

Innovative Timber Construction Solutions

- Development among SMEs in Timber Construction Value Chains

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WHY

- System & value chain positioning among timber product industry enterprises?
- Forest sector enterprises – passive adaptors or active network creators?
- How to proceed towards best (or even good) practices to implement timber solutions in mass scale residential construction?

FTP –7th Conference Warsaw 27. September 2011

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Scandinavian Residential Timber Construction

Three Country Cases and Lessons Learned

- Uncertainty & system management in complex processes like construction impede the intake of innovative (even incremental) solutions
- History of numerous technical initiatives & development projects to enhance timber construction solutions in all three countries
- Timber industry enterprises capable of working as system integrators provide major success stories

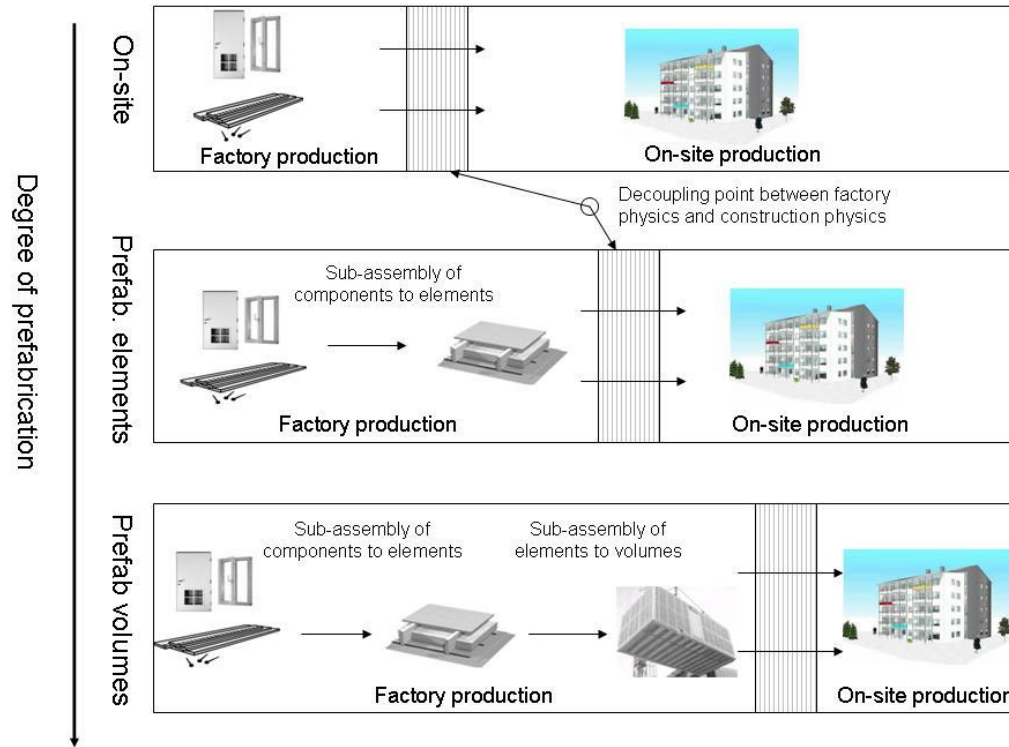
Ways ahead

- top down – timber industry enterprises passively waiting for new statements imposing construction value chains to adapt efficient carbon footprint requirements
- bottom up – developing & incorporating new practices to construction value chains thus activating even SMEs throughout the value networks to innovation processes

How to enhance market based solutions

- Enhancing demand base – identify consumer segments & true preferences
- Effective production – create lead industry & construction processes and communicate good practices

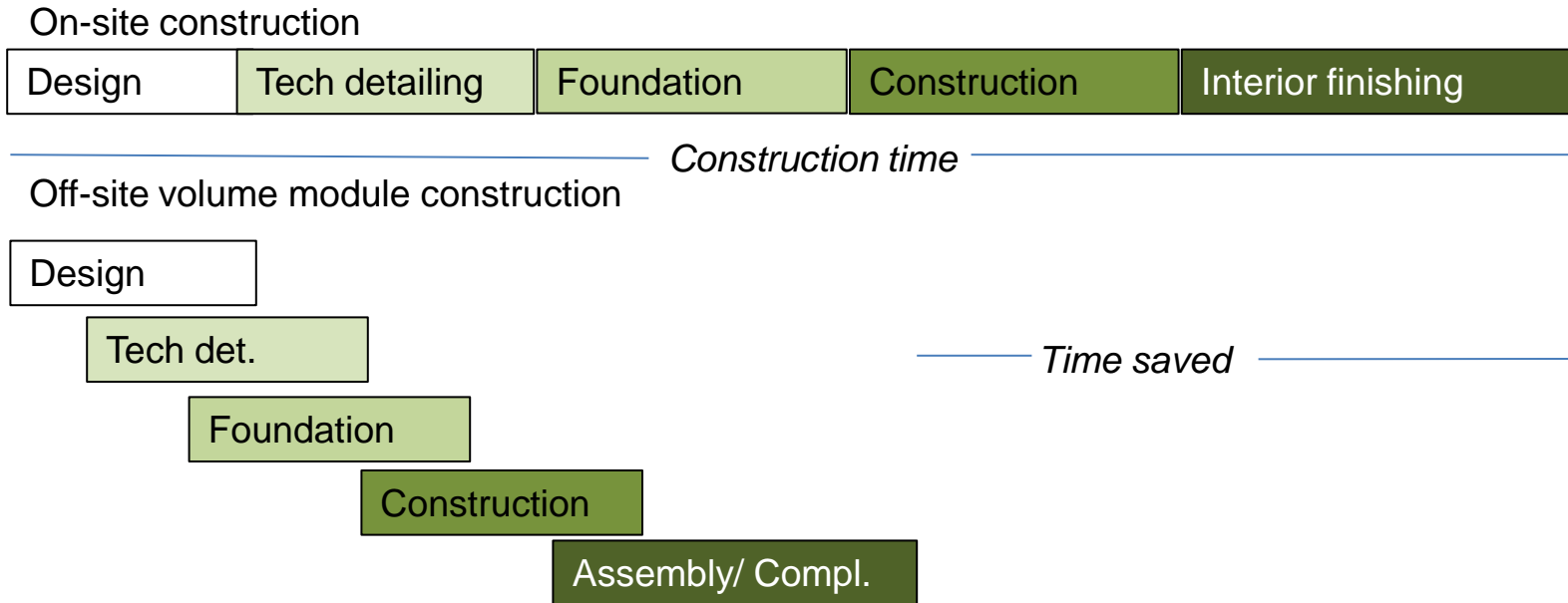
Timber products in industrial vs. industrialised construction



Challenge: Construction enterprises and real estate managers tend to be interested in process and overall quality, not that much on material solutions

Solution: Enhanced prefabrication to transmit mass customization options and improve uncertainty management in planning & on site assembly

How to create value and save time & resources?



Proposals to improve construction performance - by

Construction entrepreneurs: Intensify on site leadership and progress subcontractor competition among timber industry enterprises in the value chain

Economists: Use economies of scope & scale and enhance stakeholder specialization

Construction engineers: Optimize between the system and product solutions

System engineers: Build up Lean Industry and Lean Construction systems

Construction entrepreneur – Processed timber in traditional process

Timber in traditional processes

- Overall construction cost efficiency
- Timber industry match with low investments and high adaptability to individual architectural & planning solutions
- Strong on site leadership characterize construction processes
- System is adaptable to business cycles



Pictures adapted from Rimmler 2005 & PuulInfo Oy.

Construction engineer – Optimize timber structural systems

Choice between the technologies

- Beam-column combined with fabricated elements
- Structural elements of solid wood & plates
- Volume elements of
 - Light frame (timber & plates)
 - Solid Wood



Pictures adapted from L. Stehn, presentation at Timber construction forum in Garmisch Partenkirchen, 2009

Economist - Massive timber element prefabrication & assembling

Timber industry enterprises

- The economies of scale to fabricate solid wood & plate elements
- Strong requirements to manage industrial and on site processes & timing
- Timber modules & components have advantages in transportation and on site assembly
- Inexpensive to apply the economies of mass customization



Pictures adapted from L. Stehn, presentation at Timber construction forum in Garmisch Partenkirchen, 2009

System engineer - Lean Industry & Lean Construction



1. Element production (walls, floors etc.)



2. Assembly to volume modules



3. Interior cladding and installations



4. Exterior completion and covering



5. Storage of volume modules



6. Transport to building site



7. Erection of modules on site



8. Finalised building

- Timber industry enterprises need heavy investment & strong specialization to keep the system sensitive to business cycles
- Pre-fabricated timber volume modules have strong competitive advantages in transportation, assembling and mass customization solutions
- Allow short assembling times and low on site workforce

Pictures adapted from L. Stehn, presentation at Timber construction forum in Garmisch Partenkirchen, 2009

Where is Sweden from an innovation standpoint

An innovation development perspective

Concept & idea	Pilot-building	Strong niches	Mass market
<p>Choice of technology and business platform</p> 	<p>Technology verification leads to business development</p> 	<p>Concept development and market consolidation</p> 	<p>Concept development and Strategic expansion</p> 



Adapted from L. Stehn, presentation at Timber construction forum in Garmisch Partenkirchen, 2009

Success story in Sweden – Integrated volume element industry & construction business concepts

Market positioning

- Strict focus on the growing market segments
 - Student housing - dormitories & other solutions
 - Housing for the elderly
- Growth regions and local own real estate company in parallel
 - allow flexibility with customer requirements

Offering

- Customized value chain positioning solutions available
 - Customer designed tailor-made solutions (delivered as turn-key apartment houses)
 - Different custom solution modes for the ownership and maintenance
- Promoting resources – quality to cost ratio, time advantages, single contact person

Resources

- Constant co- operation with universities & research institutes allow access to current documented knowledge
- Volumetric, lean industry production lines & increasingly improved standard
- Intra firm design and construction skills & competencies
- External resources allowing long-term contracts

Where timber frame construction is in Norway now

Research*

Provide an overview of industrialized and systemized wood construction in Norway

Data

Ten case studies one single house & two apartment house projects analyzed

- Single family houses
- Passive houses
- Multi storey apartment buildings
 - Apartments for home buyers
 - Apartments for tenants
- Agricultural facility
- Hotel

*Nyrud & Bysheim (2011), with structured interviews & additional data collection from open sources)



Lessons from Norway

Empirical survey findings

- *The small market share of timber in urban construction expanding*
 - new construction technologies
 - increased demand for sustainable urban infrastructure
- *Several successful industrialized timber construction projects*
 - Cost competitive (timber in early planning through cost calculations)
 - Specific soil conditions (lightweight material)
 - Low risk for contractor/builder (experienced logistics & assembling)
 - Design (visual & environmental properties for developers)
- *Challenges in value chain configuration*
 - Complex architech design (eg. imported panelized modules)
 - Communication between architect and module producer
 - Complex logistics (eg. rural mountainous site)
 - Assembly (assembling communication)
 - Organizational problems (international value chain can be complex)

Major steps in multistorey processes - Finland



1995 Kerto construction element innovation derivative for multi-storey houses

Consortia: Finnforest Inc. & Oy Skanska & HUT & TUT

Reference: 3 B2B houses (three storey, 1 465 m²)



1998-2003 Pre Cut sawnwood frame and traditional carpentry on site work

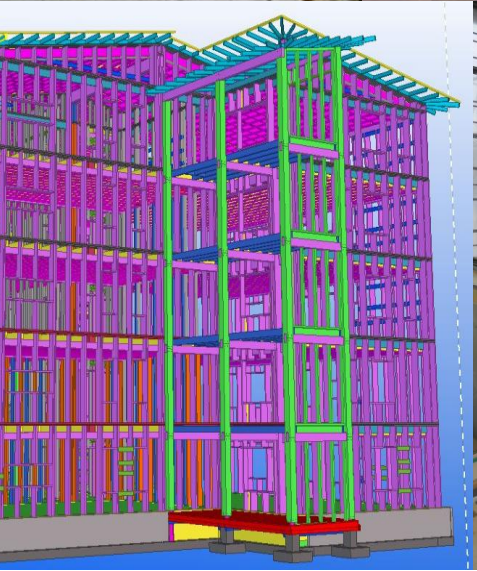
Project: Architect Pauli Lindström Oy , Const. Eng. Asko Keronen & Rakentajain Tuotekehittelypalvelu Oy & Oy Skanska

Reference: 4 owner occupied houses (four storey, 7 300 m²)

2011 PuuERA Passive energy hybride house - glue lam beams and poles integrated to walls and floors

Consortia: Mika Ukkonen (Vuorelma Arkkitehdit Oy) Versowood Oy & Reponen Oy & Koskisen Oy, Heinola City, The Sports Institute of Finland
Business objective: material independent component & module system

Reference 1 B2B house (5 floors, space 1915 m²), on process



Pictures adapted from Reponen Oy & PuulInfo Oy & Kairi, 2005.

Lessons from Finland

Architect & construction engineer specified solutions

- *successful business in low rise construction* - Modern Wooden Town and related Structural Systems
 - 20 regional projects during 1997- 2008 (3 500 apartments with total area 380 000 m²).
 - Detached, semi- detached and row house structures as well as two storey houses applied in different proportions
 - Ideal for local construction network & timber industry SMEs
 - Timber solutions frequently using pre cut mode implying intensive on site leadership to remain cost competitive
- *multi storey residential construction* - not much but reference projects
 - 11 projects during 1997- 2008 (517 apartments with total area 47 190 m²)
 - pre cut mode most frequent
 - high on site unit costs (high wage level country) and low supply of professionals with carpentry and joinery skills
 - poor match with business models among the international market enterprises

Future – common property structural system (joint standards)

- PuuPES (2010-2013) providing common platform for timber module & component innovations
- Completely revised fire regulations for timber structures

Lessons learned in Scandinavia

- Variety of initiatives & projects towards functioning of timber solutions
- Timber component design is not enough for markets & business growth
- Construction value networks with a new material need much DUI (Doing, Using, Interacting) innovations & skilled engineers & process labor
- System control in construction requires management & leadership
- Timber construction industry enterprises in B2B construction networks need system integrator competencies
- Bottom-up and a top-down approach are required
 - Entrepreneurial companies – to see the opportunities instead the obstacles
 - Regulatory bodies – to aim for the good of society today and in the future

ref. L. Stehn, presentation at Timber construction forum in Garmisch Partenkirchen, 2009

Key issue - Business Model

Identify customers and tailor the value propositions

- Good quality at competitive price
- Solutions that can be enhanced to new customer needs
- Exploit CAs from timber properties (architects + environmental conscious customers)

Key Resources

- Command to build with wood by extending to system integration competencies
- Solutions that comply with building codes
- Design and detailing carried out by someone in the organization

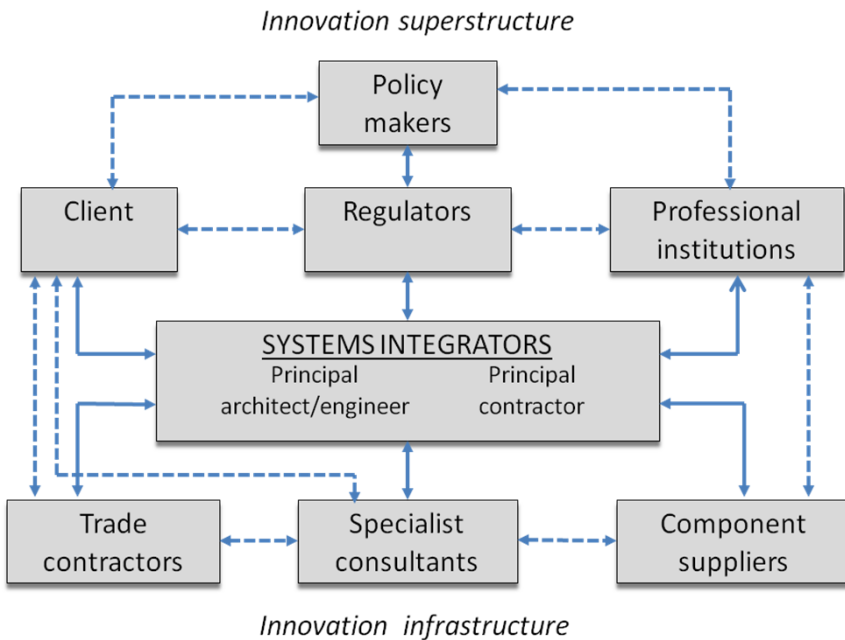
Key Processes

- Value chain: suppliers, design/specification partners and assembling partners
- Customer relationships: trust!
- Competencies to provide solutions to customers, especially to developers

Business Concept Formula

- Cost efficiency and quality
 - Standardized solutions
 - Systemized offering alternatives
- Construction time (speed)
- Identify product characteristics for which consumers are willing to pay a premium

Innovation superstructure – construction value network



Timber industry has most to gain when sustainable construction systems are required

Timber construction enterprises have actively

- enhanced policy changes
- renewed industry culture standards
- been in the forefront to adjust the traditional construction process.

Research: The innovation process of timber industry enterprises in 8 European countries,

Innovative superstructure

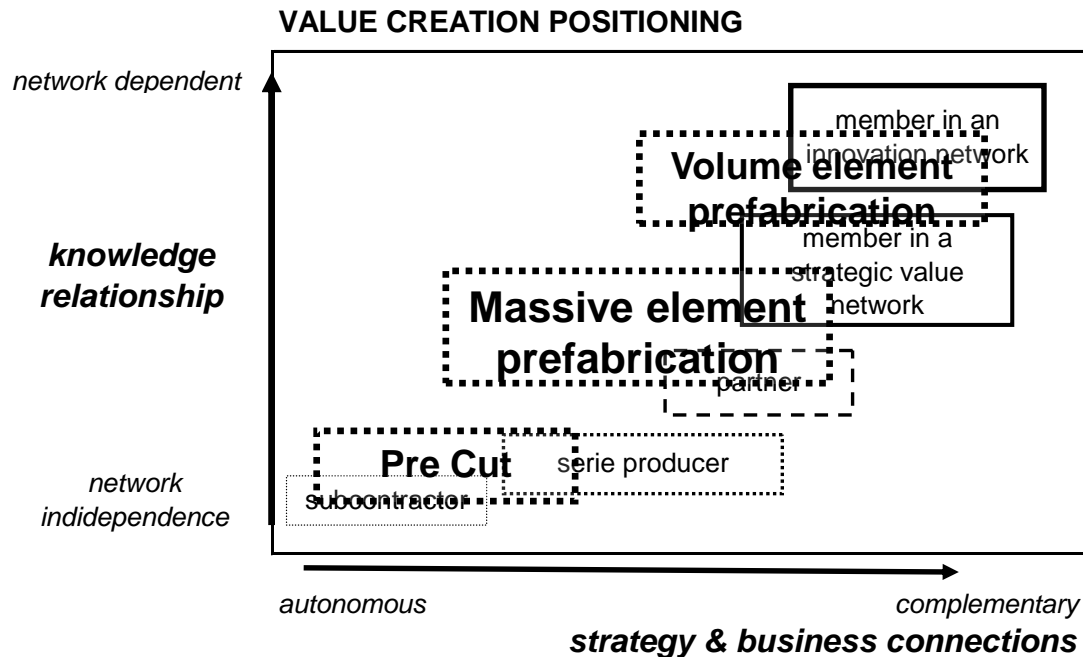
How to modify the classical Winch model to serve timber frame construction

1. Formal separation of the regulatory acts into two actor categories.
2. More interactive business models
3. Explicit inclusion of interactions between actors at the innovation superstructure level
4. More interest on developer attitudes & their business models

<http://www.boku.ac.at/coste51/>

Nord, T., Tykkä, S., McCluskey, D., Bajric, F., Bouriaud, L., Hugosson, M., Nyrud, A.Q., Ollonqvist, P., Roos., A., Ukrainski, K., Bysheim, K. 2010. Role of policies and national programs on innovations in timber frame construction, In: Innovation and the Forest sector – How do policies and processes fit? In: Innovation in Forestry – Territorial and Value Chain Relationships. Weiss, G. & Pettenella, D & Ollonqvist, P., & Slee, B. (eds)

Policy Support to Innovations among Forest Related SMEs



How to be innovative in the Construction Networks ?

Pre cut components only subcontracting along specific architect/constructor blueprints

Massive element prefabrication innovations under construction enterprise managed systems

Volume element prefabrication under mass customized timber solutions

Figure approach: based on Vesalainen (2002)

Major findings from COST E 51 the international survey

"Integrating Innovation and Development Policies for the Forest Sector"

Policies on timber construction innovations

- support mainly to product and process development
- inferior support to organizational and market innovation activities

Needs for new policies

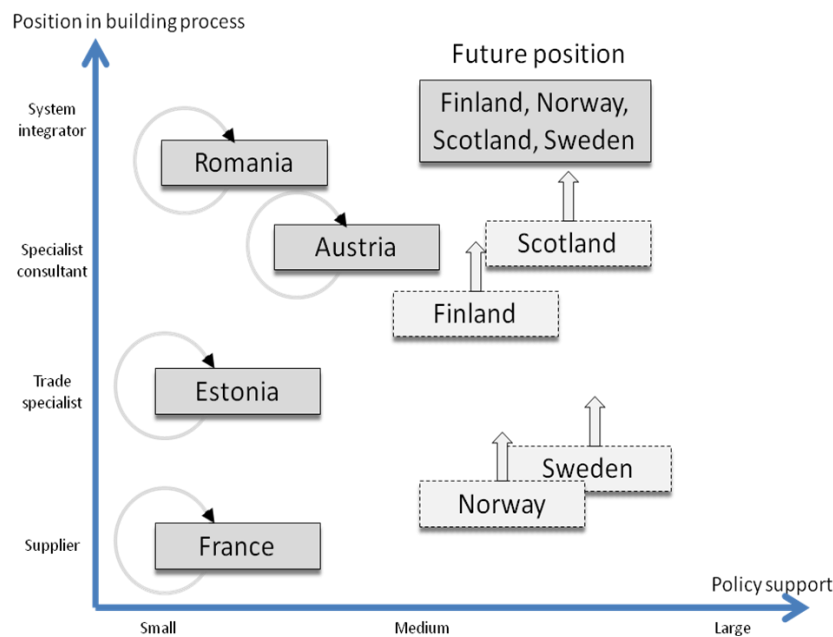
extended offerings including new services, moving down the value chain and eventually affecting the traditional building process in each country
harmonised regulation systems and especially the implementation on local level

Policy impacts

Most prominent in Finland, Norway, Scotland and Sweden

Modest public support for timber construction development in Austria, Estonia, France and Romania.

Valuable programs have been aimed to develop construction process instead the use of timber
Support on innovation activities to improve process and value chain communication & other organizational solutions has been truly progressive.



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Customer Attitudes and Timber Construction (CATCo)

Research task & partners

- true consumer preferences on timber solutions (Building & Living with Wood)
- uncertainty & risk management in complex processes
- sustainable competitive advantages through system integration & value chain positioning alternatives for timber industry enterprises in residential construction

Forestry, Consumers,

Systems

Industrial Marketing

Timber Products

- Pekka Ollonqvist & Maria Riala & Tuomas Nummelin, METLA

- Tomas Nord, Linköping University, Sweden

- Anders Q. Nyrud & Kristian Bysheim, Treteknisk, Norway