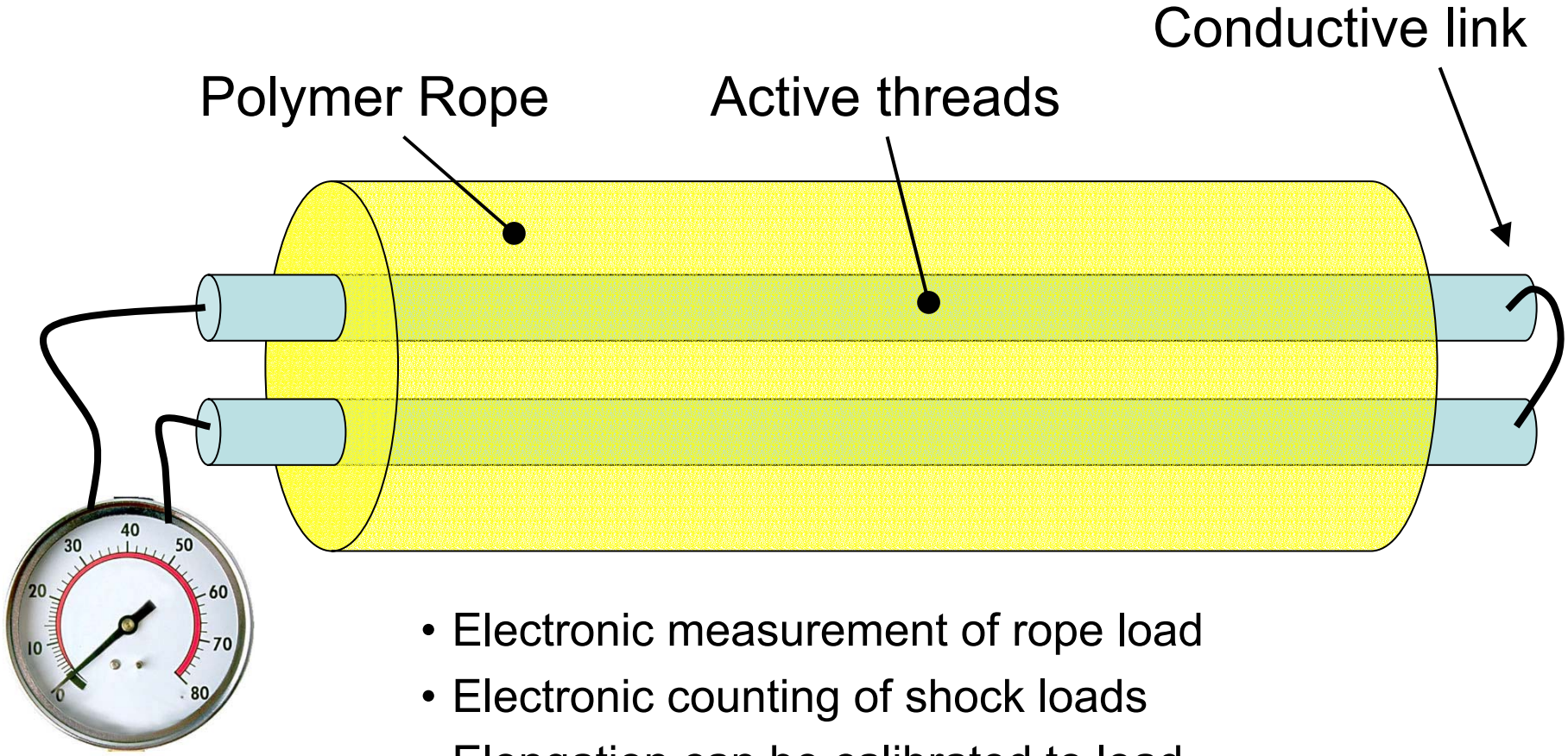
- Conductive fibers mixed with polymer carrier fibers
- Conductivity changes with load
- Standard rope polymers
- Commercially available



Rope Construction

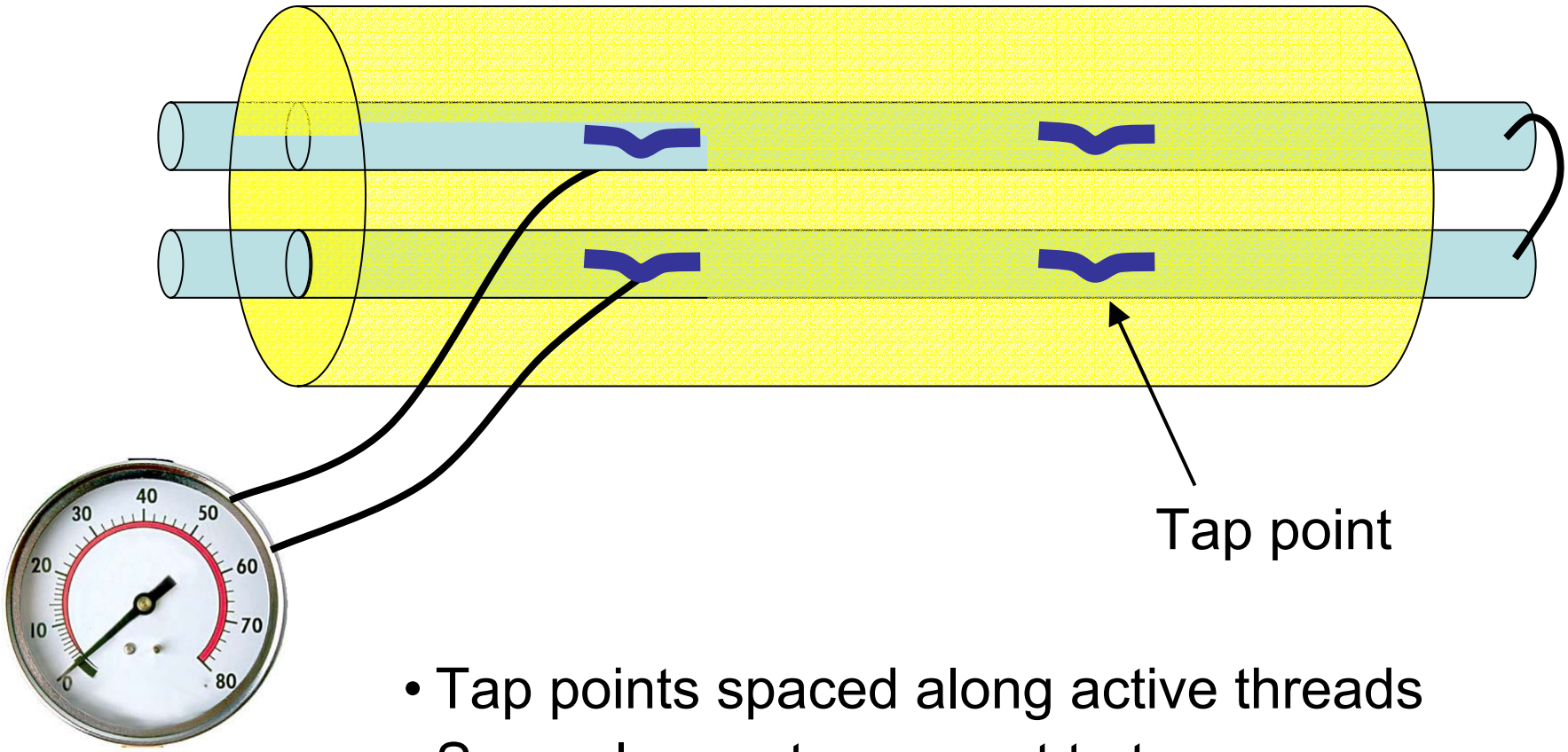
- Active threads embedded in standard rope
- Many rope geometries possible
- Electrical characteristics can be tailored via rope geometry and construction
- Twisted, Braided and multi-layer braided rope prototypes

Active Load Monitoring



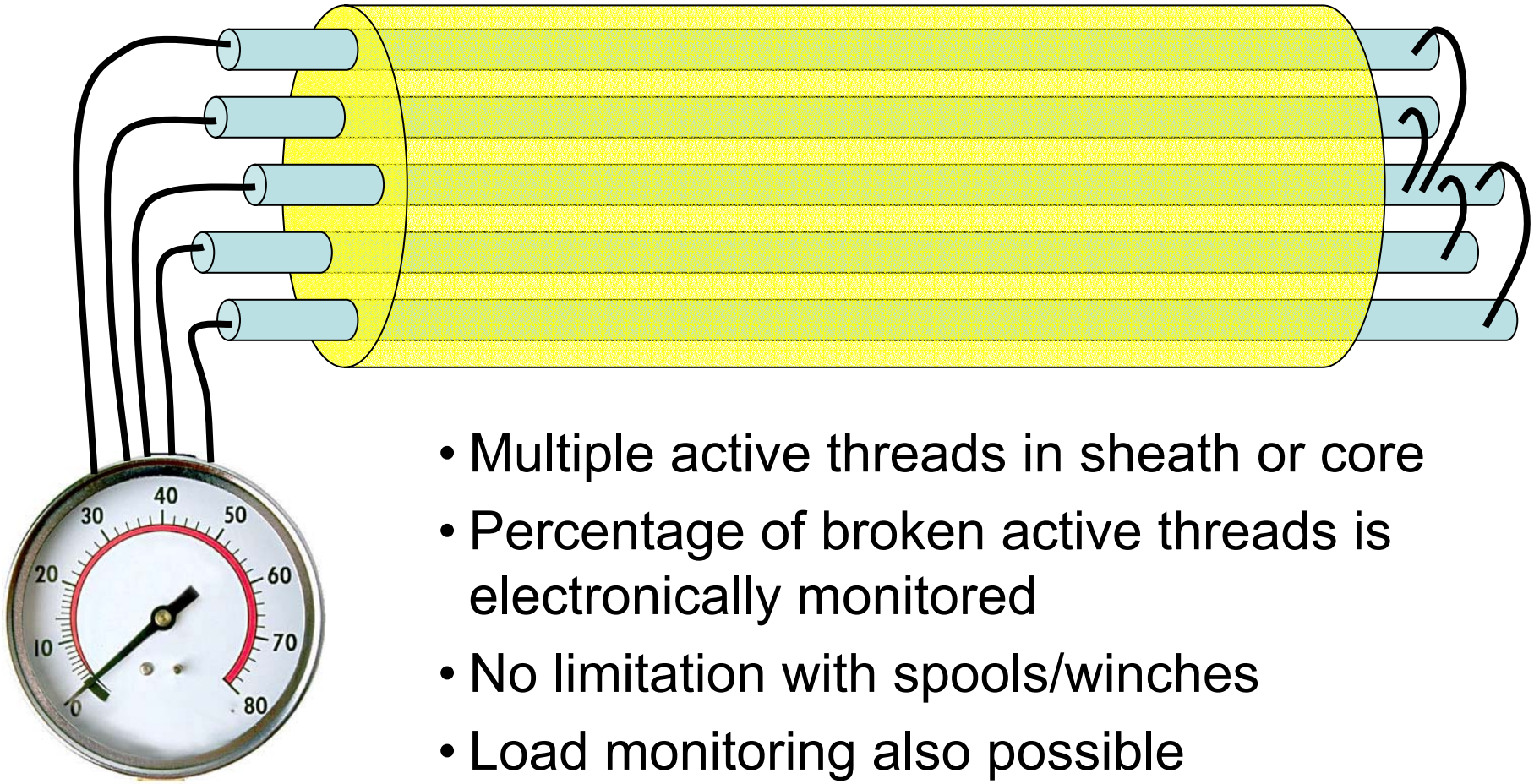
- Electronic measurement of rope load
- Electronic counting of shock loads
- Elongation can be calibrated to load
- Single ended measurement
- Spooling/Winching/etc. affect measurement
- Calibration parameters may be needed

Load Monitoring – Tap connections



- Tap points spaced along active threads
- Several ways to connect to taps
- Winding/fixturing hardware can integrate monitoring

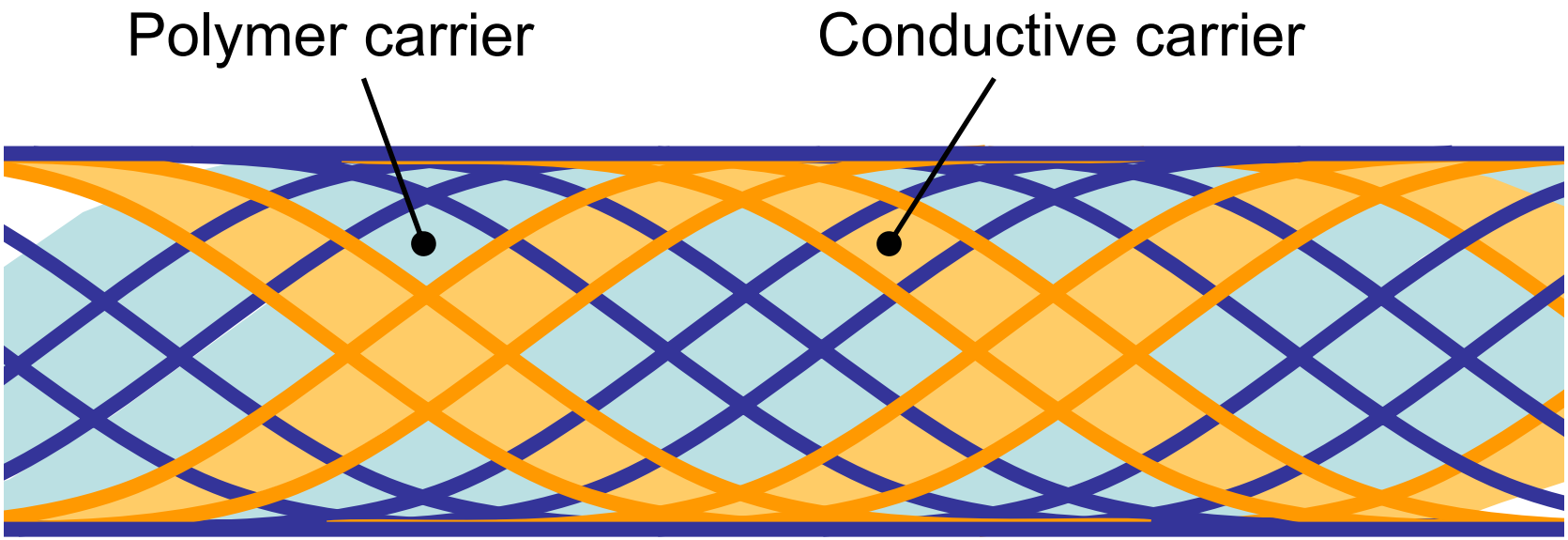
Active Wear Monitoring



- Multiple active threads in sheath or core
- Percentage of broken active threads is electronically monitored
- No limitation with spools/winches
- Load monitoring also possible
- No calibration needed

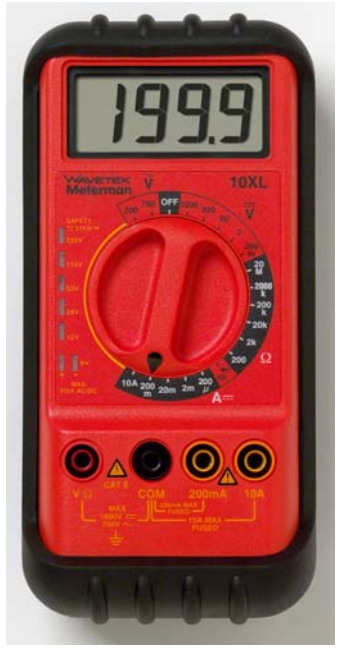
Pre-Failure Detection

- Conductive thread braided into polymer rope
- Conductive thread breaks before rope failure
- Electronic monitoring
- Carrier geometry key
- No calibration needed



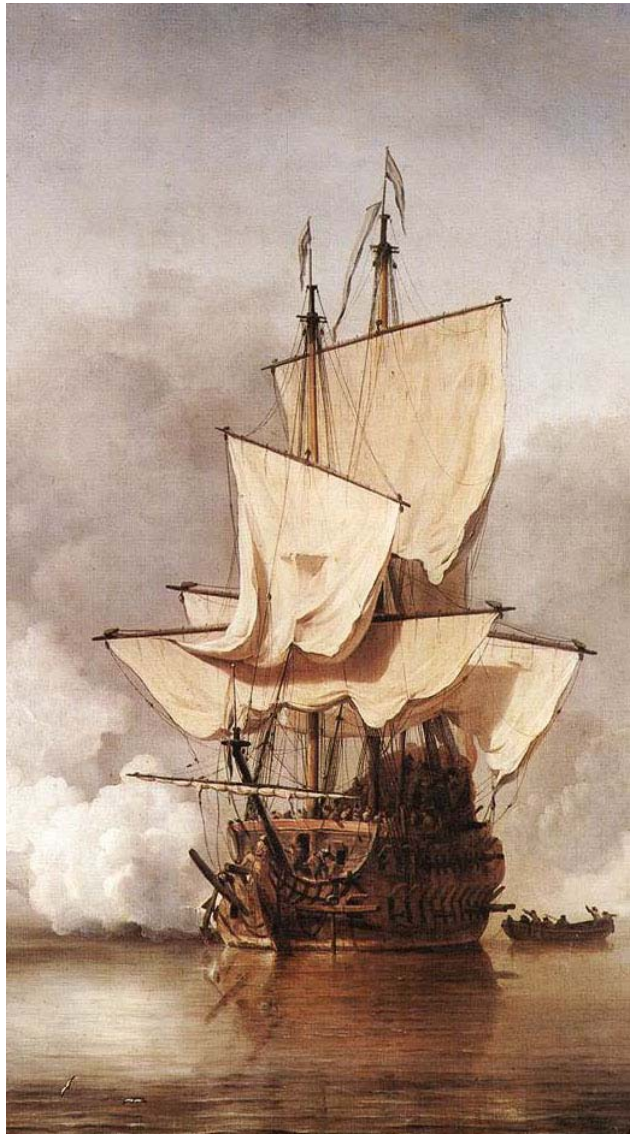
Electronic monitoring

- Programmable Microcontroller: Easy to add or change functions
  - Load monitoring
  - Shock counting
  - Wear monitoring
  - Pre-failure detection
  - Elongation monitoring
- Automated monitoring
- Auto-calibration or per-rope custom calibration
- Customized display
- Compact, low power
- Sense rate greater than 1000 samples per second
  - Can’t miss sudden shock loads
- Conductivity based sensing in current prototypes
  - Capacitive, inductive, frequency-spectrum sensing also possible
- Remote computer interface possible for advanced functions
  - Safety action
  - Logging and analysis
  - Advanced display output



Marine Applications

- Active threads available with waterproof/insulating coatings
- Electronic monitoring units can be fully sealed



Status

- Concept prototypes built
- Patents pending
- Seeking industry partners to identify applications and commercialize

- On the drawing board
  - Failure / weakness location detection
  - Other methods for load sensing
  - Water penetration detection
  - Wire rope load monitoring
  - Temperature detection

About Us

- **SQUID:Labs LLC**
  - Multi-disciplinary technology development
  - Contract research
  - Consulting
  - www.squid-labs.com

- **Dan Goldwater**
  - Electrical, hardware and software engineering
  - ScB, ScM Brown University
- **Saul Griffith**
  - Mechanical, materials, textiles engineering
  - B.MET.E UNSW, MSc USyd, MSc MIT, PhD MIT
- **Eric Wilhelm**
  - Mechanical, materials engineering
  - BSc MIT, MSc MIT, PhD MIT
- **Colin Bulthaup**
  - Mechanical, electrical, hardware and software engineering
  - BSc MIT, MSc MIT

Electronic Rope Summary

- Active threads embedded in standard rope
- Many rope geometries and functions possible
- Flexible electronic monitoring including:
  - Electronic load monitoring
  - Electronic wear monitoring
  - Electronic pre-failure detection
  - Electronic shock-load counting
  - Compact, customizable monitoring units
  - Remote computer-based advanced functions
- Improve safety
- Reduce maintenance effort
- Seeking industry partners

Extra notes

Calibration notes for load monitoring

- Active thread's response is related to its elongation
- Example:
  - Rope A stretches 4% under 1000lb load
  - Rope B stretches 1% under 5000lb load
  - We detect that the ropes stretched 4% and 1%
- Elongation (which correlates to MBL) may be sufficient for the application
- Calibration correlates elongation to lbs load if needed