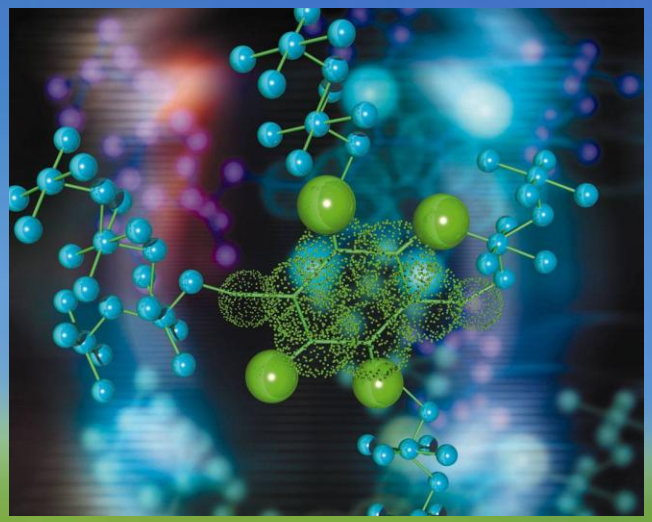
The American Textiles Scenario: Technology, Business & Education



Business

Sustainability & Carbon Footprint

Education

Technology

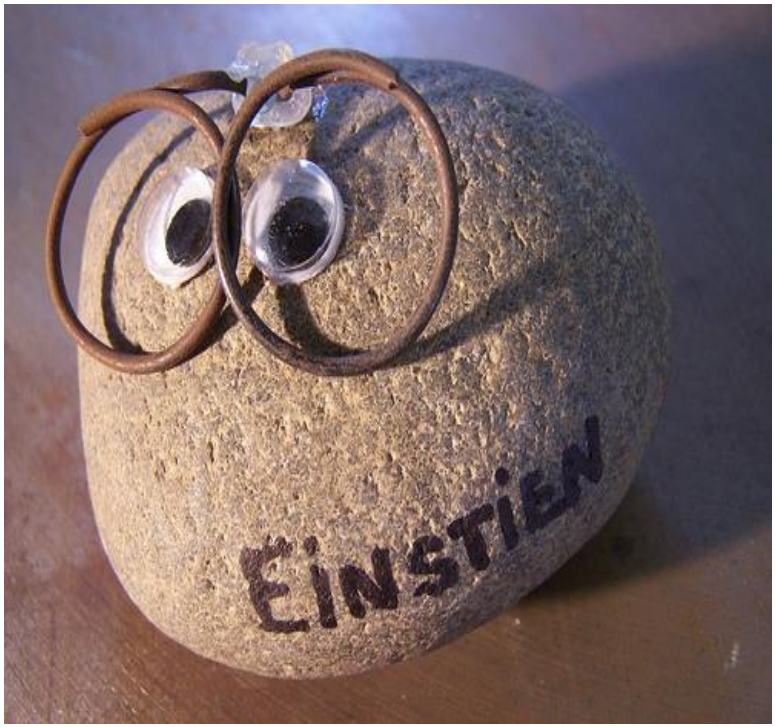
Globalization

Arun Aneja

Noéton Policy in Innovation, USA

PROJEKT OPTIS PRO FT, reg. č.: CZ.1.07/2.2.00/28.0312 JE SPOLUFINANCOVÁN EVROPSKÝM SOCIÁLNÍM FONDEM A STÁTNÍM ROZPOČTEM ČESKÉ REPUBLIKY

Agenda



Points to Consider Globally

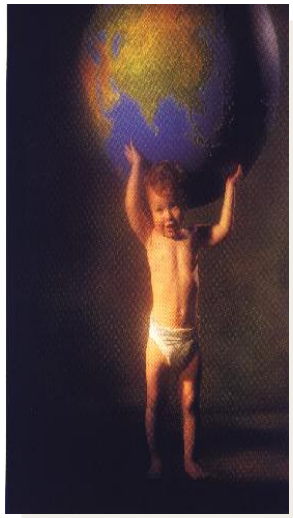
- New Challenges
- Product Innovation
- Process Innovation
- Textile Education
- Conclusion

Points to Consider - The Global Context

Points to Consider – Globally

- Slower textile consumption internationally
  - Less than 2% growth forecasted through 2020
  - U.S. apparel market growth at just 1%
- China & India will become dominant suppliers through 2010
- Africa and certain Asian and Subcontinent countries will gain in importance
- Significant price deflation due to current economic meltdown and overcapacity

World Consumption of Textiles



Werner Forecast 2000-2020

Year	Pop MM	M Tons	% Growth Ave	Kgs/Cap	% Growth Ave
1950	2513	9939		3.67	
			4.2%		3.0%
1960	3039	14934		4.91	
			3.9%		1.8%
1970	3707	21840		5.89	
			3.2%		1.3%
1980	4454	29821		6.70	
			2.6%		0.8%
1990	5279	38378		7.27	
			2.2%		0.8%
2000	6083	47763		7.85	
			1.9%		0.7%
2010	6849	57655		8.42	
			1.6%		0.6%
2020	7585	67573		8.91	

Apparel, Textiles & Fashions Industry Trends

- Globalization: Growth in Offshore Apparel Manufacturing Slows/China Remains a Major Factor
- Western Apparel Firms Enter the Chinese Market
- High-Tech, Nanotech and Smart Fabrics Finding Foothold
- Exercise Apparel Sales Fall Slightly
- 3PL Supply Chain Management Evolves to Serve the Global Market
- Bricks, Clicks and Catalogs Create Synergies While Online Sales Growth Surges

Apparel, Textiles & Fashions Industry Trends

- Alternative Sizing Is Big, But Plus Size Sales Are Slowing
- Discount Clothing Retailers See Promise in Designer Lines
- Luxury Lines Bounce Back And Go Online
- Self Service Retail Take Off
- Mass Designers and Retailers Speed Up for Fast Fashion
- Apparel Manufacturing Gains Ground in the U.S.
- Apparel Goes Green

Forces changing the business landscape

1. **Globalization of markets**
   - Seamless flow of people, technology, capital, information & products
   - *Is mfg going to shift towards low cost countries in Africa in next decade?*
2. **Societal demands for higher environmental performance**
   - Technological developments to enhance the ability of next generation to meet their own needs
3. **Financial market demands for increased profitability and capital productivity**
   - Satisfy the shareholders expectation
4. **Higher customer expectation**
   - Increasing responsiveness in terms of reduced product cycle time, adding value to customer's customer
5. **Changing workforce requirement**
   - Focus on knowledge, skill improvement, training as an ongoing part of an employee's career

Entering an era of dynamic tension –
Sustainable development through *stakeholder* engagement

Capital and Labour

- Capital squeeze on SME's (Basel2 effect)
- Equity and Venture Capital Shortage
- Skilled labour shortage
- Unskilled labour reserve still ample

Looking Ahead: Material Economy

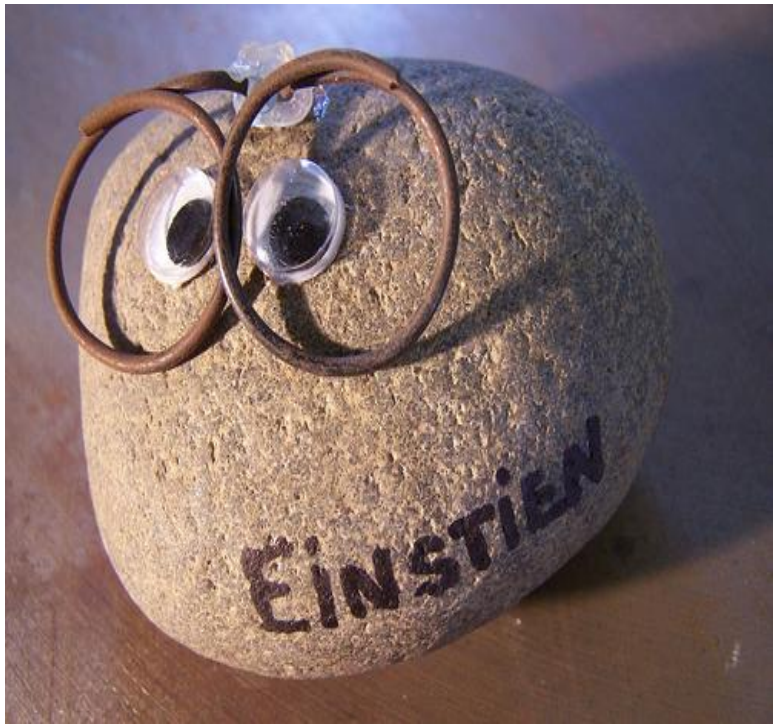
- Volatile oil prices USD 50 - 150/ bbl
  - Upward impact on synthetic fibres
- Coal back in vogue
  - Moving beyond thermal power generation
  - Coal to alcohol to olefins
  - Carbon capture & sequestration
- Energy & water price on the rise
- Biotech: Emerging alternative for non-renewable resources
- Material science at the confluence of IT, Biotech & Nanotechnology

Bottom of pyramid worst affected

Current State in USA

- Fibre base moved to Asia (80% of capacity)
- USA only in specialities(UHMWPE) and non traditional emerging technologies
- Overall de-industrialisation in USA
- EU focus on cultural capital, eco-products, mass-customization
- Global Cost Pressure
- Reduced R&D Spending
- Higher Consumer Expectation
- Diverse Customer Base
- Rapid Changes in High Tech Industries
- Regional Trading Blocks, China in WTO

Agenda



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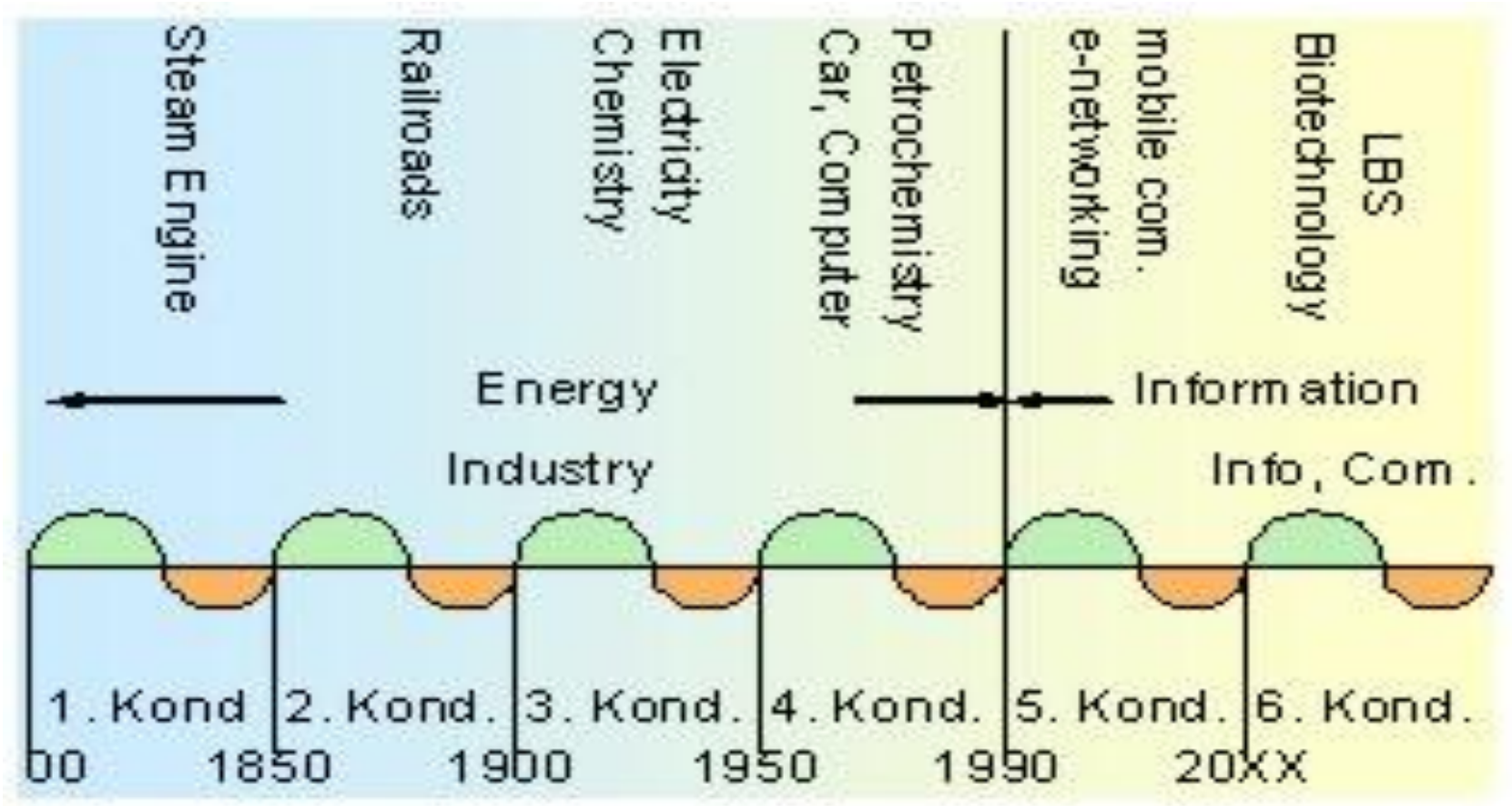
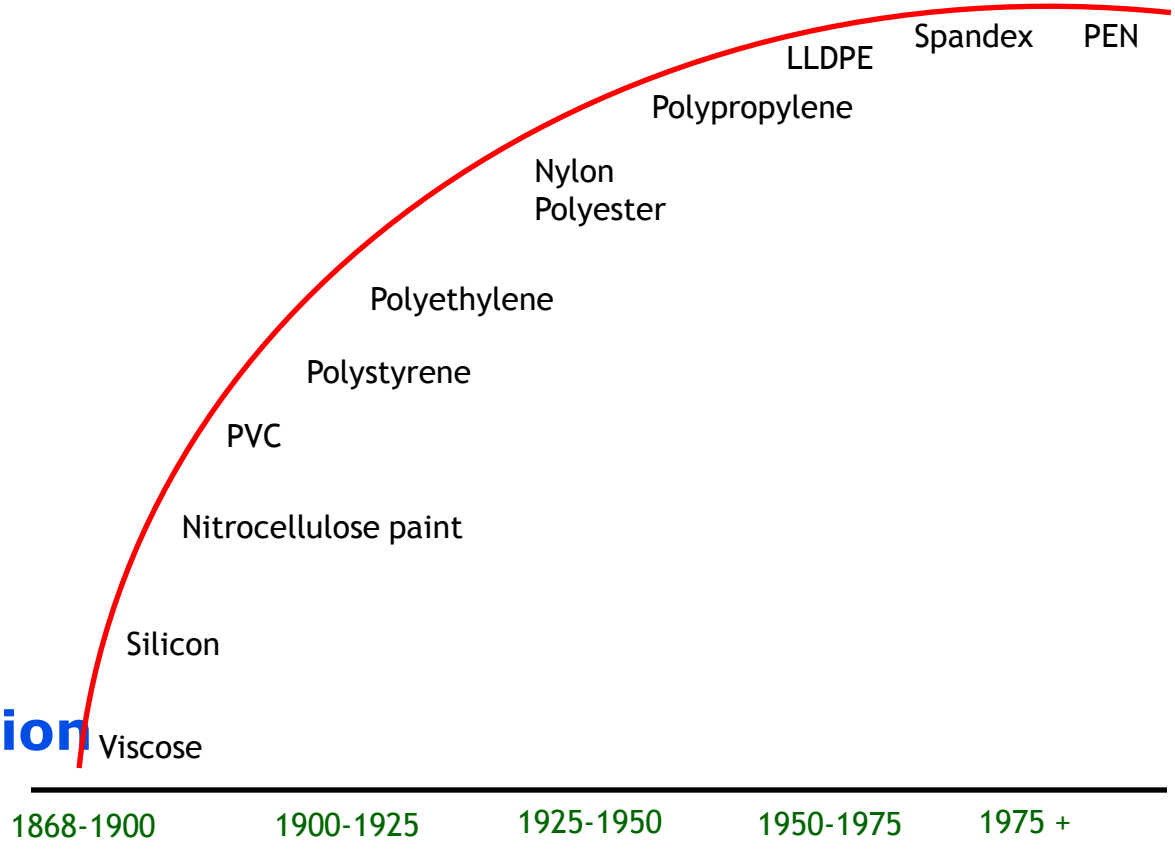
Kondratieff Cycle



Milestones

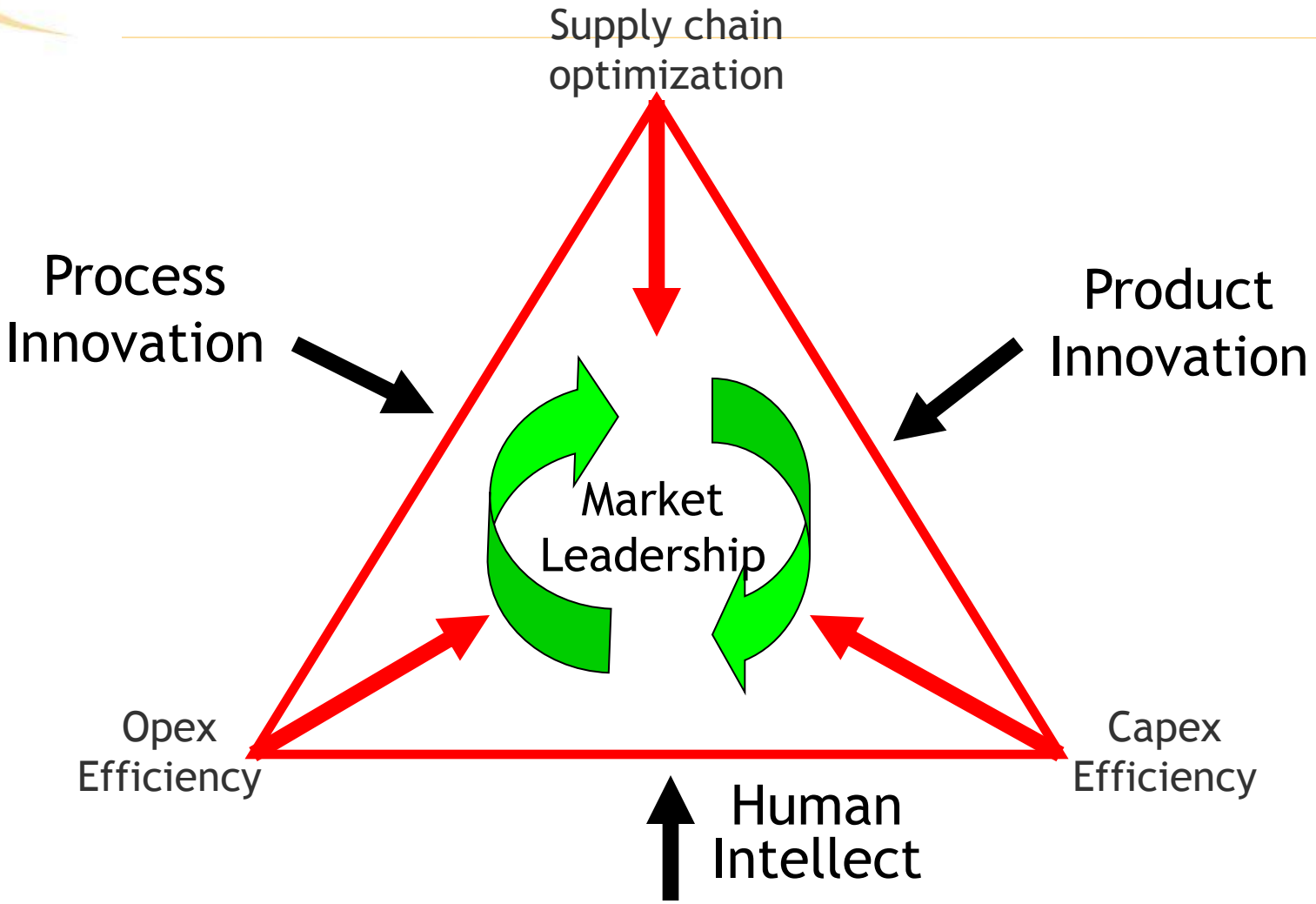
- Mechanical clock
- Printing press
- Light bulb
- Steam engine
- Immunization & antibiotics
- Telephone
- Nuclear fission
- Space Shuttle
- Internet
- Mobile communication



Material science based innovation nearing maturity ?

Source: usenvy.com, encarta.msn.com

Innovation = (Creativity + Risk) x Execution



"It is not the strongest of the species that survives, nor the most intelligent, but the one most responsive to change" Charles Darwin

Saturation in process technology !

Product	Yield			Economy of scale (KTA)		
	Laggard	Leader	Variation	1990	2008	Increase
Ethylene	30.4%	30.6%	0.2%	500	1300	3 times
Ethylene Glycol	66.4%	69.8%	3.4%	100	600	6 times
PTA	94.6%	95.3%	0.7%	250	800	3 times
LDPE	96.1%	98.5%	2.4%	80	400	5 times
LLDPE	98.9%	99.5%	0.6%	120	550	5 times
Polypropylene	97.0%	98.8%	1.8%	120	550	5 times
PET	98.9%	99.8%	0.9%	70	450	6 times

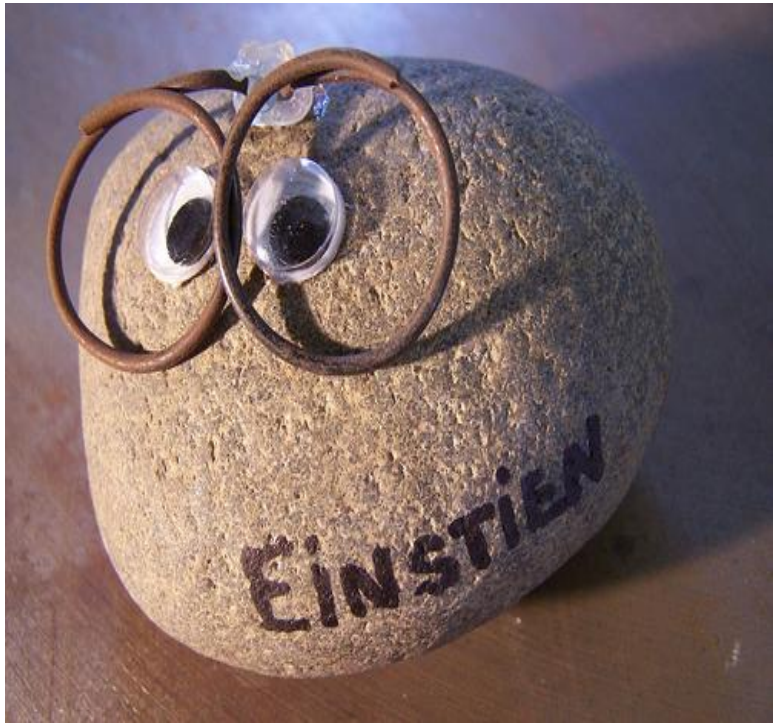
Source: Nexant, Inc./Chem Systems

*Chemical Grade - 93%, #Refinery Grade, @7% butene comonomer

Key differentiator: Past - Scale with maturing technology

Future - Ownership of new technology key to growth

Agenda



- Points to Consider Globally
- New Challenges
- **Product Innovation**
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Driving forces for New Textile Technologies

- ***Technology push***
  - **Polymer science and technology**
  - **Fibre production**
  - **Yarn and fabric forming techniques**
  - **Inter disciplinary developments**
- ***Market pull***
  - **Consumer demands**
  - **New avenues for existing products**
- ***Environmental***
  - **Stricter regulations (REACH)**
  - **Increased awareness**

Ref : R.Shishoo, Techtextil India, 2007

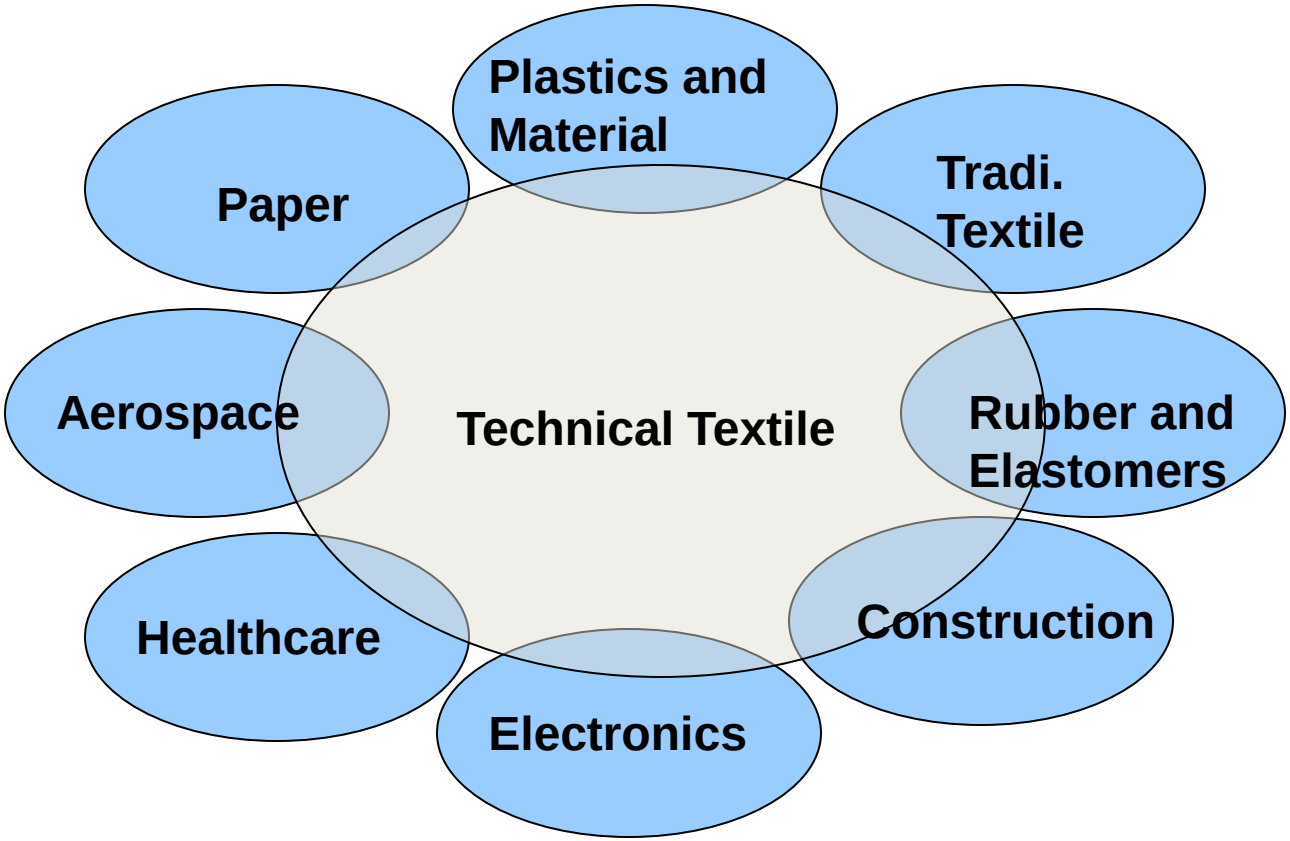
Driving Force: Sustainability & Carbon Footprint Reduction

- Must Consider Complete Product Life Cycle
- High Knowledge Content Materials
- Innovation Focused

Key Emerging Technologies
(highly synergistic/at the frontiers of the small/ in a "feeding frenzy" off each other)

- **IT** (communication, computing, sensors, electronics, machine intelligence)
- **Bio** (genomics, molecular biology, designer life forms)
- **Nano** (coatings, barriers, computers, sensors, materials)
- **Energetics** (solar, biomass, explosives, propellants, storage)
- **Societal Technological Systems** (virtual presence, tele-everything, robotic everything, digital earth/digital airspace)

Technical Textiles: Fusion of products (Marriage of Properties)



Covers a vast range of products & applications

Global Market Size: Technical Textiles

Technical Textiles	Unit	2005	2010
Output	MMT	19.7	23.8
Value	US$ bn	107	127
Avg value/MT	US$/MT	5431	5336
Avg value/MT	INR/MT	2,17,000	2,14,400

Source: DRA

- **India & China are expected to be the main growth drivers**
- **Technical textiles to grow at CAGR of 6.45% in volume terms to reach 24 MMT**
- **Numbers shows that value of technical textiles is at least 3-4 times the non-technical textiles**

Higher margins over conventional textiles

Technical Textile: Fibre Consumption

Fibre (KT)	Year			CAGR (%)
	2000	2005	2010	
Natural	3462	3839	4447	2.54
Man-made/Inorganic(glass)	13252	15843	19327	3.85
Total	16714	19682	23774	3.59

Source: DRA

- **MMF has a dominant share of 80% in technical textiles**
- **Polyester & polyolefin's share is 50%, natural fibres have a share of 20% while other man-made fibres have a share of 30%**

Versatility in properties makes MMF the preferred fibre

Technical Textile: Consumption Pattern

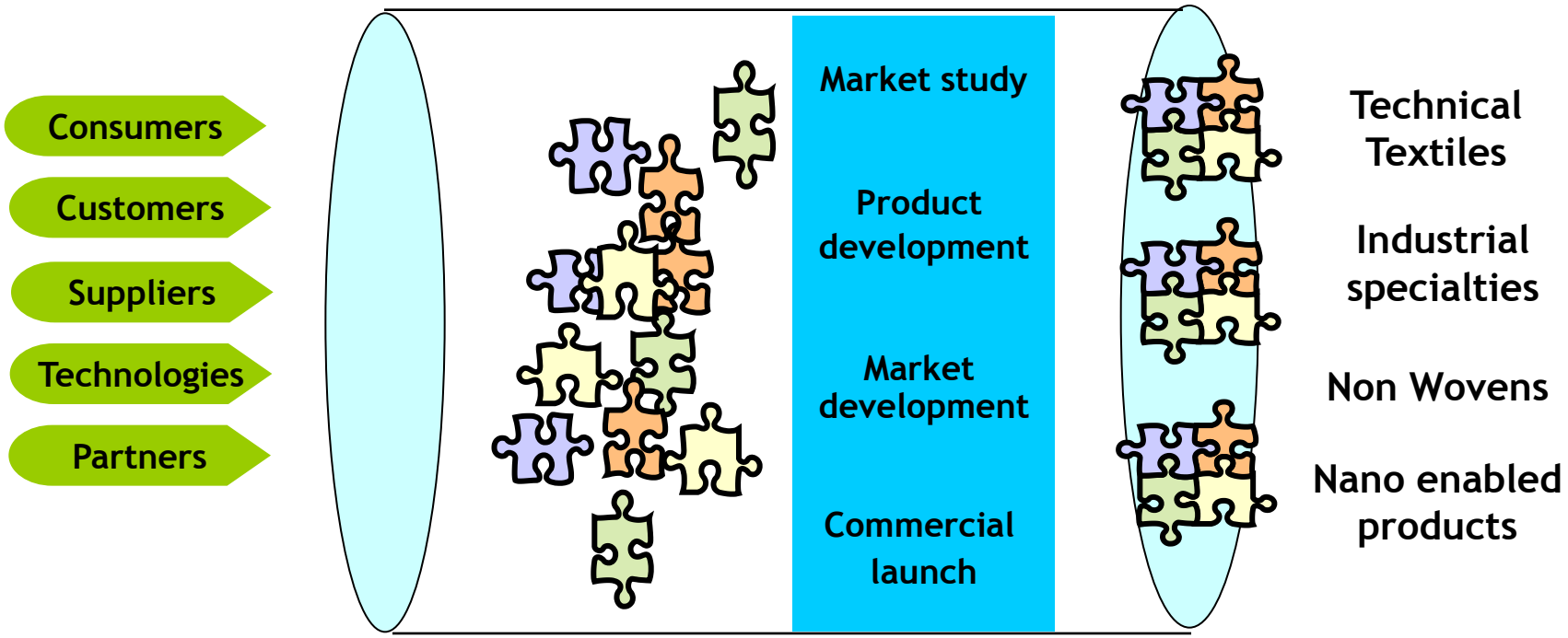
Product type	Share (%)
Filling material	24
Yarn	9
Fabrics -Woven -Knitted -Non-woven	**67**

- **Major consumption is in form of fabrics (67%)**

Huge opportunities ahead

Focus on specialties ➔Super specialties

Intelligence → Opportunities → Idea fragments → Projects → Roll outs



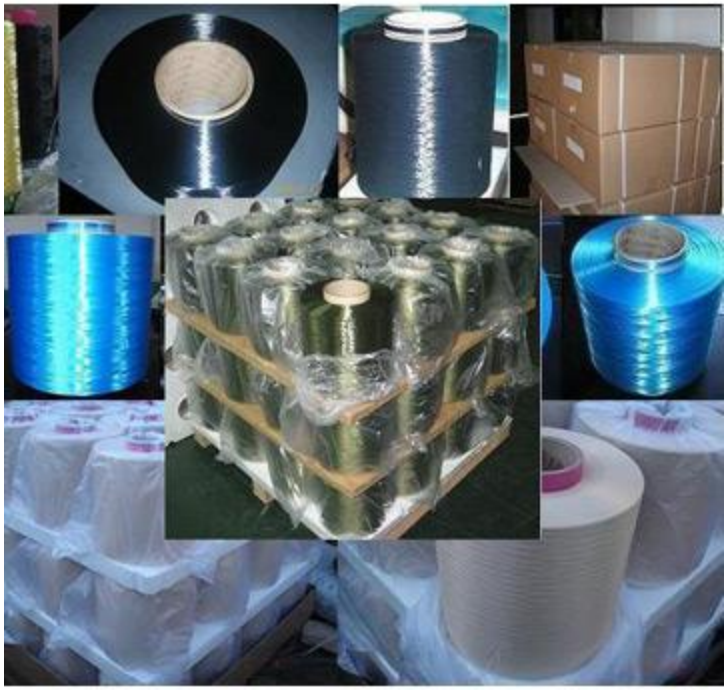
360^0 focus on product selection

Functionality Directions

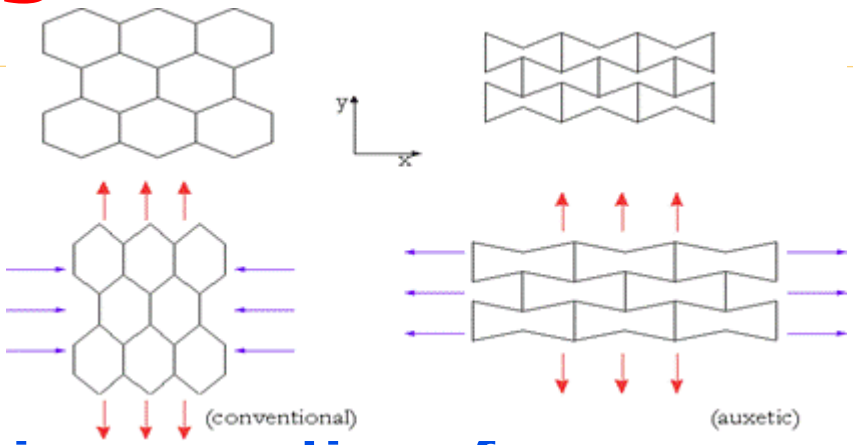
- **High strength**
- **High modulus**
- **High thermal stability**
- **High flame and heat resistance**
- **High chemical resistance**
- **Special functionality**
  - ***Conducting, Barrier, Impact, Cut***
- **Adaptable/smart**
- **High performance - *Nano fibres***
- **Combination of functionality - *Polymer blends***
- **Eco friendly - *Renewable resources, recycled***

Advanced Fibres

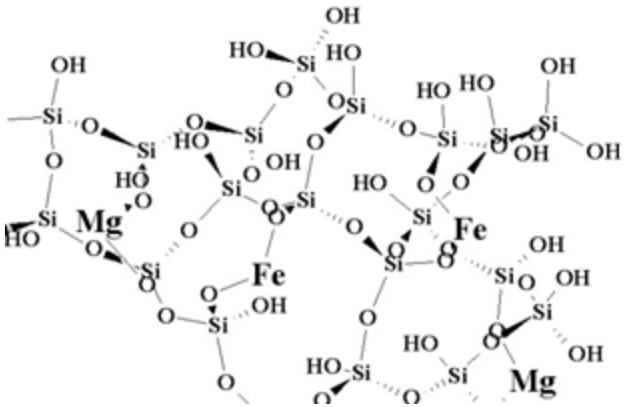
- HT-PES,
- UHMPE,
- Aramid (Kevlar, Nomex)
- Carbon
- PEEK
- Melamine (Basofil)
- Ceramic (Silicon Carbide)
- Electro spun nano fibres
- Conducting Polyanilines, Polypryrroles
- Eco friendly - PLA, PTT, recycled PET

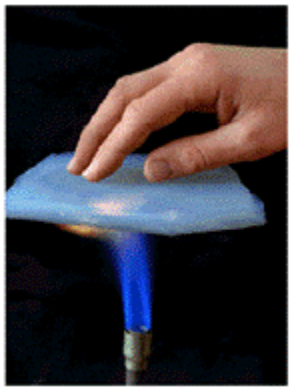


New Technologies

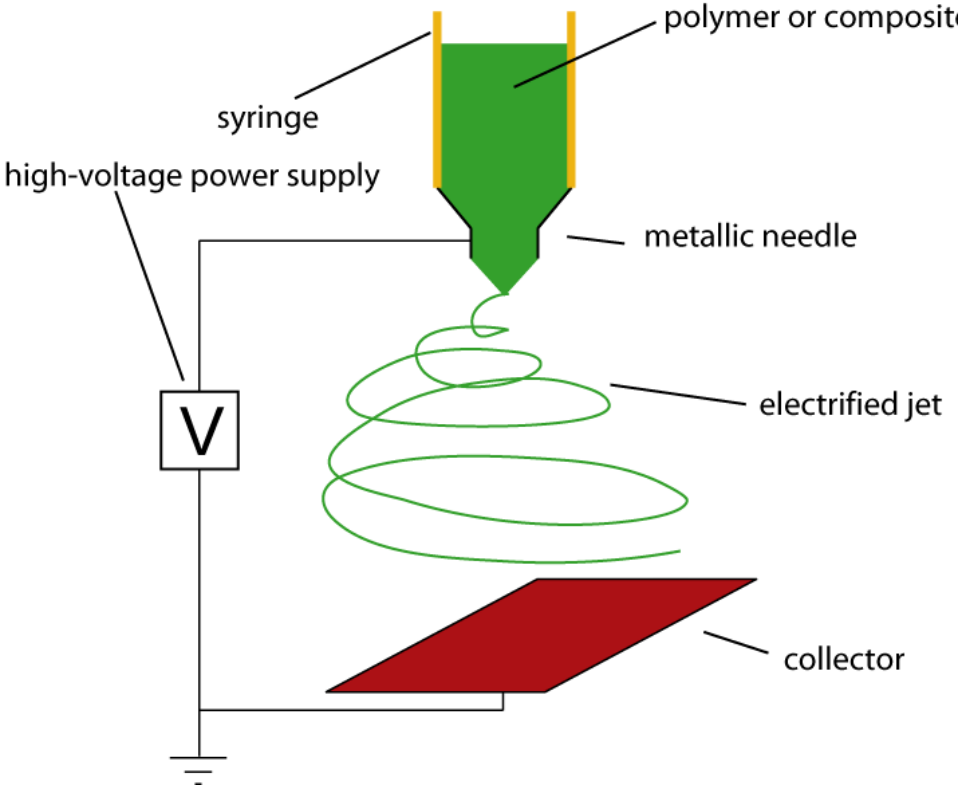


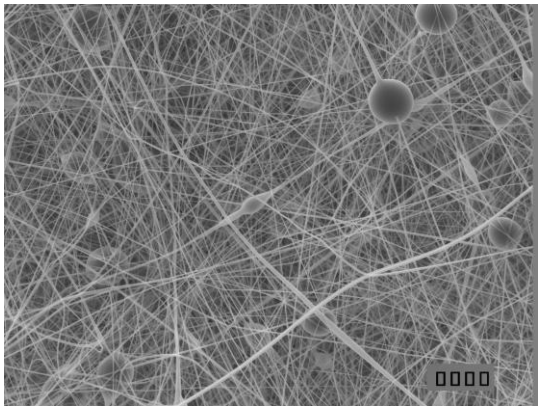
- Micro-fibre spinning
- Bicomponent spinning
- Conjugate spinning allowing incorporation of microcapsules and inorganic substances
- Electro spinning for Nano fibres
- Auxetic Textiles
- Aerogels



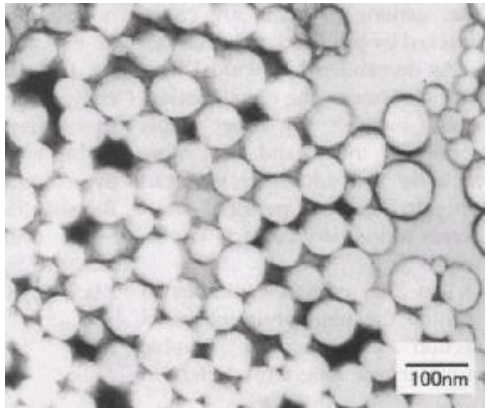


Electro Spinning



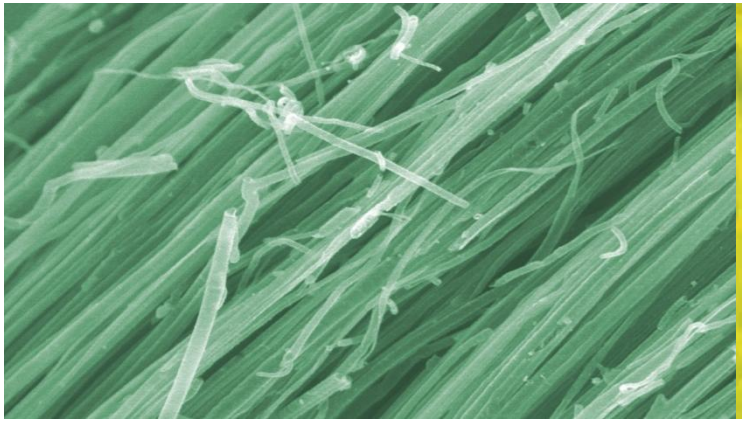


Electrospun polyester X 1000

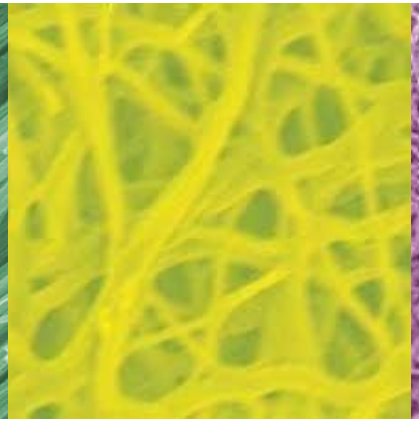


Nanofibres from Toray- conventional

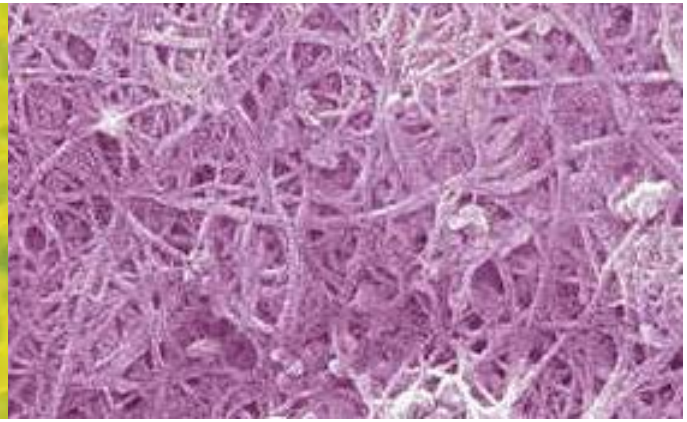
Nano-Materials



Nanotubes

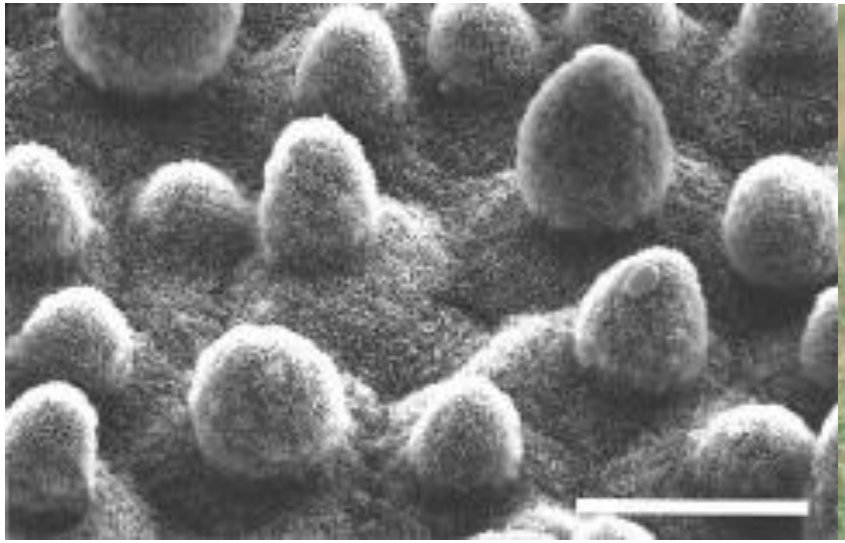


Nanotissue

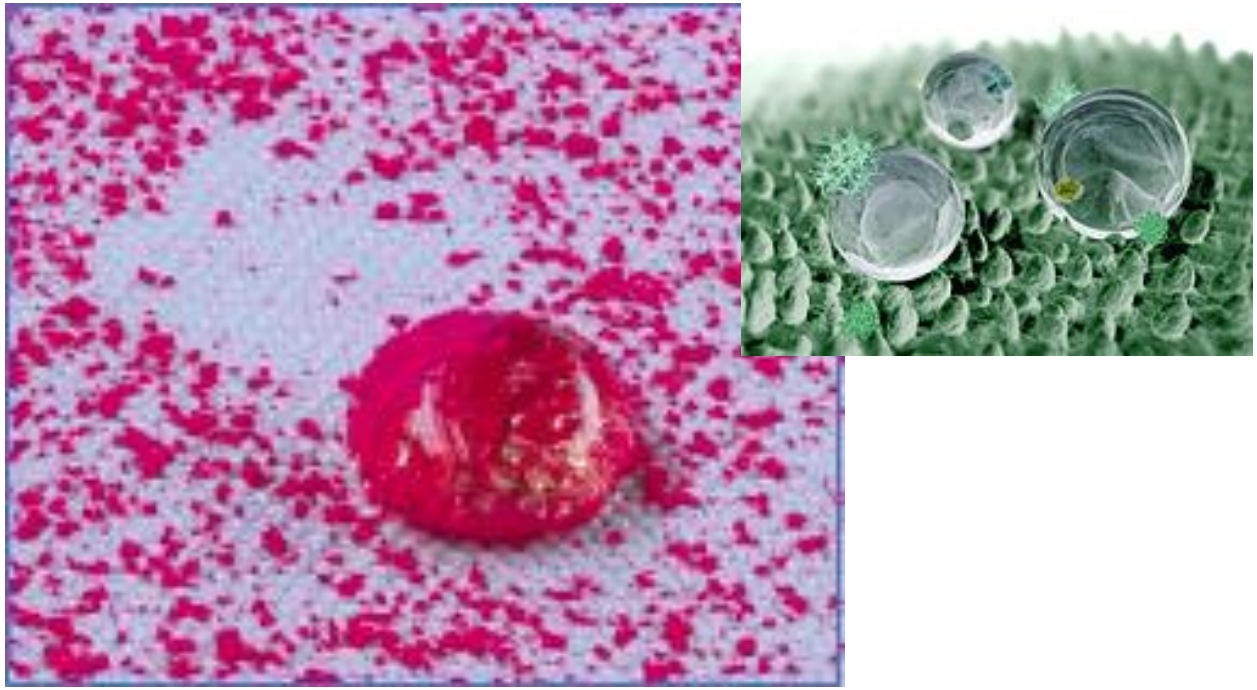


Nano-muscles

Nano Surfaces (Lotus Effect)



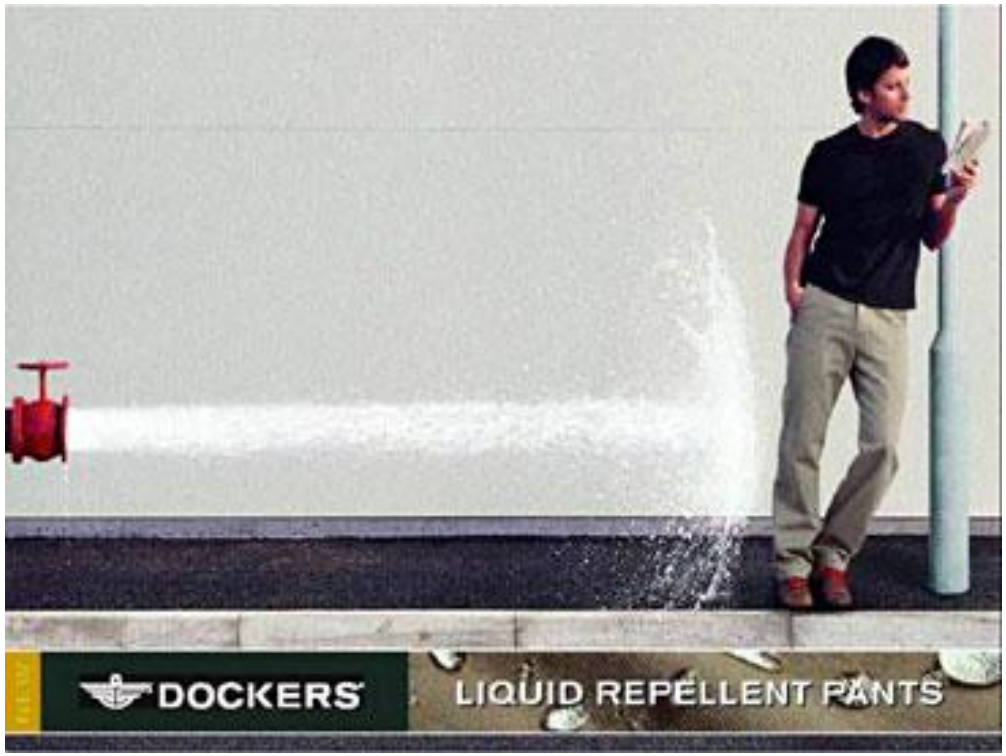
Self Cleaning Fabrics



- Biomemetic led to developing the fabric based on lotus leaf effect
- Alternative technology based on photocatalysis of $Ti0_2$ nano particles

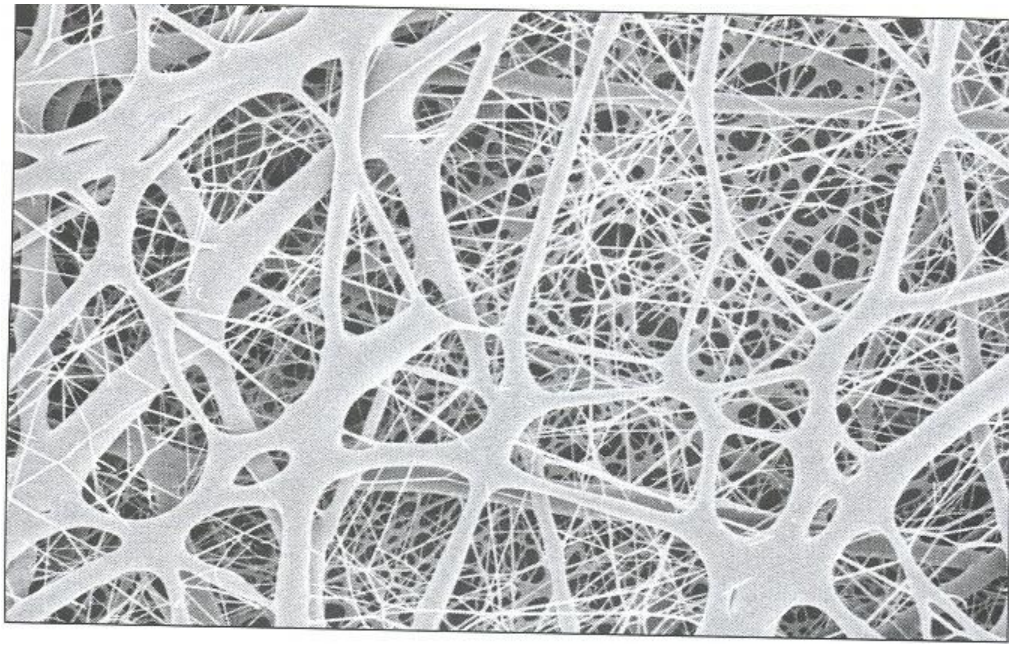
New Functionalities

Nanofibres / Finishes



Nano Fibre Structures

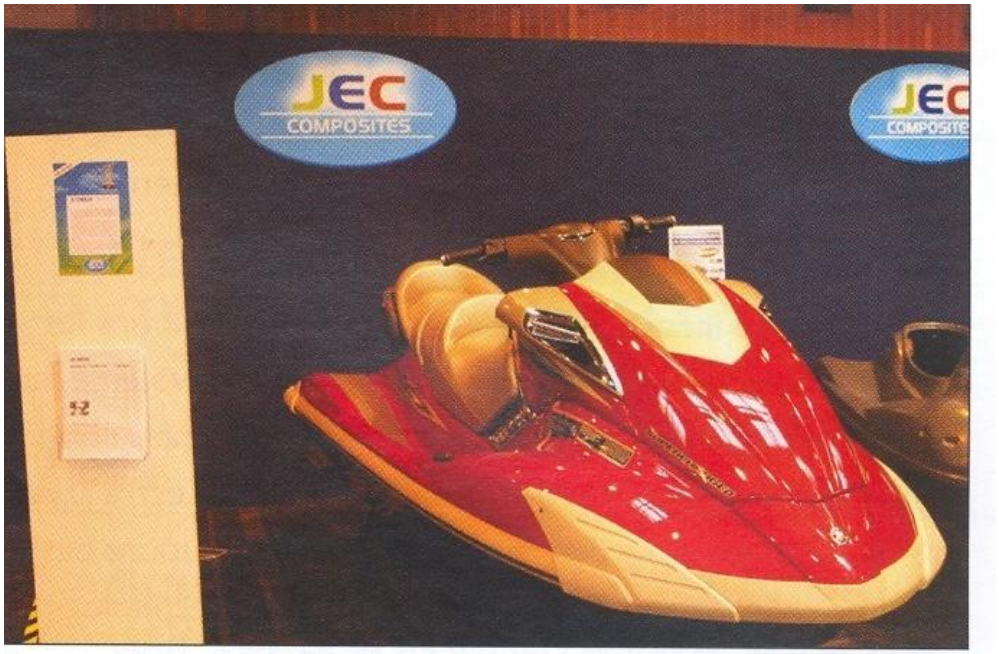
- **Gradient**
- **Porous**
- **Oriented**
- **Composite**



- Prepared by dual electro spinning to enhance
  - Filtration efficiency
  - Tissue engineering

Ref : Technical textile international Jun 2008.

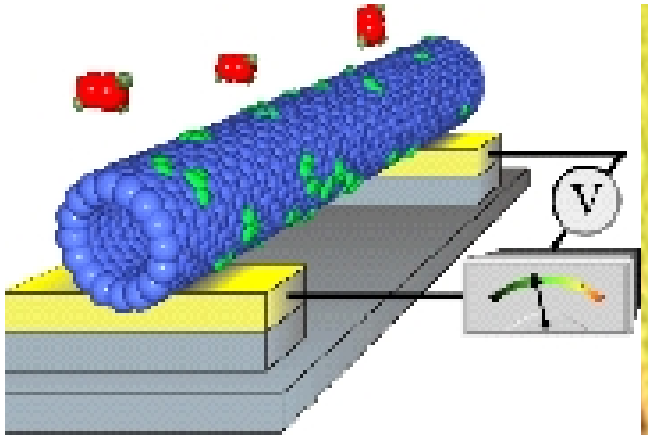
Nano Clay Composite

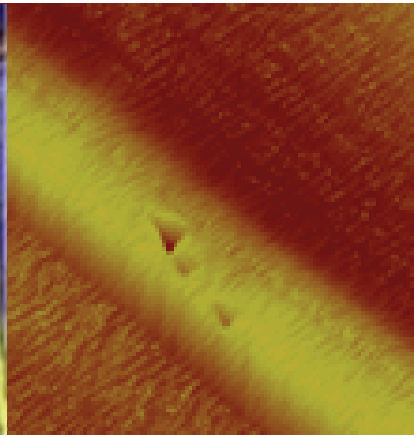


•NanoXcel a new generation sheet moulding compound used to produce WaveRunner by Yamaha motors and Interplastic Corp.

Ref : Technical textile international Jul/Aug 2008.

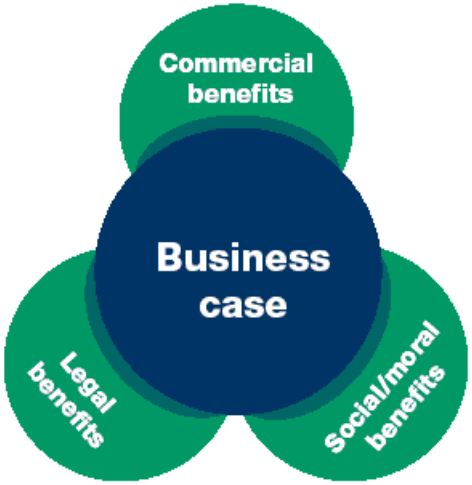
Nanocircuits and Sensors





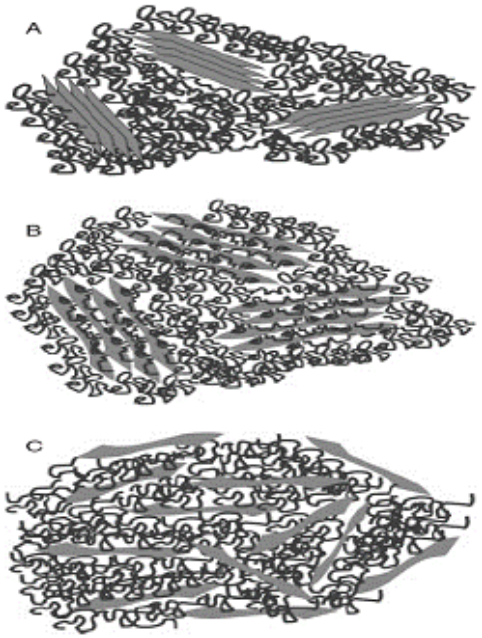
Nanotechnologies: A Business Case

- Search for the launching customer (military, paramedical, sports, industrial)
- Many Unknowns (medical guarantees)
- High Upfront investments
- New business models (product service systems)



Understanding of the Fundamentals of Nano's

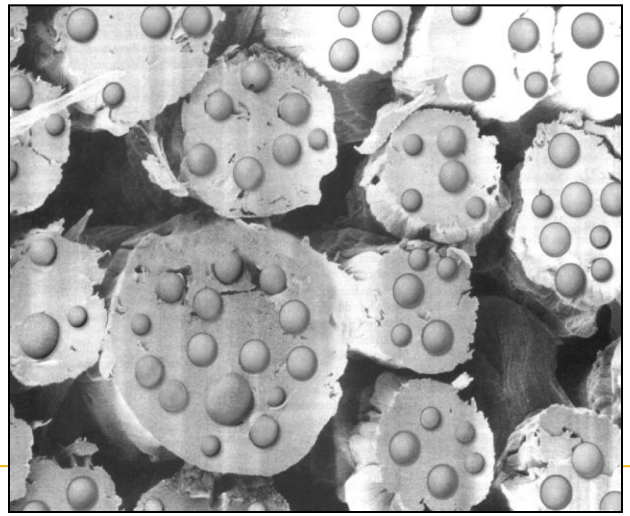
- Much nano in no-nano
- Textile properties often badly described
- Most are at proof of concept stage
- Processes still small scale
- Functionalities are not stable / predictable
- Life-time behaviour is not known



Micro Encapsulation

- **PCM encapsulation results in a thermo-regulating effect, which keeps the microclimate temperature, close to the body surface, nearly constant**

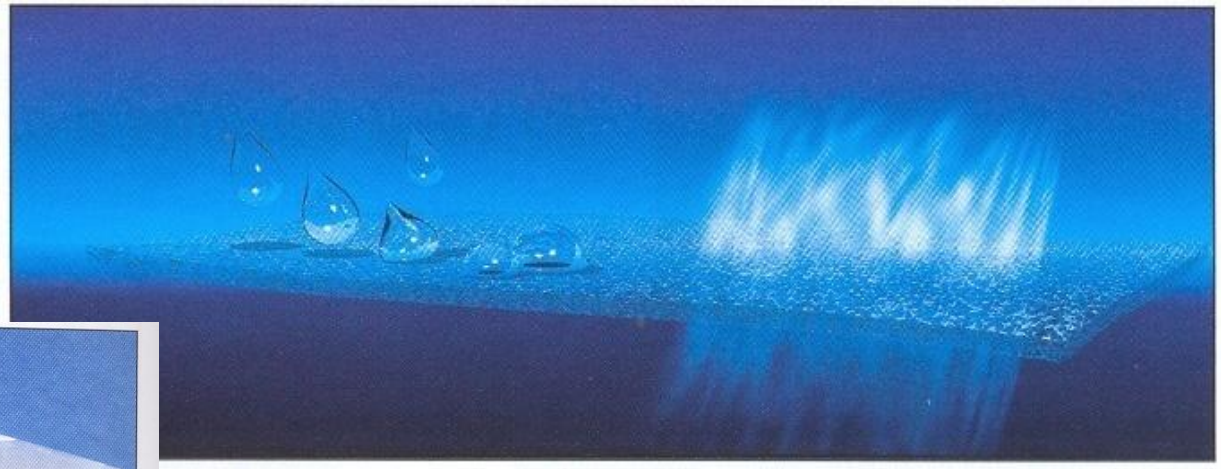
- **Controlled release of micro encapsulated fragrance, vitamins, etc exploited in new brands of clothing**



Ref : R.Shishoo, Techtextil India, 2007

Building Insulation with PCM Coated Fabrics

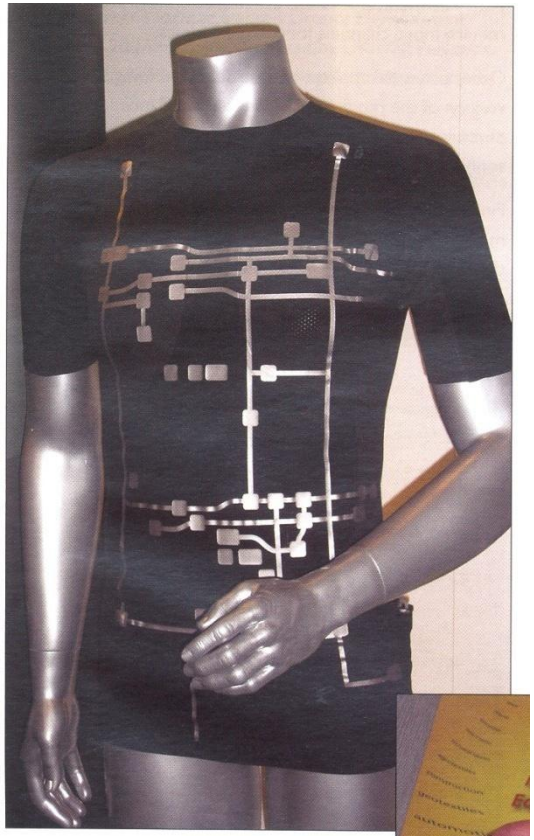
Water Proof Breathable Textiles



- Ticona's Riteflex PET elastomer is barrier to water but permeable to water vapour, at the same time recyclable

Ref : Technical textile international Mar/Apr 2008.

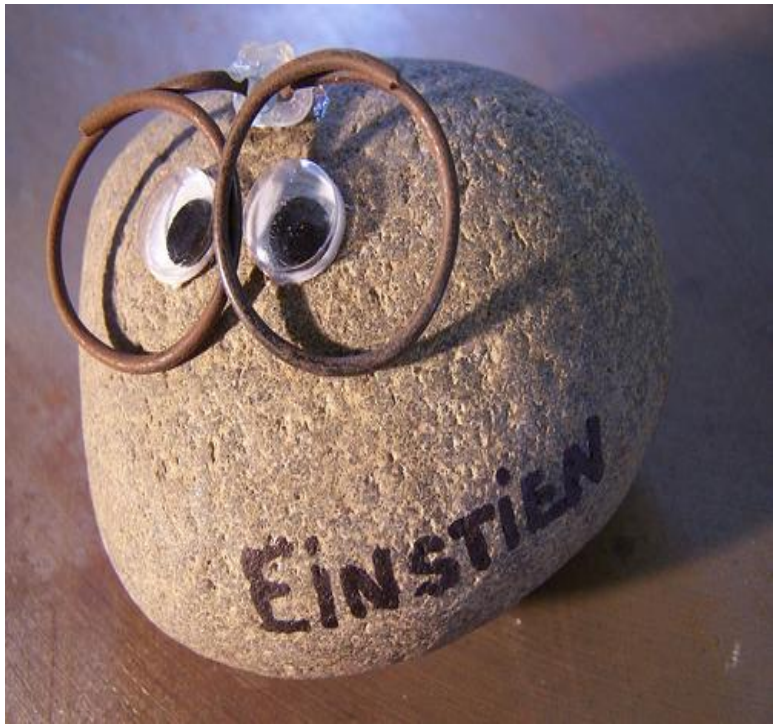
Wearable Electronics



- **Vitaljacket T-shirt with built in heart wave monitor from Biodevices**

Ref : Technical textile international Jun 2008.

Agenda



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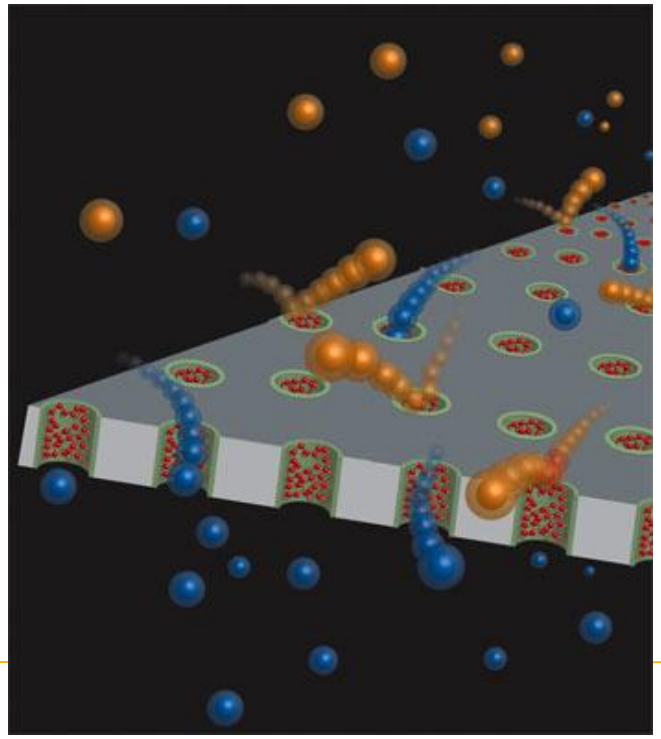
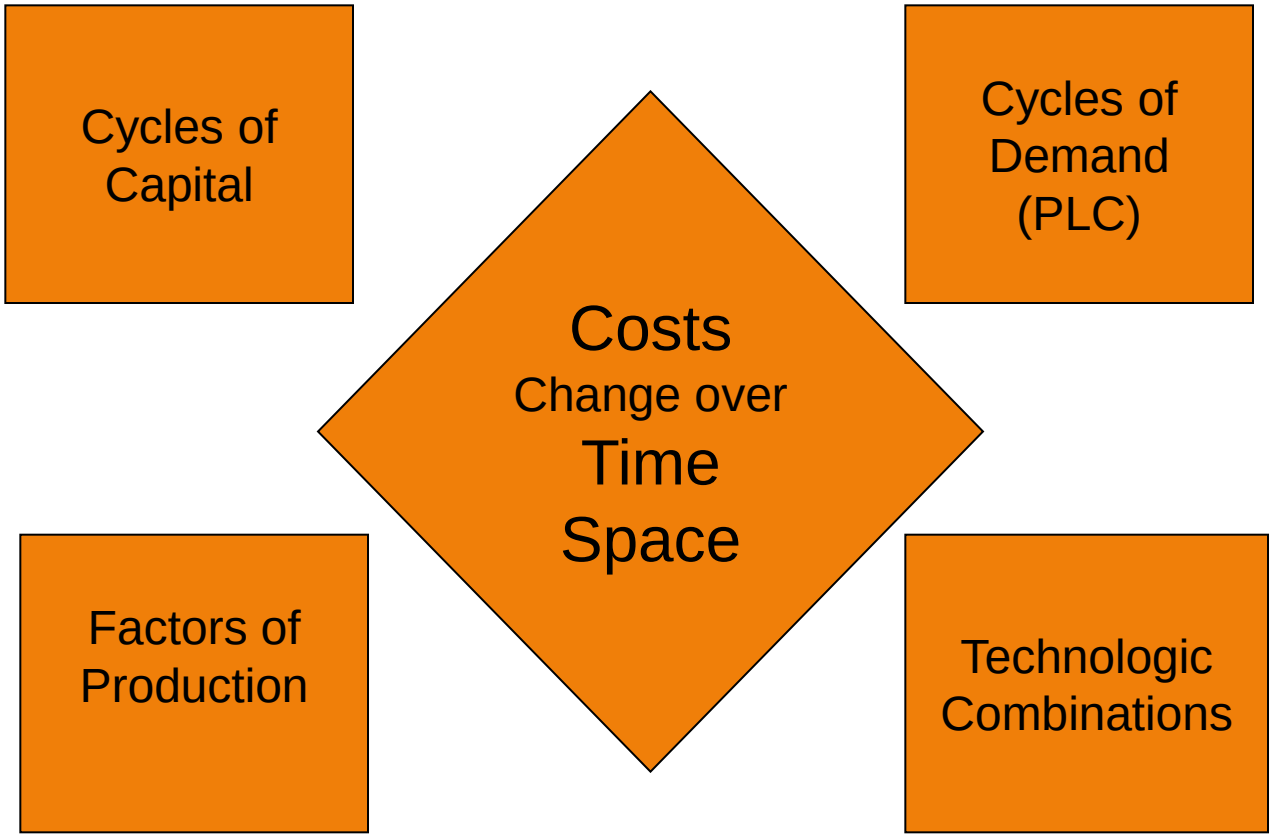
The Locus of Functionalisation

Where does added value make a difference?



Key Relations



Factors

- **Costs: Costs of Labour (Globalisation)**

  Costs of Capital (Technology)

- **Time \ Point of Differentiation**

  - **Supply Chain Management**
  - **Access (transaction costs)**

Innovation Supply Chain

Fibre Fabric Product Maintenance

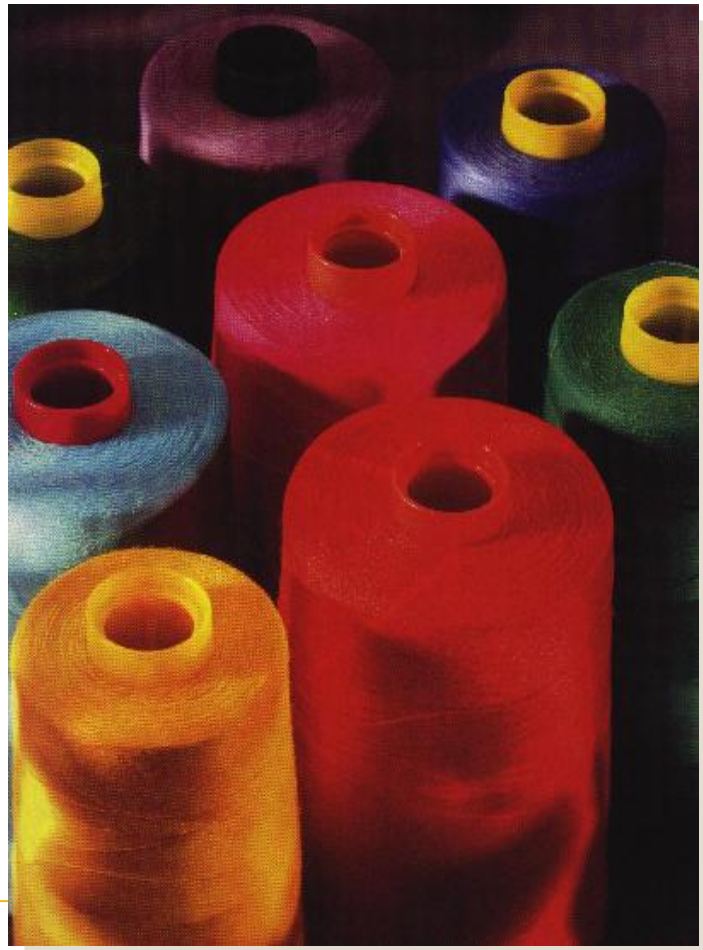
Impact of value addition

Impact of efforts

Technologies

- **Functionalisation**
- **Customization**
  - **Scale versus Scope**
  - **Labour versus Capital Intensive**

Process Environmentally Friendly

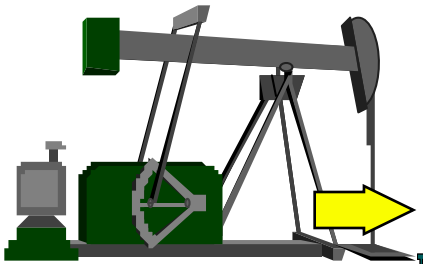


Producer-Colored Yarn

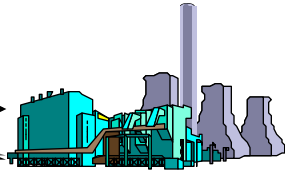
Bio-processing for the Future

Present

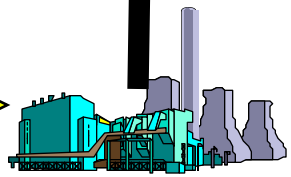
pharmaceuticals, solvents, crop protection chemicals ....



Petroleum

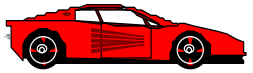


Refining



Chemicals& Intermediates

Polymers



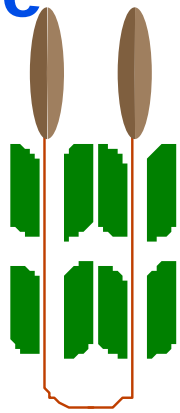
Plastics

Films

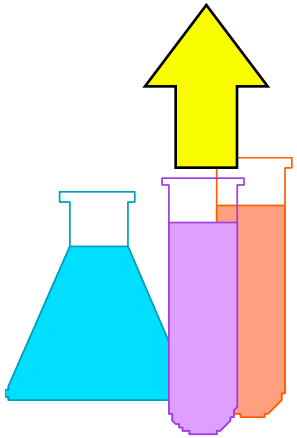
Fibers

Coatings

Future



Engineered Crops



Bioprocessing

Fiber recycling

Typical recycling chain

- Collection network: costly to start!
- Sorting & identification: if needed
- Direct reuse (clothes) or as wipes: if possible
- Processing into products: most often
- Marketing & distribution of products
- Residue sent to Waste-To-Energy or landfills

Process Environmentally Friendly

Bottles to Fiber/Fabrics

Process Environmentally Friendly

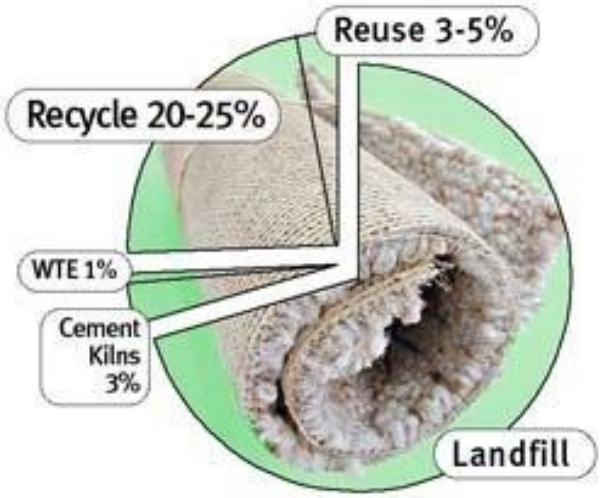
Nylon Carpet Recycling

Carpet recovery effort in US

2012 Goals for Carpet Recovery: 40% Diversion from Landfill

	2002	2012
Total Discards	4,678	6,772
Reuse	0	203-339
Recycling 180		1,354-1,693
Waste to Energy	–	68
Cement Kilns	–	200
Landfill	4,498	4,812
Recycling Rate	3.8%	20-25%

(Millions of pounds | Carpet & Rug Institute)



Carpet America Recovery Effort (CARE):
www.carpetrecovery.org

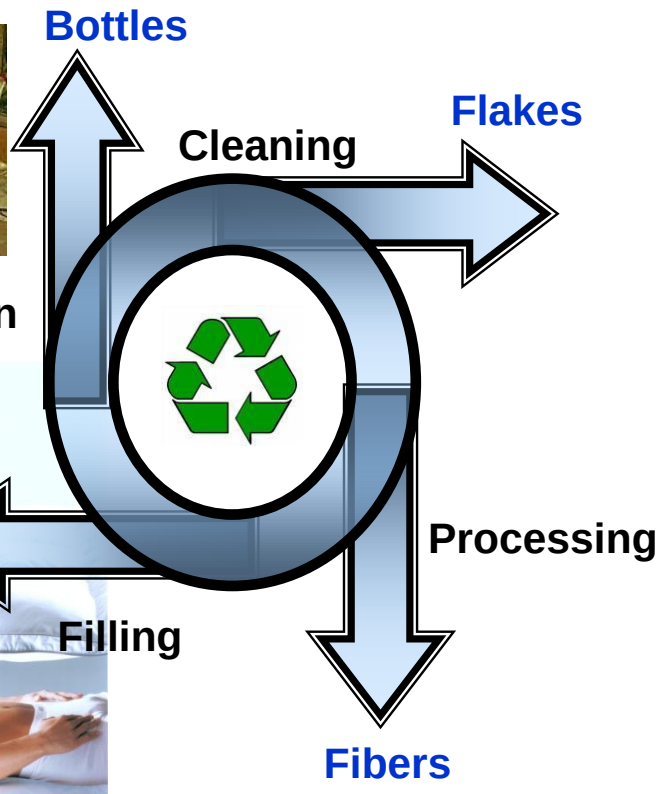
Agreement signed: January 8, 2002

CARPET AMERICA RECOVERY EFFORT

Green Products - PET

Business to fulfill societal obligation along with earning adequate returns for shareholders

- **Waste bottles collected by unskilled uneducated manpower - reduces land fill & provides earning opportunity for downtrodden**
- **Processed to produce fibers**
- **Fibers used to make pillows**
- **Business earning above cost of capital – Waste to wealth**
- **Self sustaining business**



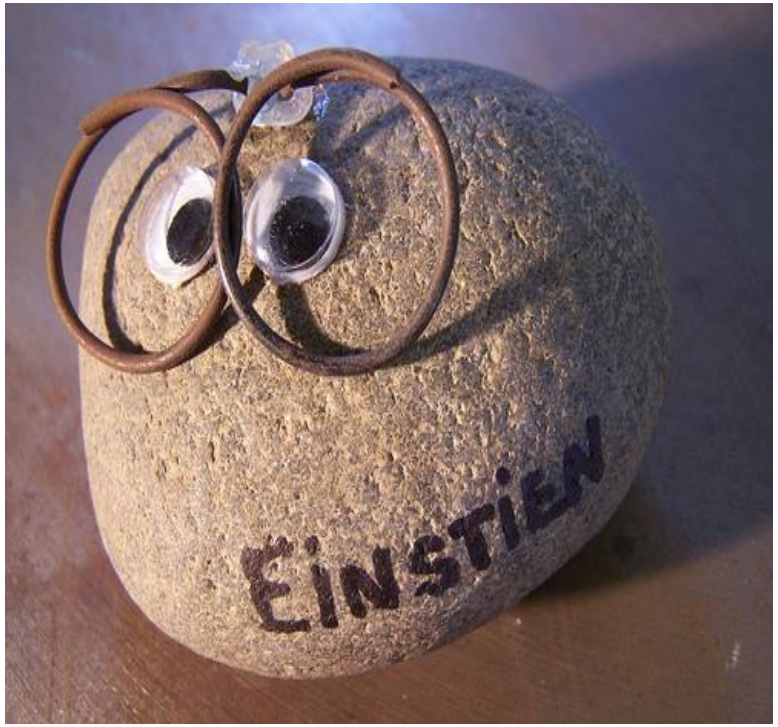
Livelihood to 2 lakh people at the bottom of the pyramid

Emerging Process Technologies

Yarn/ fabric/ process technologies

- **DREF spinning**
- **3D weaving**
- **Spacer knitting**
- **Multifunctional coating/Laminating**
- **Micro encapsulated finishing technology**
- **Extrusion/Hot melt coating**
- **Plasma technology**

Agenda



- Points to Consider Globally
- New Challenges
- Product Innovation
- Process Innovation
- **Textile Education**
- Conclusion

The value-drivers

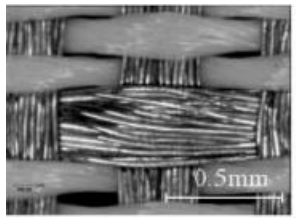
Variables that disciplines compete on:

- **Earning Potential:** What will the market compensate?
- **Time to Degree:** The time required to earn a degree?
- **Placement Rate:** At graduation, do graduates have either a job or a post-graduate program opportunity?
- **Educational Effectiveness:** Discipline perceived hierarchy, faculty competence, and employers perception of programs effectiveness?
- **Tuition and expenses:** The cost-per-year for students?
- **Funding and student support:** Availability of student support by a scholarship or student assistantship?

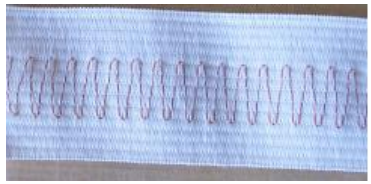
Why Study Textile Specializations

- Textile critical for economic growth covering both apparel and technical textiles with large contribution to GDP

- Textile technologies can be integrated with latest developments in material science, machinery, mechatronics, chemistry, biology, control, computers etc.



- It is possible to design large number of special products based on the high variability of patterns and structures.



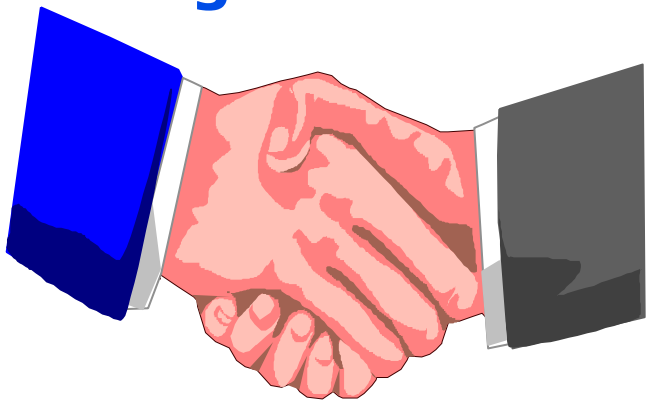
- Textile growth driven not only by size of population but with societal development

Distance Education (.edu)

- New green-space
- At home low cost
- Web-based on-demand
- Highly motivational
- Life-long distance learning

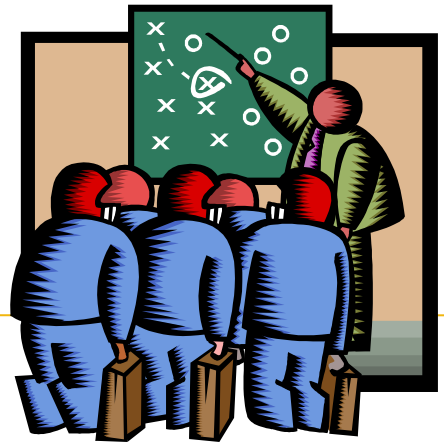
If You Cannot Beat Them- Join Them

- **Incorporation and Merging of Textile Disciplines into Higher Growth Departments such as:**
  - **Textile Fashion, Graphics & Design**
  - **Other Engineering Fields:**
    - **Mechanical Engineering**
    - **Material & Polymer Science**
    - **Etc**



Paradigm Shift & Curriculum Modifications

- Meet Aspirations of:
  - Students
  - Industry
  - Educational Institutions
- Fundamentals of fiber, yarn, fabric & garment
- Integrated Science (Polymers, Biological & Information Science)
- Focus on Rapidly Advancing and Emerging Disciplines:
  - Composites
  - Nanotechnologies & Structures
  - Biomimetics
  - Technical Textiles
  - Nonwovens



The Future of Education

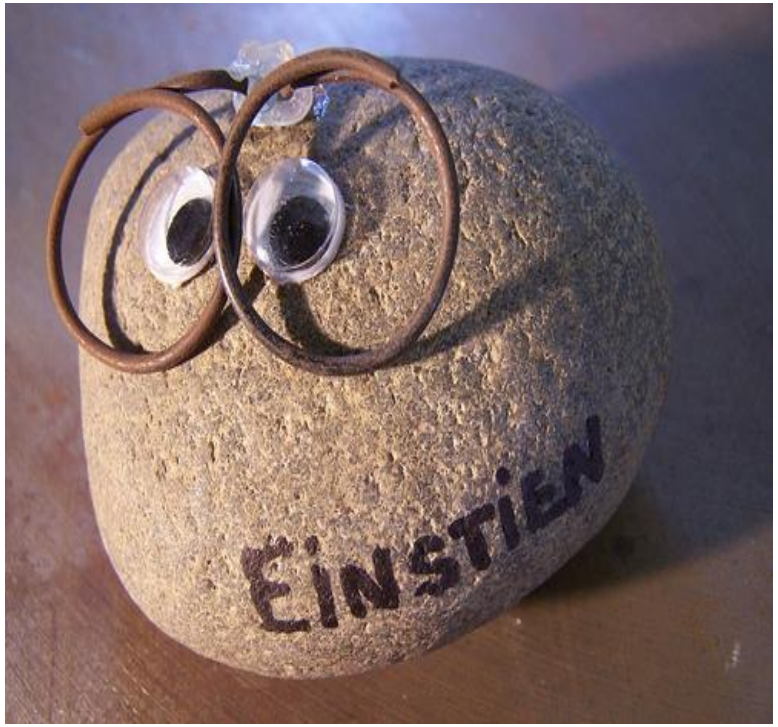
- Transition from Teaching to Learning
- Exponential Growth of Information
- Courseware Vacuum
- Expanding Gulf Between Literates and Super-Literates
- Our "Touch Points" for Interfacing with Society are Changing
- Learning Drivers
- The Age of Hyper-Individuality
- Transition from Consumers to Producers

Source: The DaVinci Institute

The Resource Hurdle

- Do we have the money to spend on the necessary changes?
  - Fighting for resources will take time and divert attention from the underlying problems & the innovation agenda.
- Identify "Hot Spots" -- activities that have low resource input but high potential performance gains.
- What actions consume our greatest resources but have scant performance impact?
- Identify "Cold Spots" -- activities that have high resource input but low performance impact.
- What activities have the greatest performance impact but are resource starved?
- Free up low-return resources and redirect them to high-impact

Agenda



- Points to Consider Globally
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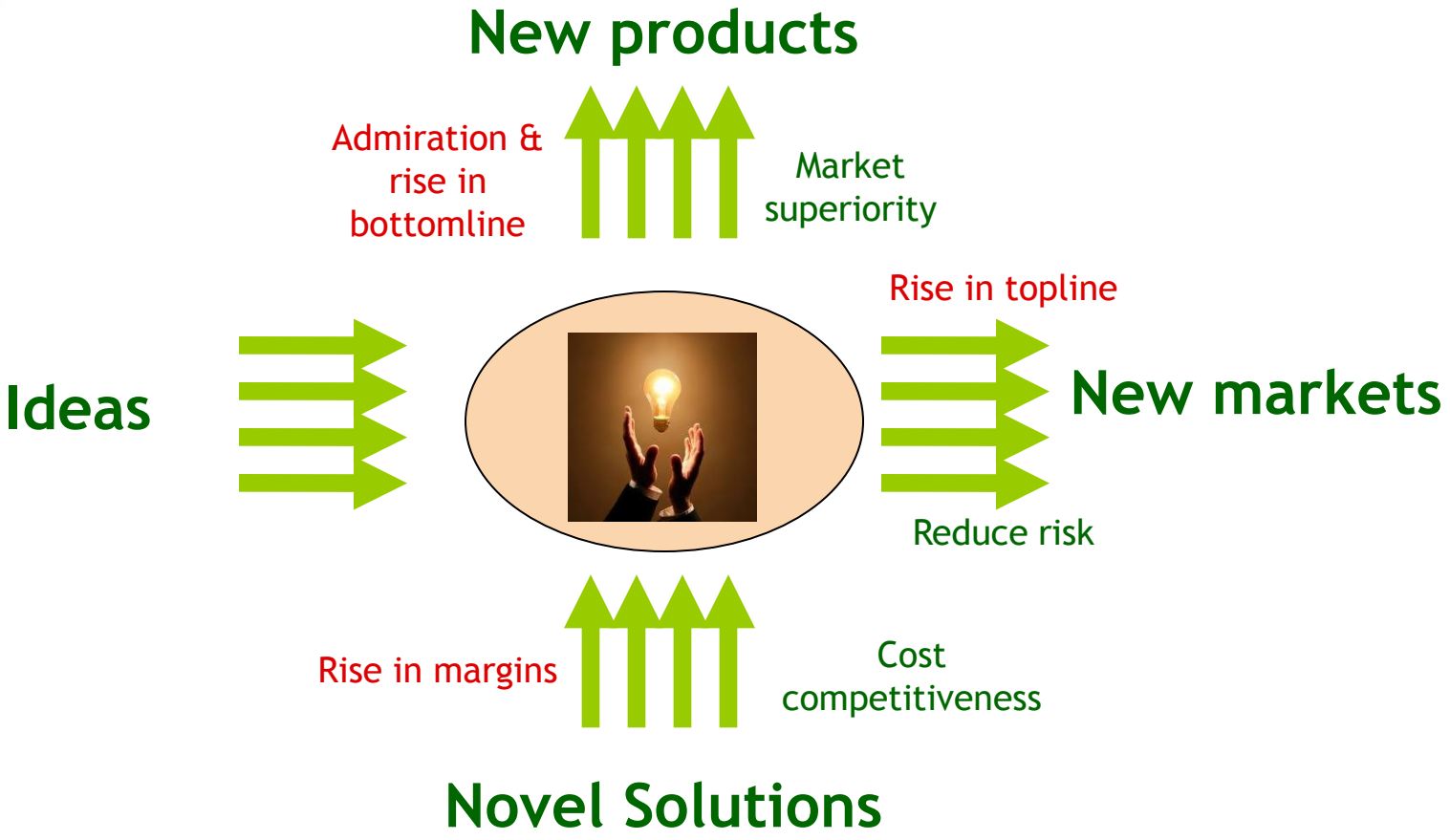
Future Directions

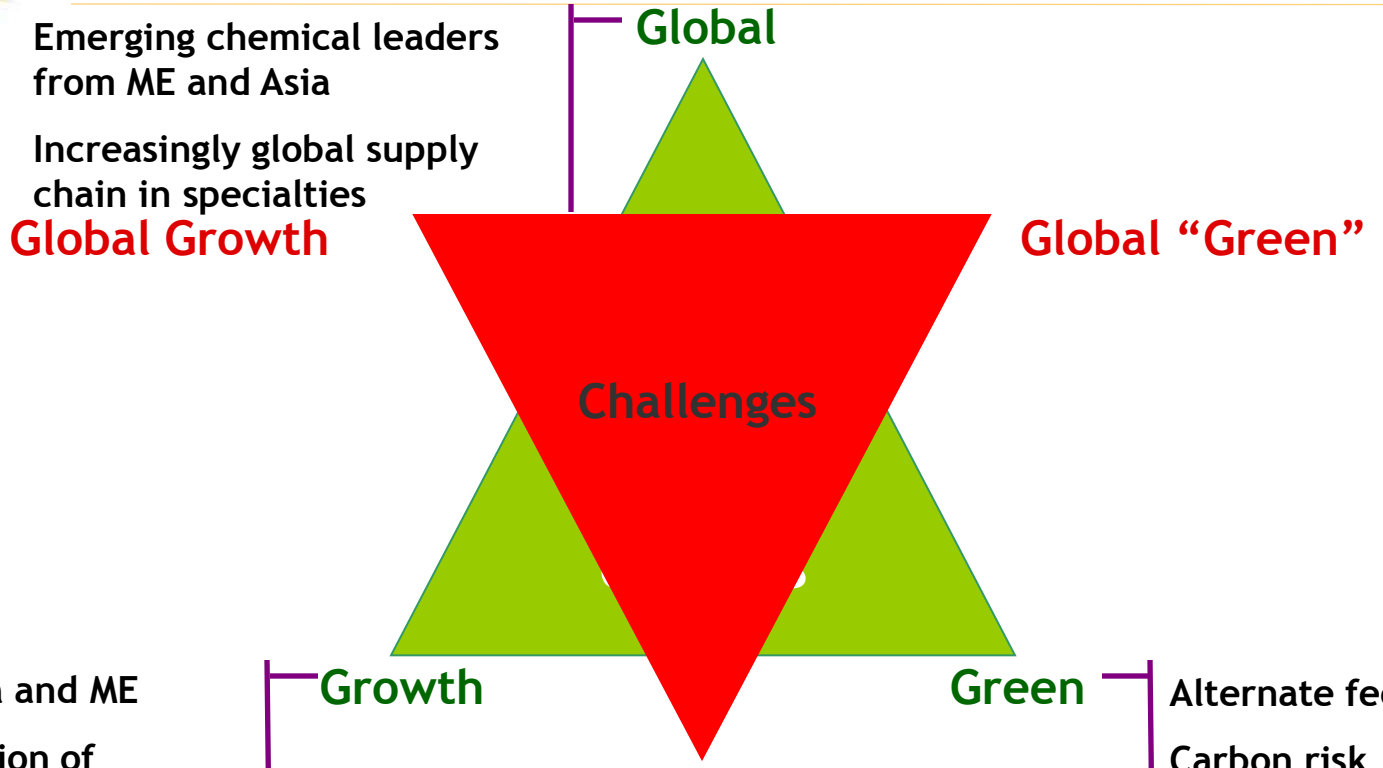
- **"Intelligent" adaptive textiles**
  - controlled comfort , antimicrobial activity, self cleaning potential
- **"Intelligent" knowledge based technical textiles**
  - locally compressive behavior and complex actions e.g. comfort type mattresses for disabled persons, intelligent car seats
- **Hybrid multifunctional textiles for protective clothing**
  - improved protection (a barrier against the selected types of radiation and particles) with improved comfort

Emerging Business Model



Leadership through business model innovation

Strategic Drivers & Challenges



Innovation to overcome challenges

Conclusions

- Global trends lead to new paradigm
- Abundance of low cost labour leads to industrial regression
- Lack of technology leadership (end of fibre dominance)
- Product Innovation: Low cost solution is the prime driver
- Process Innovation: Competitiveness through cost leadership
- Business innovation: Competitive edge is emerging paradigm
- Innovation in Education: Responsive to Students
- Innovation distinguishes leaders from followers