



COST FP1407



Universität für  
Bodenkultur Wien



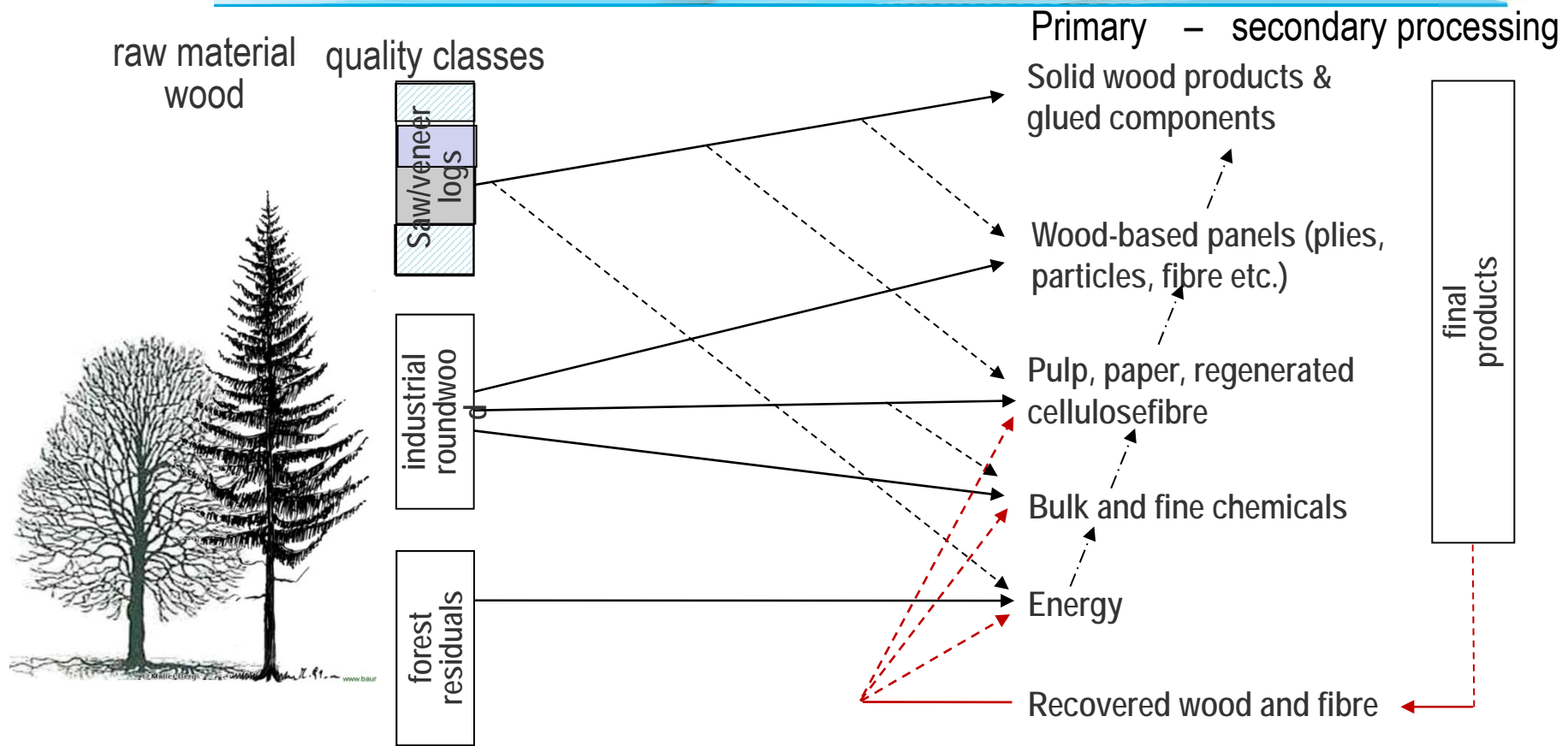
Institut f. Holztechnologie

# Best practice examples of wood utilization: Which high value products are currently being researched or produced

Alfred Teischinger

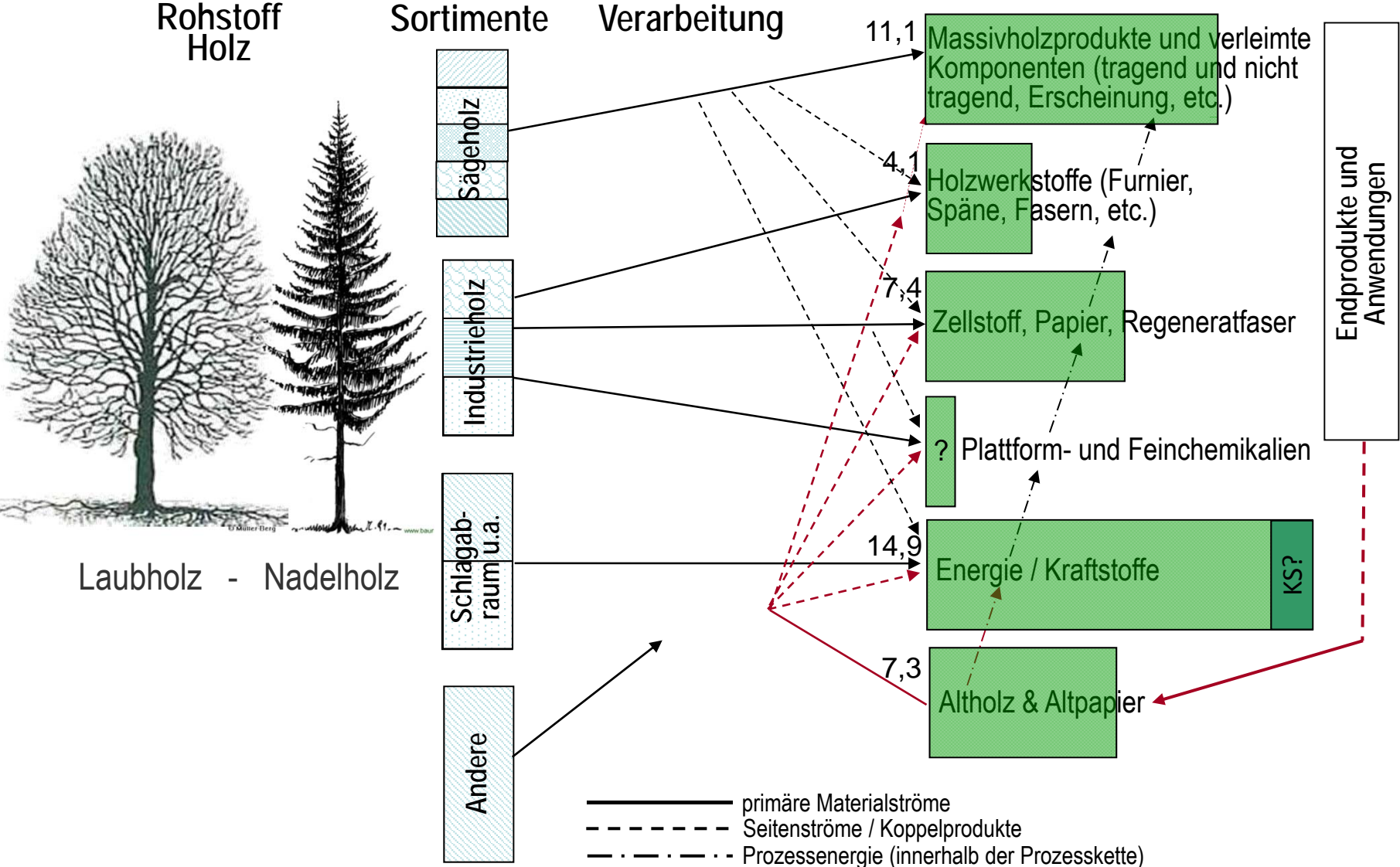


# The wood process chains (survey)



- currently the established pathways are changing
- what is the proper material flow and process concept?

# Der Wettstreit um den Rohstoff Holz

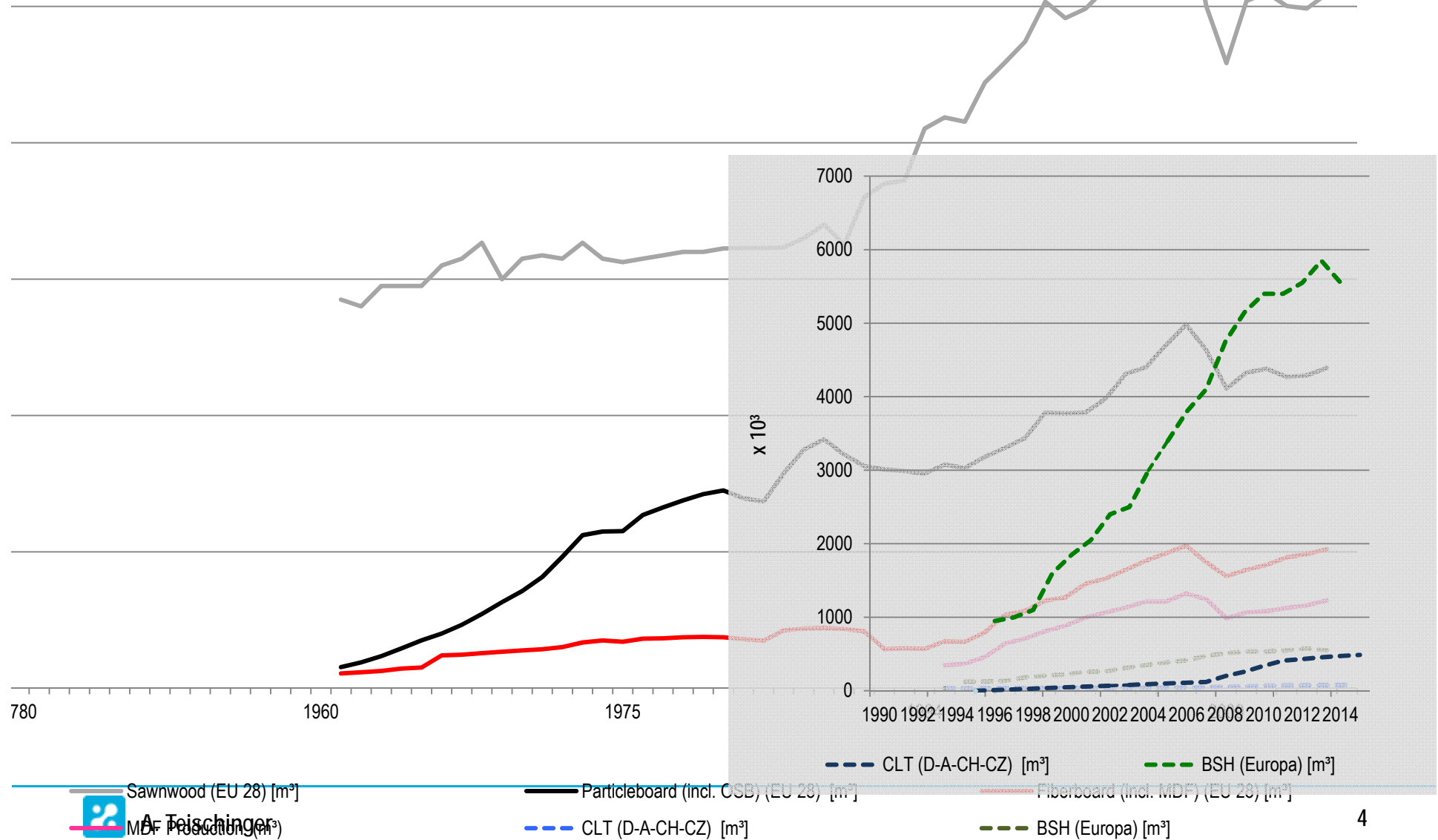


# Development of wood industries

## Experience – advent of science - innovation



Datenquellen: Eurostat, EUWID, Verbandsangaben

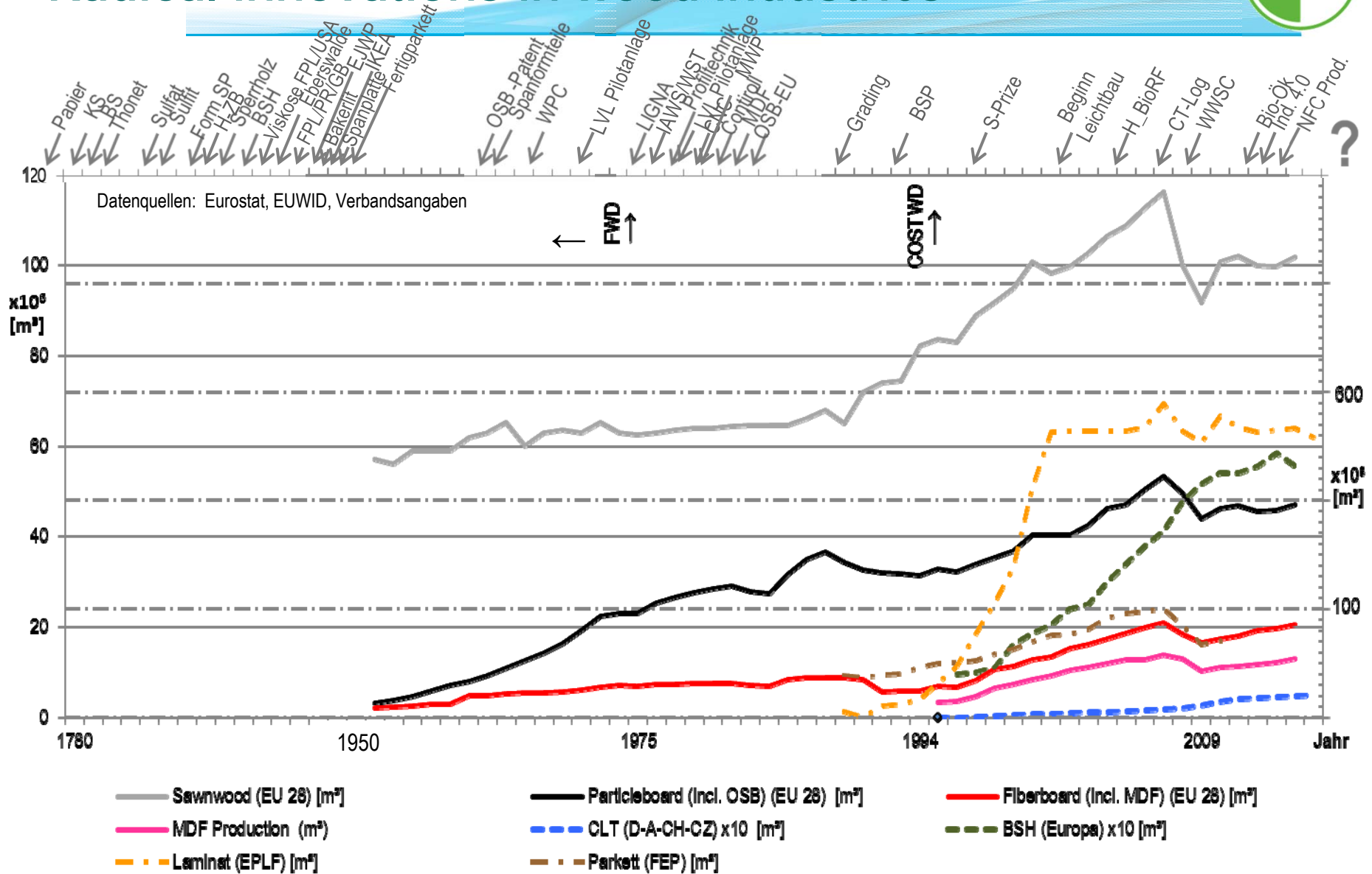


Sawnwood (EU 28) [m³]  
 A. Teischinger  
 MDF Production [m³]

Particleboard (incl. OSB) (EU 28) [m³]  
 CLT (D-A-CH-CZ) [m³]

Fiberboard (incl. MDF) (EU 28) [m³]  
 BSH (Europa) [m³]

# Radical innovations in wood industries



# COST Action – Research Topics – over time



- E 2 Durability of wood
- E 5 Fire safety of medium-rise timber frame residential building
- E 8 Mechanical performance of wood and wood products
- E 9 Life cycle assessment of forestry and forest products
- E 10 Wood properties for industrial use
- E 13 Wood adhesion and glued products
- E 15 Advances in the drying of wood
- E 18 High performance in wood coating
- E 20 Wood fibre cell wall structure
- E 22 Environmental optimisation of wood
- E 40 Innovative utilisation and products of large dimensioned timber including the whole forest-wood-chain
- E 41 Analytical tools with applications for wood and pulping chemistry
- E 44 Wood processing strategy

- E 49 Processes and performance of wood-based panels
- E 53 Quality control for wood and wood products
- FP 0602 Biotechnology for lignocellulose biorefineries
- FP 0702 Net-acoustics for timber based lightweight buildings and elements
- FP 0802 Experimental and computational micro-characterisation techniques in wood mechanics
- FP 0901 Analytical techniques for biorefineries
- FP 0904 Thermo-hydro-mechanical wood behaviour and processing
- .....
- .....
- FP1407 Understanding wood modification through an integrated scientific and environmental impact approach (topics of applications which have failed?)

# Conferences and seminars – conference topics



- IUFRO all Division 5 conference (and IUFRO subdivision meetings) – *Forest sector innovation for a greener Future*
- SWST annual meeting (mostly linked to other conference series)
- FPS annual convention (*2018 in conjunction with TAPPI Nanotechnology Conference*)
- IAWS (mostly linked to other series)
- WCTE (biannual) *world's premier forum for dissemination of the latest developments, technologies innovations in wood or timber design, engineering and construction*
- Adhesion, WPC, hardwood, surface, IRG (wood preservation), European Wood based panel symposium (industry&academia), IAWA Meeting, WPC conf. series etc.

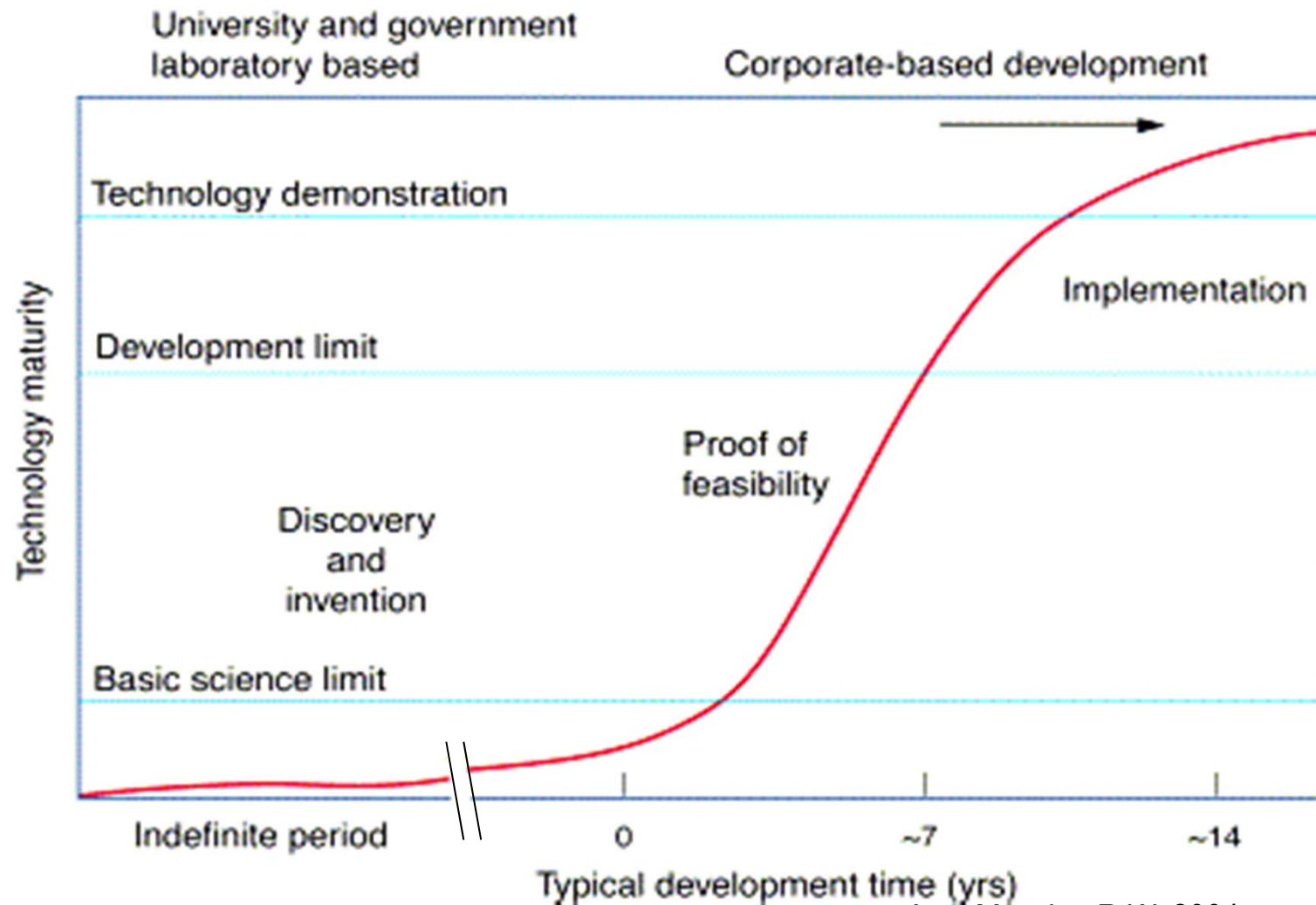
# The Nature of Technology – some mediation



- Transfer/utilization of knowledge to achieve practical/useful things (mediations but no clear agreement on technology)
- Technology creates from empiric observation and harnessing of natural phenomena
- Combination of parts from technologies that preceded them
- Taking advantage of new knowledge from research and scientific literacy ----- COST is a platform for this (??)
- Technology is a branch of knowledge in for the application of science and a study of techniques („techne“ and „logos“)
- Technology is a means to fulfill a human purpose

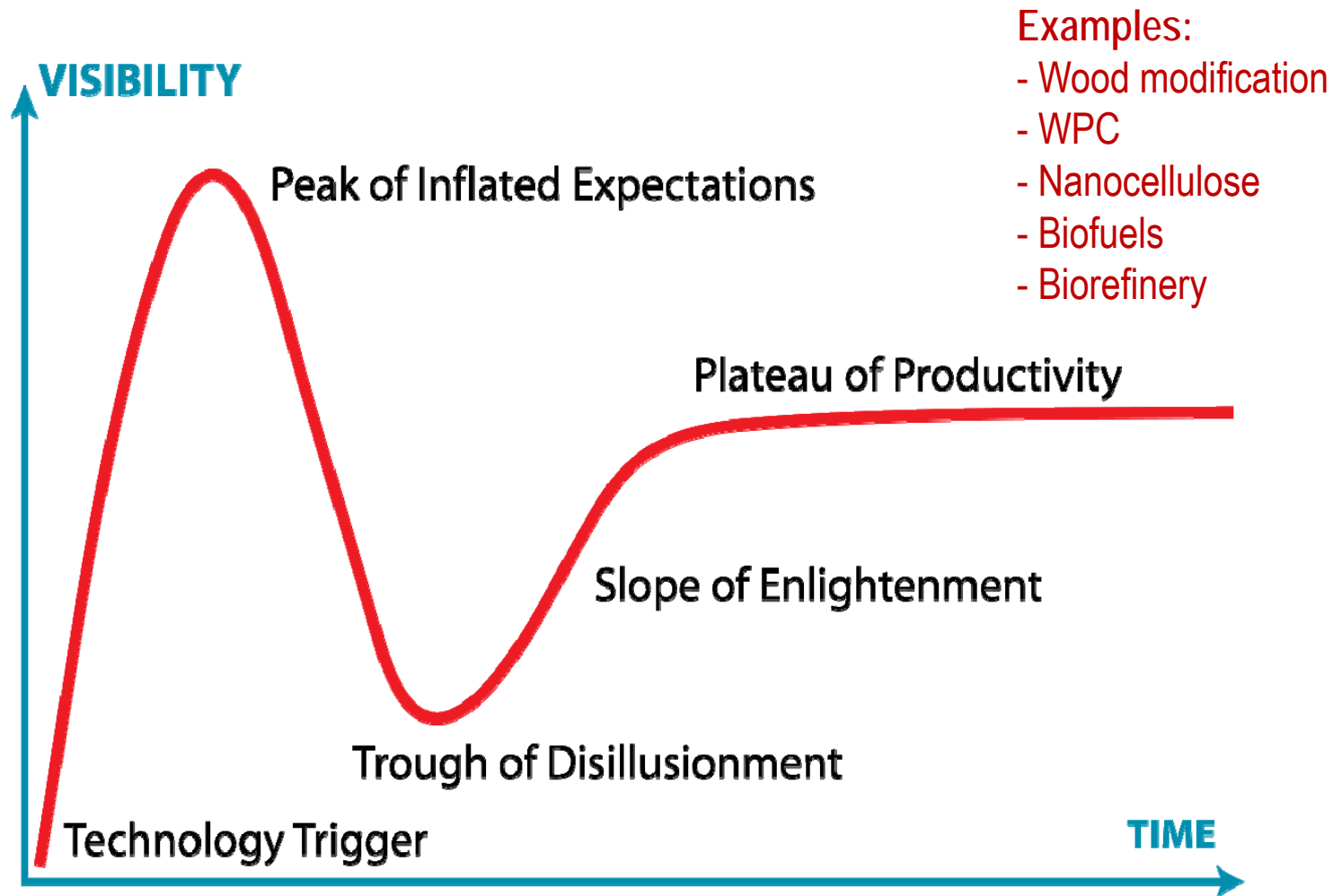


# Technology development



Aus: Messler, R.W, 2004, materialstoday/  
march 2004, rpt. Dimiduk, D.M. 1999

# Hype Cycle of emerging Technologies, Gartner

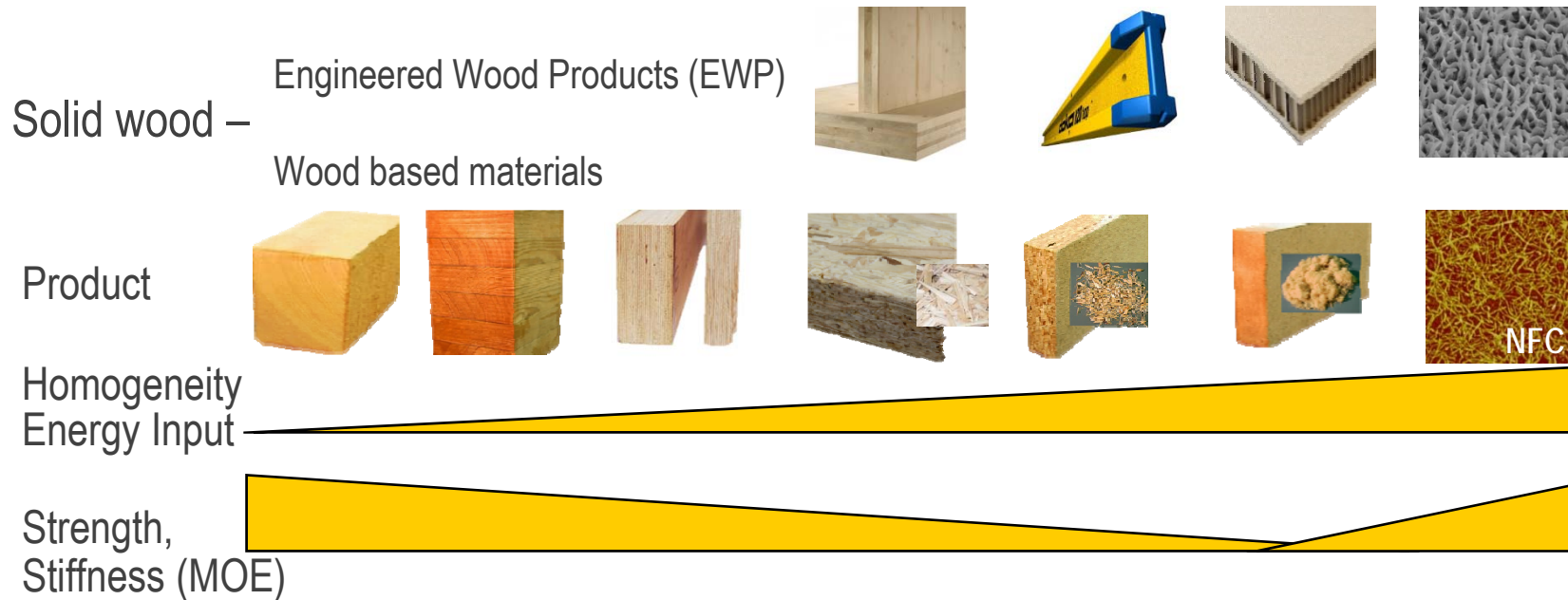


Gartner  
2016

# From raw material wood to wood based materials



Disintegration – sorting – modification - re-engineering



Current research and innovation activities



Scanning technologies (sorting)



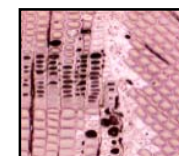
New (chipless) disintegration technologies



**Wood modification and functionalisation – missing topics?**



New shape forming technologies, WPC



Intelligent adhesion, compounds and EWP

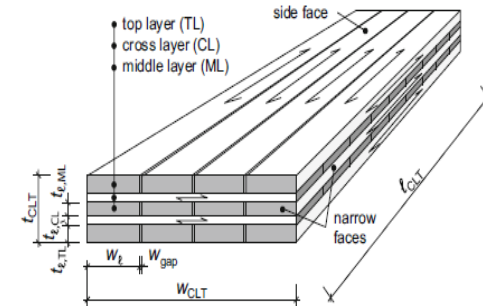


Complete new properties (transparent, functionalised)

# Best practice – the CLT story



- 1985 – First Univ. Chair for Timber in Construction in Austria (TU Graz)
- G. Dröge und K.-H. Stoy are using the term „Brettsper Holz platten“ 1981 in connection with property right about the product family STEGträger“ (Kämpf-, Wolff- und Poppensieckerplatte).
- KLH 1998 first ÖTZ (technical approval – building component/reliability is important), cooperation with TU Graz (graduates als engineers and consultants)
- Merk-Dickholz MDH technical approval Z-9.1-354 im Dezember 1998.
- Prof. G. Schickhofer TU Graz (2003) – CLT of high academic interest – various Master Theses, PhD Theses, long-term research programme (COMET) in close cooperation with industry, scientific and technical publications, standardization prozess (EN 16351 (2014) Timber structures—cross laminated timber) – CLT handbook in German, English etc., Followers, CLT manufacturing systems (e.g. MINDA, Ledinek etc.)
- Technical Design App and software for design calculation available etc.



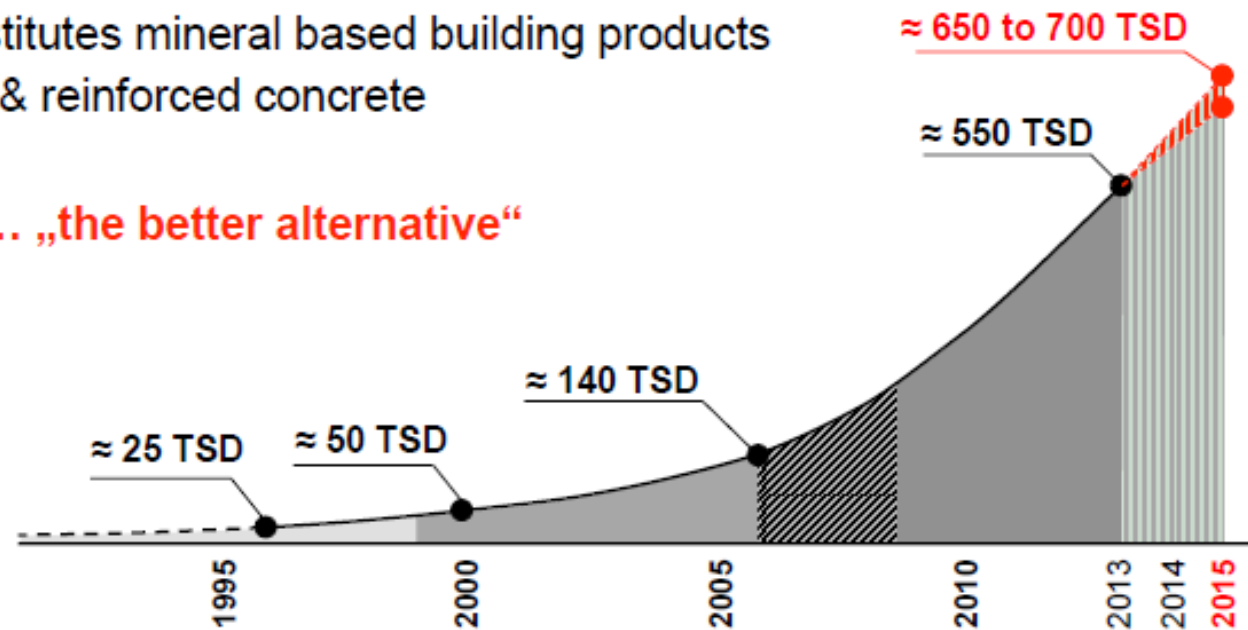
Brandner et al 2016

# Current market leaders



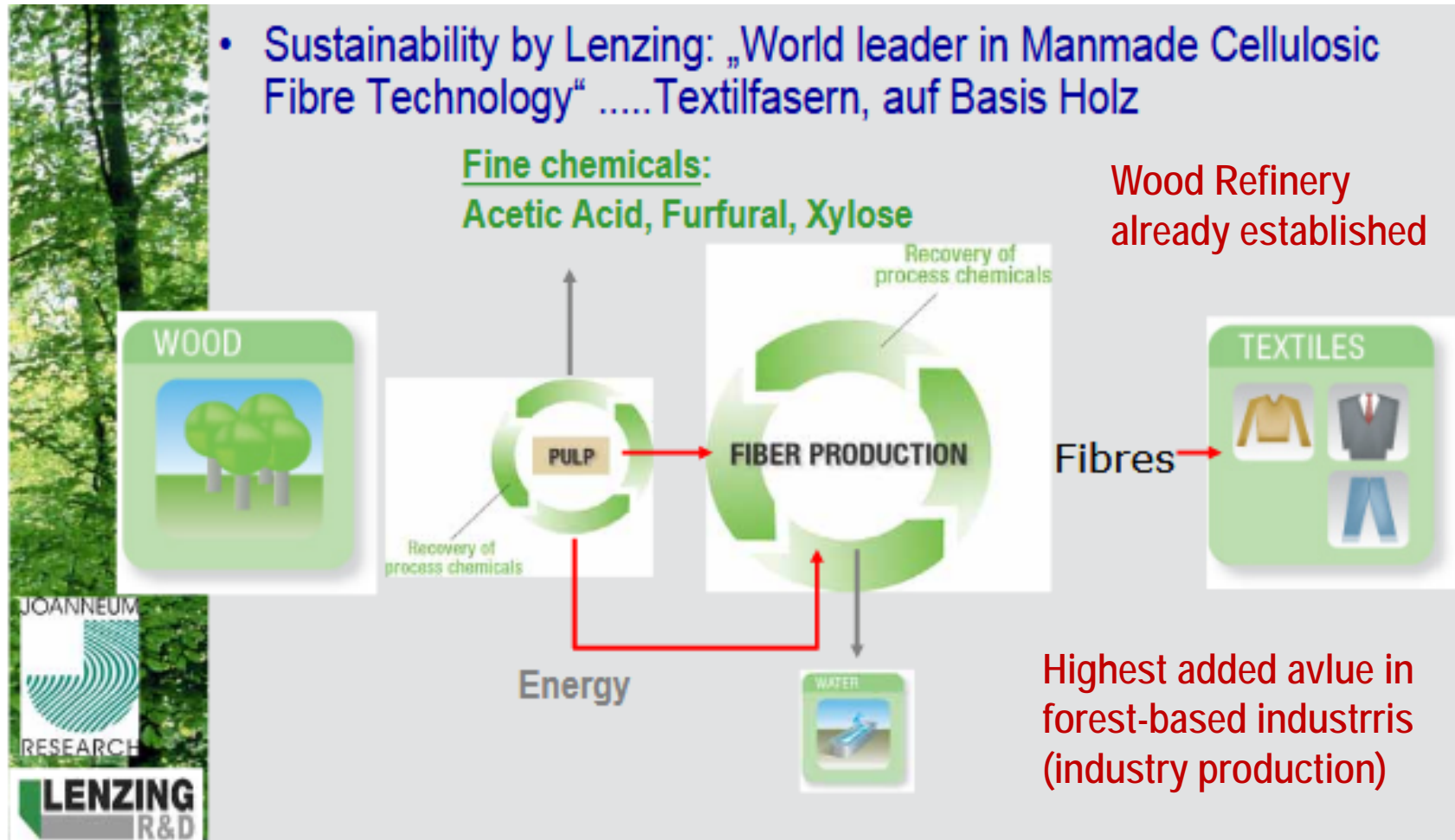
- CLT extends, not competes timber engineering
- CLT substitutes mineral based building products masonry & reinforced concrete

→ CLT, ... „the better alternative“



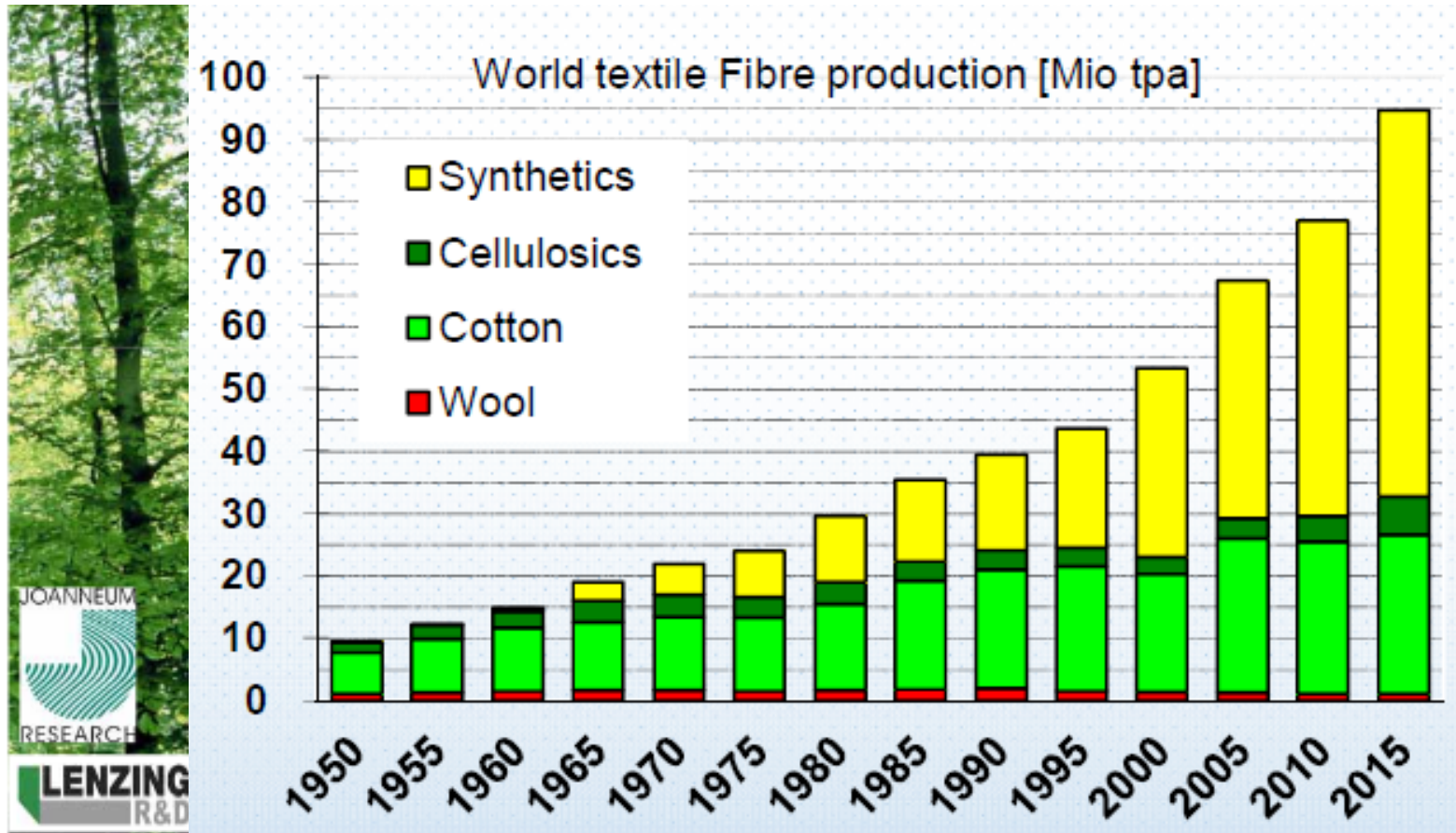
COST FP1004 – Enhance mechanical properties of timber, engineered wood products and timber structures

# Viscose – the Lenzing story



H. Harms 2004

# Survival of the fittest



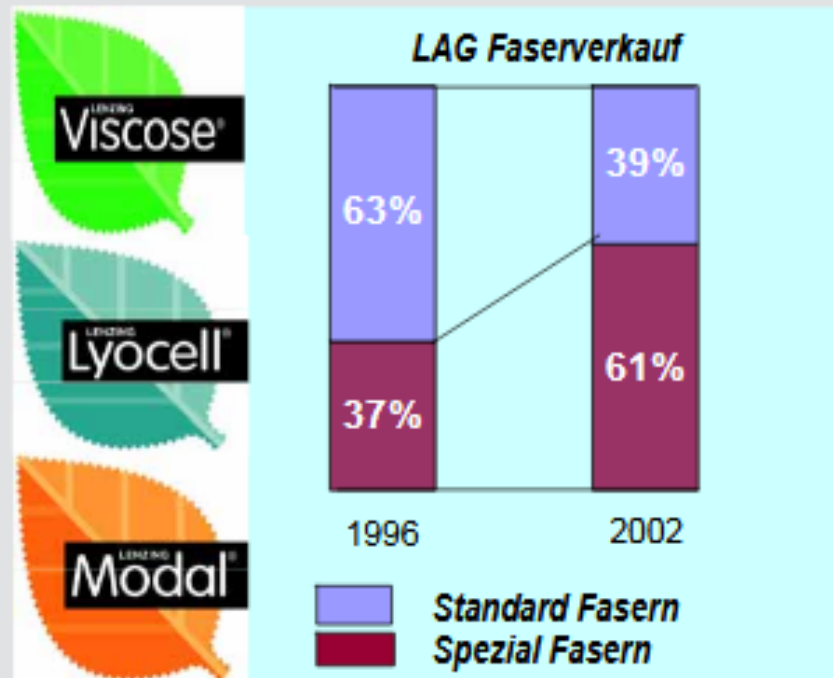
Due to many reasons: research and development (50-70 people R&D, link zu universities (CD Lab, Wood COMET etc.), Lenzinger Berichte/Scientific Journal, H.Harms 2013: over 60 years of Lenzing Research

# Old process – incremental/radical innovations



- Die Viscosefaser ist 100 Jahre alt: Erfolg durch Spezialitätenstrategie: Stabilere und weniger zyklische High-end Märkte
  - Breites Technologie Portfolio: Viscose-, Modal- & Lyocellfasern
  - Qualitätsfasern für hightech Anwendungen: textil, Nonwovens, technisch
  - Einzigartiges Angebot an Spezialfasern mit besonderen Funktionaliäten

New pulp dissoving process, environmental friendly, new fibre properties, whole chain had to follow



↑ Role model for new functionalities of bulk wood, wood surfaces etc.???  
Modification (modficare)

H. Harms

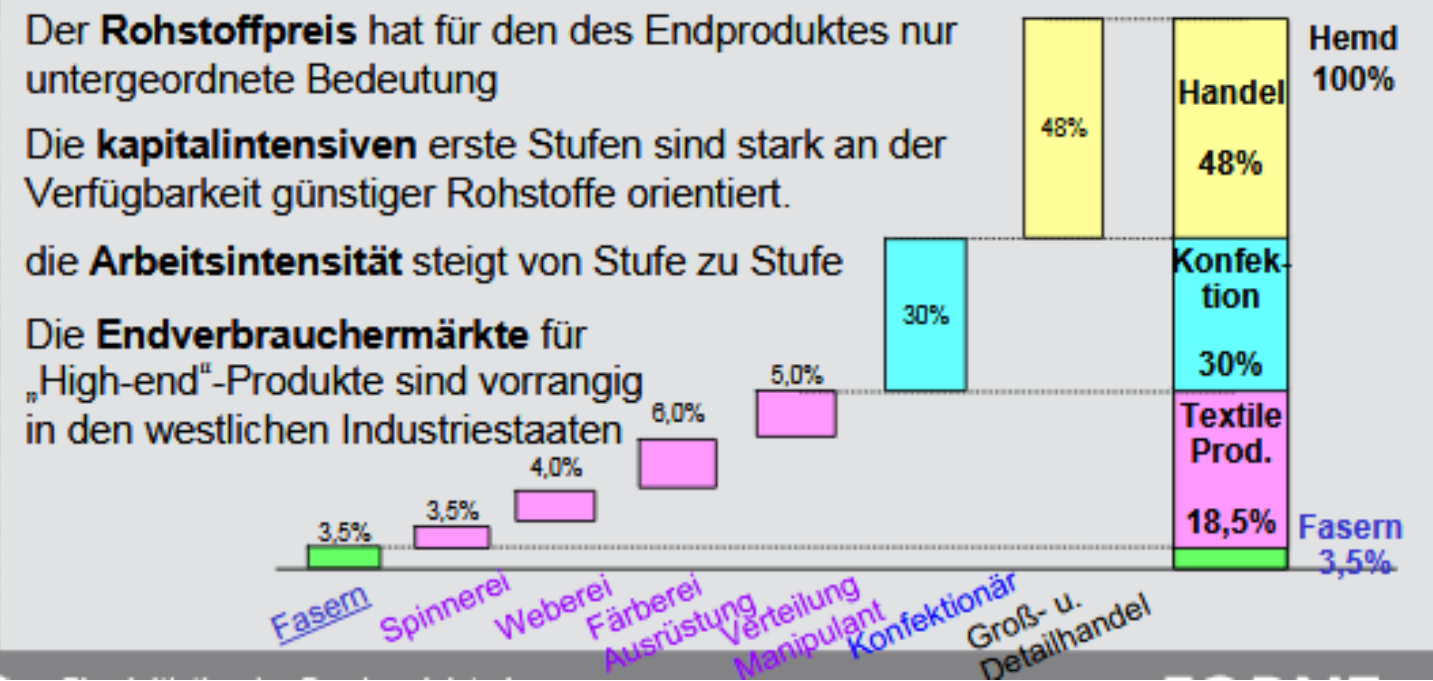


# Wood textile chain – added value



- Die Wertschöpfung geschieht in einer Vielzahl von kapital- und arbeitsplatzintensiven Stufen

> Cellulose im Holz kostet 0,1 €/kg	> Cellulose als Garn kostet 5 €/kg
> Cellulose als Zellstoff .... 1 €/kg	> Cellulose als Gewebe .... 10 €/kg
> Cellulose als Faser .... 2 €/kg	> Cellulose im Kleidungsstück ... !!!!



H. Harms

# Hot spots in research – bibliometrics in wood science



Institution	Country	Nb publications	Annual Growth Rate
USDA Forest Service	USA	973	2,2 %
Univ. British Columbia	Canada	566	-1,3 %
Kyoto Univ.	Japan	481	0,5 %
Oregon State Univ.	USA	458	1,2 %
Swedish Univ. Agr. Sci. SLU	Sweden	358	5,5 %
Forintek Canada Corp.	Canada	336	11,8 %
Univ. Laval	Canada	331	9,0 %
Univ. Nat. Resources and Appl. Life Sci. BOKU	Austria	281	8,0 %
N Carolina State Univ.	USA	274	6,6 %
Virginia Polytech Inst. & State Univ.	USA	261	7,0 %
Univ. Lorraine	France	243	9,9 %
Finnish Forest Res. Inst. METLA	Finland	241	7,2 %
Inra	France	241	6,4 %
Forestry & Forest Prod. Res. Inst.	Japan	230	0,0 %
CSIRO	Australia	223	-2,4 %
Univ. Helsinki	Finland	221	-1,0 %
Univ. Maine System	USA	218	3,9 %
Mississippi State Univ.	USA	213	5,3 %
Univ. N Dakota	USA	213	1,7 %
Univ. Wisconsin System	USA	212	5,8 %
Chinese Acad. Sci. CAS	Chine	205	32,6 %
Univ. Sao Paulo USP	Brazil	201	22,8 %

## Contribution to Science

- North America 45%
- Europe 43%

## Highest growth rates:

Brazil, China

## Research Topics (highest growth rate)

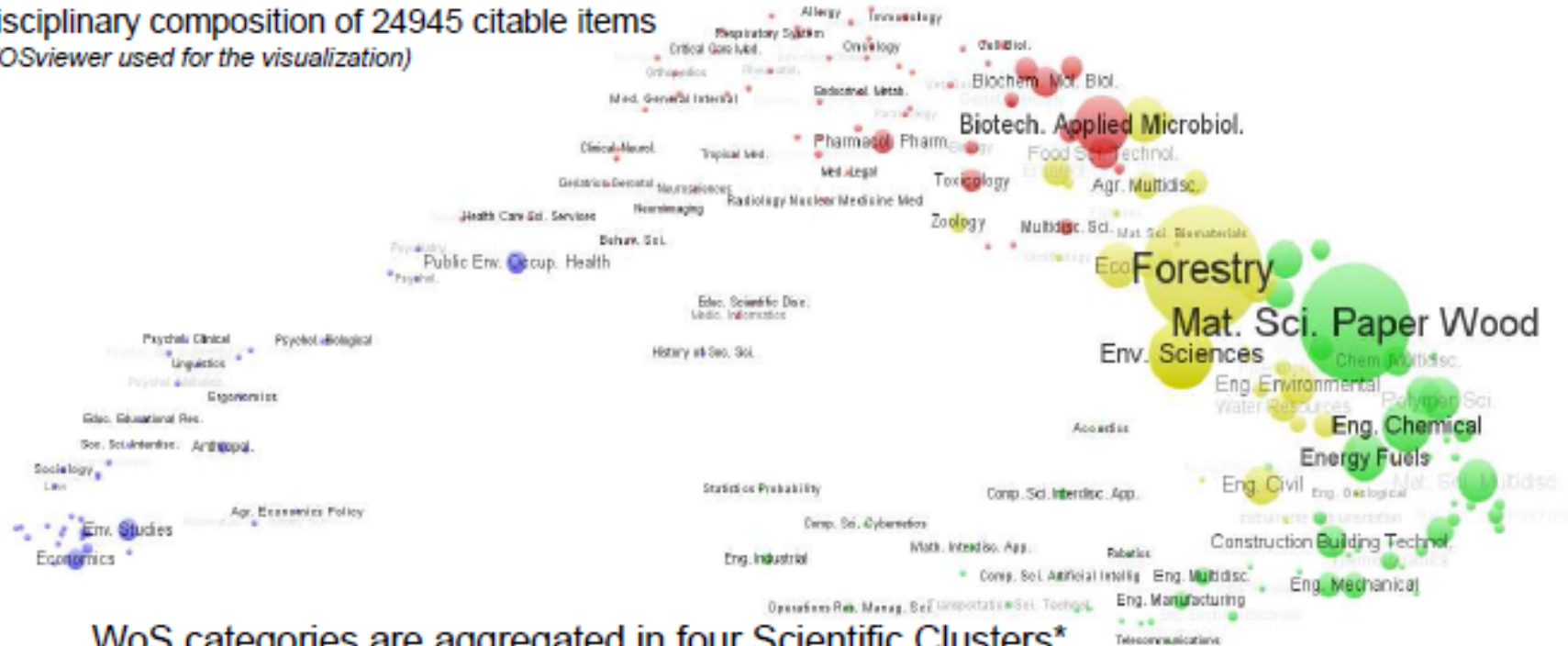
Engineering, construction, energy and fuels (*currently changed to wood refinery, nanocellulose*)

Relative importance of the wood science community is increasing

# Map of Wood Science 2001-2011



Disciplinary composition of 24945 citable items  
(VOSviewer used for the visualization)

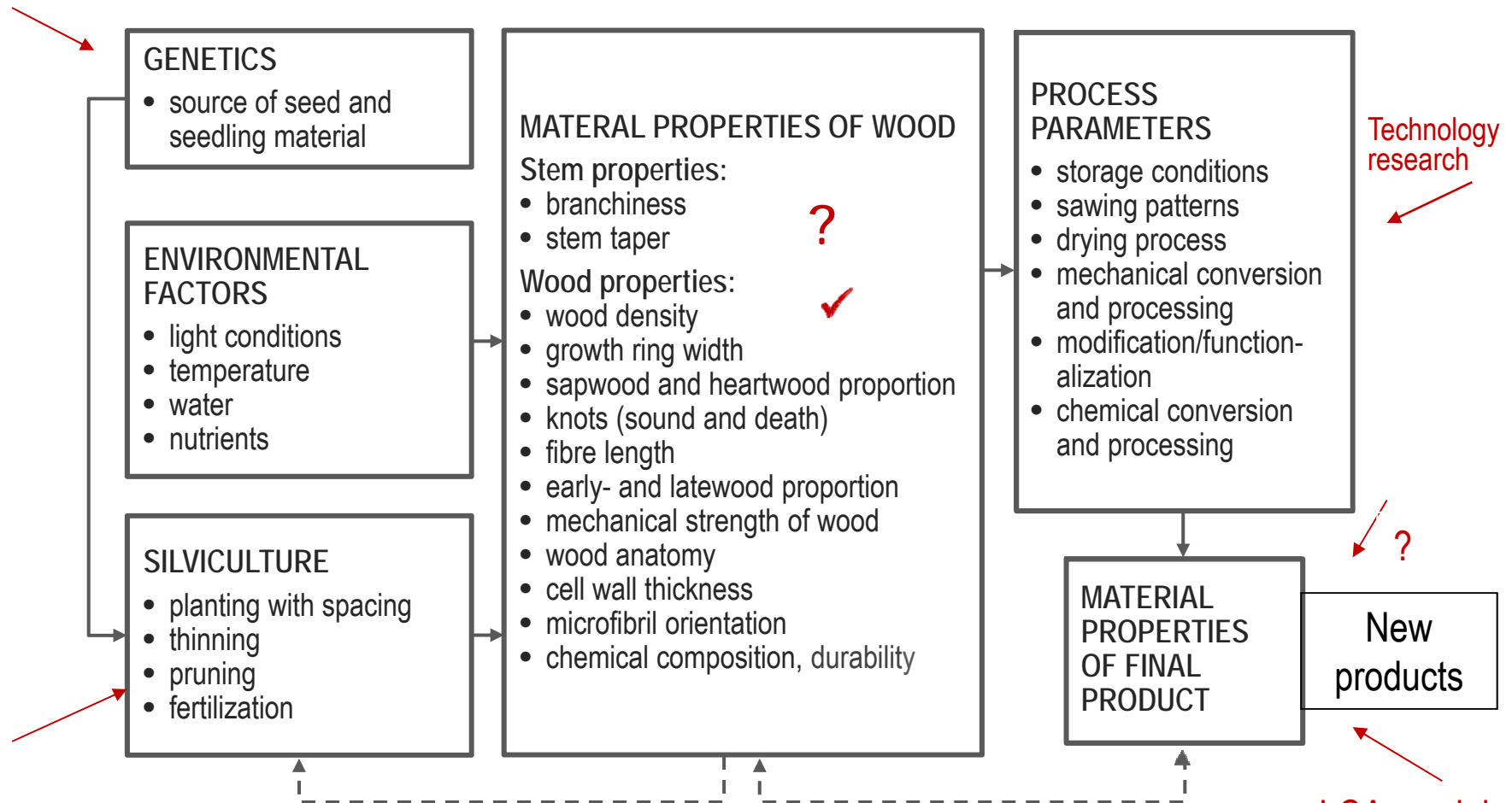


WoS categories are aggregated in four Scientific Clusters\*

The wood sciences papers belong mainly to Environmental Sciences (Yellow) and Physical Sciences (Green)

\* The four Scientific Clusters are, Environmental Sciences, Physical Sciences, Biomedecine, Social & Human Sciences, Leydesdorff et al. (2012)

# Interaction of wood properties and product properties



Where is the research activity?

Where are research needs? – climate change – mixed species etc.

adapted from Kellomäki (2002)

# Technology Road Mapping - create the Future

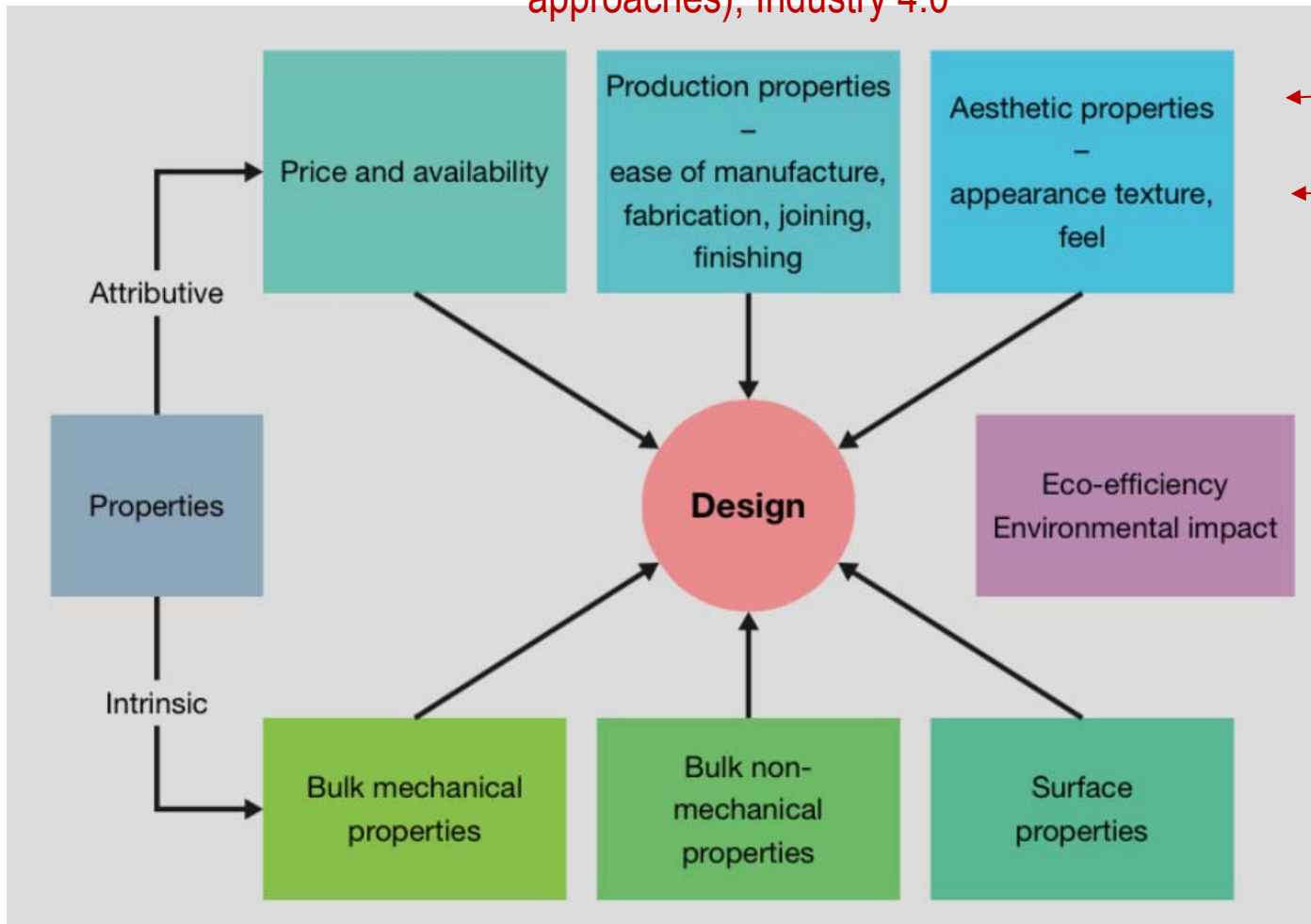


- TRM: method for the of planning supra-company technology agendas
- Important: industry involved has to assume ownership for the process and the results
- Starting point: common problem and / or opportunities that can better be tackled in co-operation
- Key element: collective planning in workshops with representatives from companies in the sector (+ other players from science, the administration...)
- Results: a shared agenda – and more:
  - Common knowledge and a shared vision
  - Common understanding of problems and approaches to solution
  - Orientation and a basis for decisions
  - A basis for co-operation and joint R&D
- Iteration is important for maximum benefit

# How material properties affect design

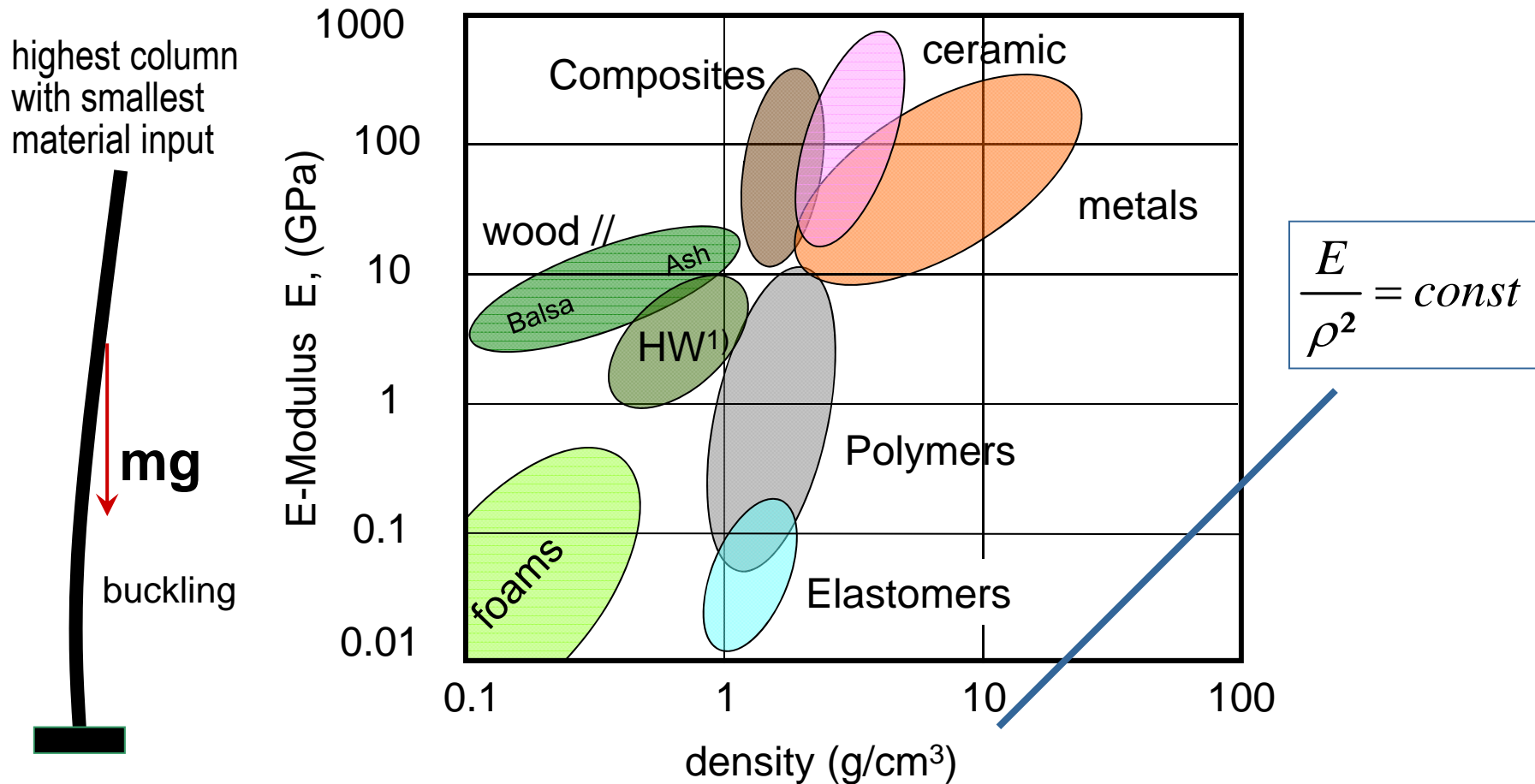


Manufacturing concepts? (new approaches), Industry 4.0



© adapted from Ashby 2005

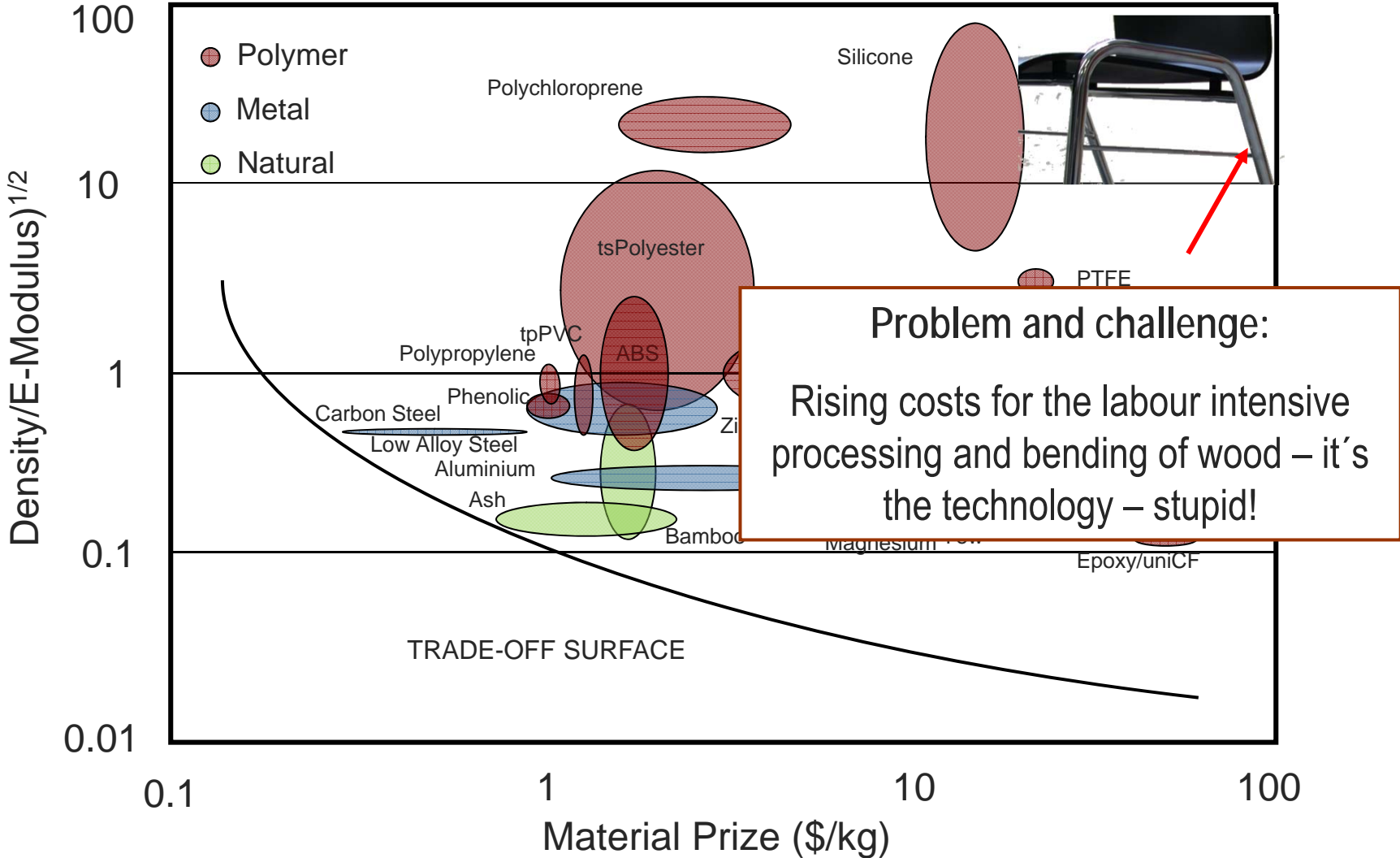
# Material property chart: E-Modulus and density



<sup>1)</sup> HW – wood composites, very blurred

source: M. Ashby and D. Cebon

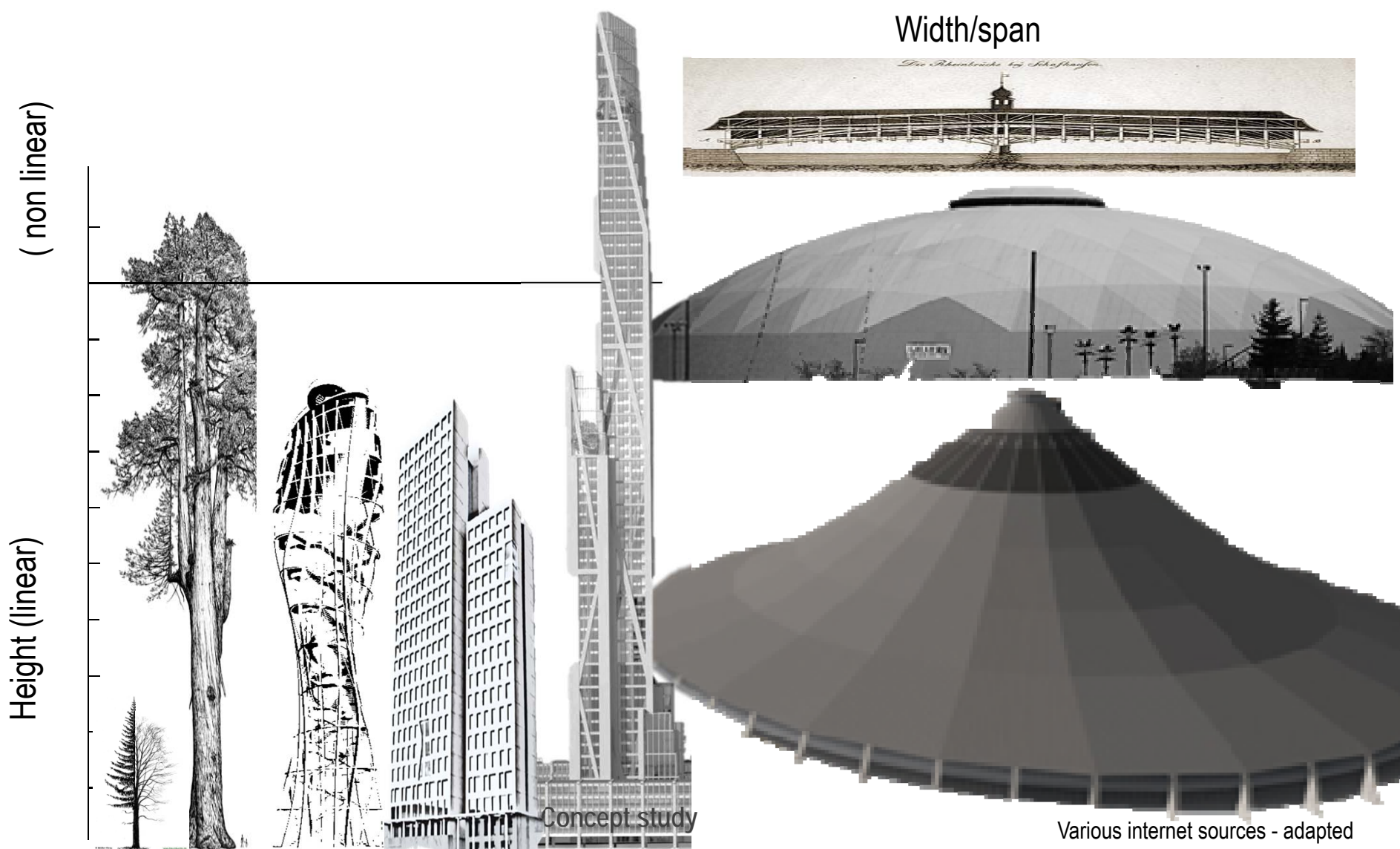
# Economic efficiency/viability of materials



source: M. Ashby and D. Cebon



# Dimensions in wood – from nature to technical design



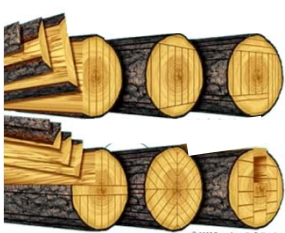
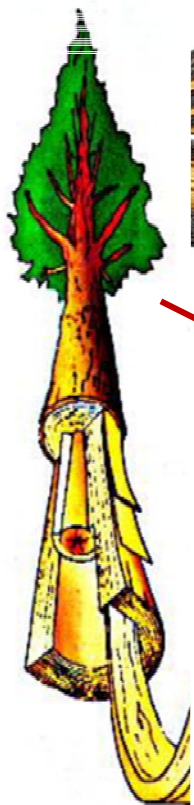
# Value chains – added value of wood and wood products



Universität für



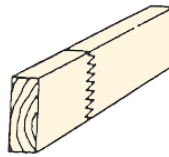
Holzbau



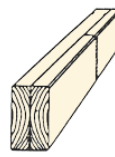
Sägerundholz/  
Schnittbilder



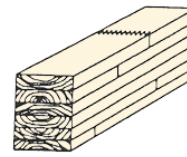
Schnittholz



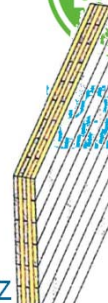
Konstruktions-  
vollholz



Duobalken



Brettschichtholz



Brettspertholz



Hackgut



Spanplatte

Faserplatte



Innenausbau



Schäl furnier



**Added Value**



Papierfaser



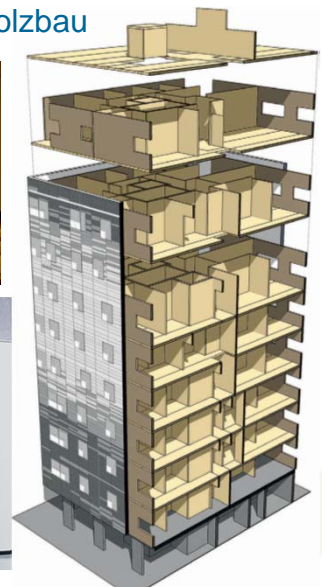
Regenerat Faser



Papier/Karton



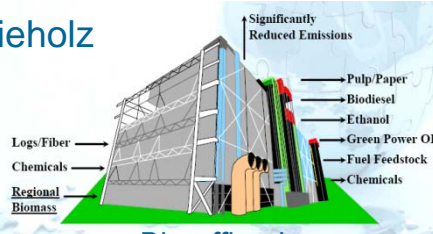
Möbel



Textilfaser/  
Textilien



Industrieholz



Bioraffinerie



Hygiene-  
produkte

Zellstoff  
Plattformchemikalien  
Feinchemikalien  
Energie (thermisch, Ethanol  
etc.)



Union Innovation  
Institut de Recherche  
Forestières



Thank you for your attention



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Tel.: +43 1 47654-89115, [www.boku.ac.at](http://www.boku.ac.at)

- Part 1 (15 min) – in Groups
  - 1. What would you really like to research (topic and short motivation, justification, rationale) – assume, you would get budget and infrastructure.
  - 2. As a group: What do you think are the most important research issues for a break through (topic, rationale, expected benefit)
    - Group 1: Technology solid wood
    - Group 2: Technology composites
    - Group 3: bulk products – added value
    - Group 4: niche products – added value
- Part 2 (20 min) – in Groups (selected topics from Part 1)