

The background of the slide is a microscopic view of wood grain, showing concentric growth rings in shades of orange and brown. A prominent knot is visible in the upper center. The text is overlaid on this background.

**Unfolding  
New Fibers – New Paper  
New Applications  
New Markets**

**Art Ragauskas  
Professor**

**Institute of Paper Science and Technology  
Georgia Institute of Technology**

# **Driving Forces of Change in Pulp and Paper**

## **The Technology Explosion**

**About 90% of all scientific knowledge has been generated over just the last 30 years**

**Greater than 80% of all the scientists and engineers who have ever lived are living and working now**

**In 1960 < 5% of the general population in North America and Europe had completed 4 or more years of college**

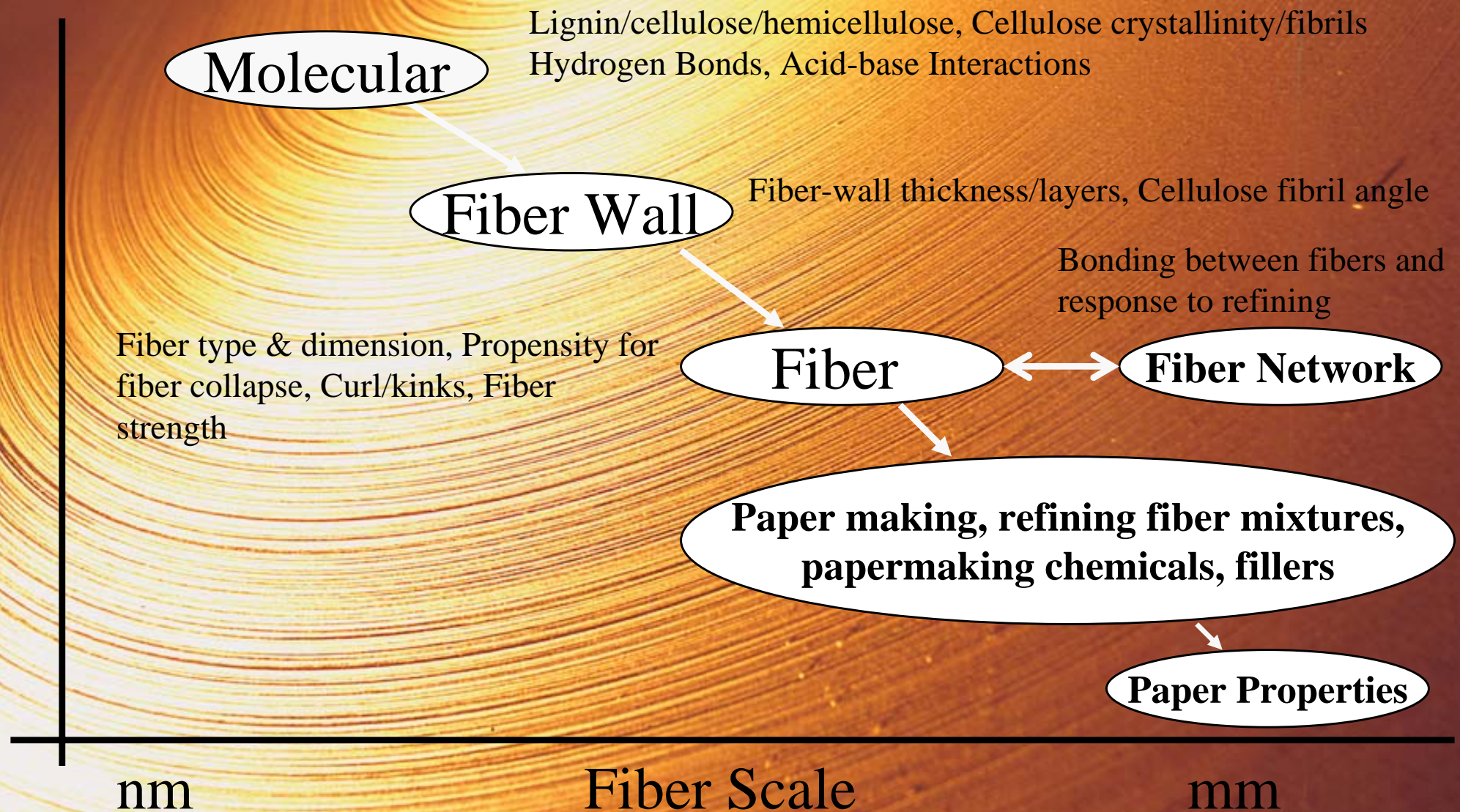
- In 1999 this increased to ~20%**
- Demographic analysis indicates this trend will continue**
- Increased technological competence of society drives change**

# Basic Realities of New Millennium

- **Major forces of change will continually restructure all world economies**
- **Business now is the management of continuous change, requiring all organizations to restructure to manage change**
- **Wealth no longer will be measured by ownership of rapidly obsolescing fixed physical assets, but in terms of knowledge--high value-added, technology intensive proprietary systems**

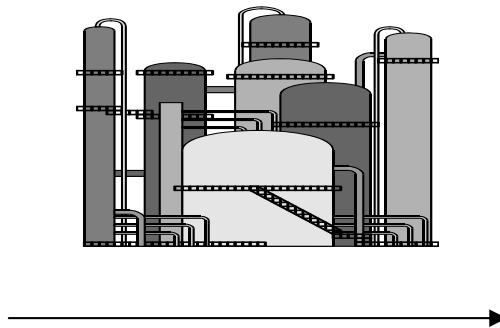
# Hierarchical Structure of Paper

## Dimensions of Innovation



# Pulp – Paper

## Research Patterns



**Process Research Publications: +140,000**

**Product-Platform Research Publications: ~9,000**

**What's Next?**



**“The Future Ain’t What It  
Used To Be”**

Yogi Berra  
New York Yankees

# New Packaging

- Origami Packaging
  - Self adapting packaging
- Transportation
- Interior
- Building
- Electronics
- Medical
- Hygienic
- Food

- *Controlled Inner Environments*
- *Active – Passive Anti Bacterial/Fungi Defense*
- *Odor – Flavor Control*
- *Freshness Sensors*
- *Tamperproof Security*
- *Anti Counterfeiting/shoplifting*
- *Tamper Resistant*
- *No Fridge Storage*
- *Extended Shelf Life*
- *Retortable*

# New Packaging

- Innovative Packaging
  - Deformability
  - Cut Proof
  - Flexibility - Squeezable
  - Functional Barriers
  - Disposable Food Deliver Systems
  - Ultra-Lite Weight Containers
- Intelligent Packaging
  - Brand Authentication
  - Active Messaging - Displays
  - Environmental Responsive
  - Printed RFID



# New Barriers

- Self Cleaning
- Flexible Electronics
- Conductive – Magnetic
- Controlled Inner Environment
- Optics
  - Iridescence
  - Adaptive Printing
  - New Security Features

# Innovative Fibers

- **Moldable**
- **Non hydrogen bonding fibers**
- **Active Release**
- **Environmental Sensitivity Detectors**
- **Conductivity**
- **Ion Exchange**
- **Odor Control**
- **Degradable Superabsorbers**
- **Superhydrophobic**
- **Moisture Control**
- **Anti-static**

# New Fibers - Composites

- High Fiber Composites
  - Enhanced strength properties
  - Improved life-cycle
  - Piezoelectric
- Surface Functionalization
- Construction Additives/Panels
- Moisture Stability
- Breathable

# New Fibers - Composites

- High Filler Sheets
- Paper Foam Packaging
- Extrusion celluloseics
  - Disposable cookware, bottles
- Controlled Diffusion Packaging
- Polymer Templating
- Cellulosic Laminates

# New Filters

- Bio-capture – Clean Air Control
  - Allergens, fungi bacterial, mold, mildew
- Odor control
- Water purification
- Environmental remediation

# New Tissue

- Wiping – Cleaning - Preventative
  - Antibacterial/Fungi
  - Odor Control
  - Fluids Control
- Caring
  - Diagnostic tissue
- Nursing
  - Biosensors
  - Active Release
  - Bioactive Pretreatments

# **New Convenience Platforms**

- **Disposable Home Cleaning Platforms**
- **Toner Free Laser Printing**
- **Acoustic Tiles**
- **Disposable Hygiene Clothing**
- **Fashion Furniture**

# Intrinsic Cellulosic Strengths

- Readily Available Bioresource
- Consumer Convenience, Excellent Graphics
- Adaptable Manufacturing Technology
- Integratable into Biorefinery
- Environmental Compatible
- Carbon Neutral
- Biodegradable
- Sustainability
- Recyclable
- Cost
- Safe



A photograph of a modern building at night. The building has a large glass facade on the left side, reflecting the interior lights. To the right, there is a curved, multi-story section with a grid of windows. In the foreground, there is a fountain with several jets of water spraying upwards, illuminated from below. The sky is a deep blue.

**Thank You!**

“It is not necessary to change

‘But’

Survival is not mandatory”

Deming

arthur.ragauskas@ipst.gatech.edu

ragauskas@hotmail.com