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Aspects on Paper Machine Designs for the Future

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World is changing
Does it affect the paper machine?

• Are design criteria changing due to new markets or new requirements?
• Will "good enough" paper quality and low costs be the drivers?
• Is it only the size that matters?
• What can be done to decrease the energy consumption or increase the energy efficiency?
• Will increasing scarcity of water have an effect to machine design?
• Do we see revolutionary development in paper making process?
Paper machine features in early 1970’s

• Speed 1000 m/min
• Width 8500 mm
• Efficiency 80-85%
• Production 125 000 t/a
A modern paper machine

- Speed 1800-2000 m/min
- Width 11000 mm
- Efficiency 90+%
- Production 350 000 t/a
Paper machine development since the 1970’s
Which technologies did it require to be possible?

• Air cushion h/b => hydraulic
• Fourdrinier => twin-wire former
• Three or four press nips => shoe press, single nip
• Introduction of zone controlled rolls with polymer roll covers
• Bottom and top felts => single tier dryer section with modern fabrics

• Automation and sensors
• Fluid dynamics
• Surface chemistry
• Polymers
• Ceramics
• Metallurgy
• Chemistry
Challenges drive development
Profitability main concern

• Low profitability limits new investments
  - Aging capacity in industrial countries
  - Yet, new capacity has cost and quality advantage

• High capital investment, yet a low margin commodity business
  - Business very vulnerable to capacity utilization ratio
  - High capacity targeted to minimize both capital and operation costs per ton produced
    ⇒ New investments create oversupply in the market, resulting in lower capacity utilization and prices for all producers when started up

• How to get out of this vicious circle?
  - New capacity to be combined with closure of outdated capacity in order to make sense.
Challenges drive development
Industrial logic favours efficiency

• Efficiency is still a driving force in industrial production, cost competitiveness drives decisions today

• Even in low labour cost countries the development has gone for big machines and high automation level

• Will this change? Is there an economic reason for another approach?
Will smaller entities have a new life?

- Same paper quality achievable regardless of the size
- Simpler and lighter designs can contribute in competitive investment cost per ton of production
- Advanced automation a must, but simplified design should contribute to economic solutions
- Possibility for stepwise growth through rebuilds and modifications
- Paper mill infrastructure and operation development
  - Simplified mill concept to support cost competitive operation
Challenges drive development
Environment a growing concern for all

• Environmental issues ever more important in decision making
  - energy, water, emissions, noise, raw material origin...

• A lot has already been done, but
  - image of industry is still poor
  - energy will become more expensive
  - fresh water threatens to become a scarce resource in many more areas
  - population grows and the mills are getting closer to residential areas

• Will scarcity and price of oil boost the use of fiber based packaging?
### Importance of cost components

#### Average Cost Structures

**BHKP (Global)**
- Wood: 51%
- Personnel: 12%
- Energy: 10%
- Chemicals: 14%
- Other manufacturing costs: 13%

**Newsprint (Global)**
- Wood: 12%
- Chemical pulp / Other fibre: 4%
- Recycled paper: 17%
- Personnel: 17%
- Energy: 26%
- Chemicals: 6%

**LWC (Global)**
- Wood: 7%
- Recycled paper: 28%
- Chemicals: 12%
- Personnel: 17%
- Energy: 16%
- Chemical pulp / Other fibre: 21%

**Copy paper (Europe)**
- Recycled paper: 51%
- Personnel: 10%
- Energy: 10%
- Chemicals: 9%
- Other manufacturing costs: 19%

**WLC (Europe)**
- Recycled paper: 26%
- Personnel: 21%
- Chemicals: 15%
- Energy: 17%
- Chemical pulp / Other fibre: 3%

**Testliner (Europe)**
- Recycled paper: 28%
- Personnel: 16%
- Energy: 26%
- Chemicals: 12%

**Market based pulp pricing also for integrated producers**

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Typical distribution of PM electricity use

- Approach system: 31%
- PM sectional drives: 18%
- Vacuum system: 16%
- Compressed air system: 10%
- Ventilation & runnability: 10%
- Hydraulic & lubrication: 10%
- Water system: 10%
- Finishing: 10%
- Broke system: 10%
- Other: 10%

Typical distribution of PM steam use

- Press section steam box: 15%
- Drying cylinders: 68%
- Water heating: 15%
- Ventilation: 5%
- Calander: 2%
- Other: 1%

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Fresh water consumption of a paper mill

- FM showers: 28%
- Chemical preparation: 14%
- Sealing water: 35%
- Wash-ups: 14%
- Evaporation: 14%
Reduction of fresh water consumption

- Fresh water consumption decreased ~ 20 % in last 10 years
  - Efficient process water cleaning and closed process loops

- Chemical preparation, high pressure showers and wash-ups
  - Material development and designs to allow cleaner fabrics and machine with less water
  - Chemical preparation – process development to reduce the need of chemicals

- HC-forming
  - Forming technology development has increased headbox consistency from < 1 % to 1.3...1.4 % (especially in wood containing grades)
  - In HC forming (~ 3 %) fresh water consumption not affected due to recirculation of wire waters

- More efficient cleaning of effluent water
  - Use of ultrafiltration and nanofiltration technologies
  - Zero effluent technically possible with reverse osmosis and evaporation processes but has not been economically feasible so far
Wanted features of a future paper machine

• Simple and cost efficient process and machine design
  - On-line processes, single nip press, simple stock prep
  - Flexibility, easily modified for grade change or increased capacity

• High usability and uptime
  - New embedded service concepts, simple technical solutions, new materials, use of automation to monitor machine performance and condition
  - Cleanliness, quick grade changes, maintenance friendly

• Reduced energy consumption
  - Former without vacuum, efficient pressing
  - Solutions depend on the choice of energy source at the mill

• Efficient use of fresh water
  - Develop water reuse even further
Summary conclusions

- No viable alternatives for fiber-water suspension can be foreseen in paper making
- Cost structure and environmental issues will be key drivers
- Most likely development takes place in small evolutionary steps
- Cost structure in paper making has supported big entities
- If cost structure changes, e.g. due to increased energy price, some grades might have a new situation
- It would be optimal to be able to invest in suitable size, not only giant
  - New technical solutions need to be developed to allow competitive investment and operating cost