

WEAVING TECHNOLOGY II

- Weaving Productivity**
- Operational Productivity**
- Comparing Issues of Weaving Machinery**

Weft Insertion Rate (m/min)

- $WIR = \text{Speed (rpm or ppm)} \times \text{Working width (m)} \times \eta$ (efficiency)

- ***Fabric Production, L or P***

$L = (60 n \cdot \eta) / (D \cdot 100 \cdot 100)$ (m/h)

$P = L \cdot b$ (m²/h)

$n = \text{rpm or ppm}$ $b = \text{fabric width (m)}$

$\eta = \text{efficiency(\%)}$ $D = \text{pick density (ppc)}$

WEAVING PRODUCTIVITY

Table 2.1. Weft Insertion rates for various machines and weft insertion system during 80's

| Machine Type | Working Width (m) | Speed (rpm) | Weft Insertion Rate (m/min) |
|---------------------------|-------------------|-------------|-----------------------------|
| Shuttle | 1.88-3.57-4.14 | 60-160 | 357-420-525 |
| Projectile | 1.90-3.30-5.45 | 250-400 | 600 -1250 |
| Ordinary | | | 250 -700 |
| Rigid Double-cloth | | | 700 -1000 |
| Rapier Twin(face to face) | 1.60-4.00 | 200-420 | 1000 -1100 |
| Two Phases | | | 1100 -1300 |
| Flexible Rapier | 1.80-4.20 | 200-500 | 550 -1150 |
| Air-jet | 1.40-3.60 | 400-700 | 650 -1600 |
| Water-jet | 1.50-2.30 | 800 | 1000 -1700 |

WEFT INSERTION RATES

Table 2.2. Machine speeds and equivalent weft insertion rates for various machines and weft insertion systems (1992)

| Machine and System | Width (m) W | Weft Insertion Rate | | Machine Speed | |
|---|-------------------|---------------------|------|---------------|------|
| | | (m/min) | WIR | (rpm) | |
| Toyoda Air Jet JAT600-JA25-MTIT600 | 3.3 | 2186 | (4) | 662 | (7) |
| Nissan Air Jet LA51A-2MH4 | 2.8 | 2066 | (5) | 739 | (6) |
| Tsudakoma Air Jet ZAX-190-2C-4S | 1.9 | 2550 | (2) | 1342 | (2) |
| Picanol Air Jet PAT-A-4R190 | 1.9 | 1702 | (7) | 896 | (5) |
| Sulzer Ruti L5200.S190-NZ.1K.TE | 1.9 | 1747 | (6) | 919 | (4) |
| Sulzer Ruti Projectile P7200.B360.NZ.EP/RTQ | 3.6 | 1200 | (8) | 333 | (14) |
| Somet Rapier Thema 11 | 3.6 | 1173 | (9) | 326 | (15) |
| Somet Rapier Thema 11E | 1.9 | 954 | (11) | 502 | (9) |
| Nuovo Pignone Rapier FAST.2 | 2.0 | 907 | (13) | 454 | (10) |
| Vametex Rapier P1001 | 2.1 | 950 | (12) | 452 | (11) |
| Sulzer Ruti Rapier G6200B.190.N6.SP.U | 1.9 | 992 | (10) | 522 | (8) |
| Nissan Water Jet LW542-4-190 | 1.9 | 2336 | (3) | 1230 | (3) |
| Tsudakoma Water Jet ZW-315X-170-1C-4S | 1.7 | 2601 | (1) | 1530 | (1) |
| Dornier Rigid Rapier HTV8/SD | 2.0 | 761 | (15) | 381 | (13) |
| Vamatex Telescopic Rapier SD.400SE | 1.85 | 770 | (14) | 416 | (12) |
| Jurgens Shuttle Loom | 11.6 | 557 | (16) | 48 | (16) |

WEFT INSERTION RATES- ITMA 2003

Fastest Air Jet Weaving Machines, RFI > 2000

| Company | Machine | Fabric | Speed, picks/min | RFI, m/min |
|------------|---------------------------------------|----------------------------------|------------------|------------|
| Dornier | AWSL 4/-EasyLeno 540 | Carpet Backing | 450 | 2,349 |
| Picanol | OMNIplu-2-P 280 | Air Bag | 770 | 2,079 |
| Picanol | OMNIplu-4-P 340 | Awning | 750 | 2,385 |
| Picanol | OMNIplu-2-P 280 | Sheeting | 770 | 2,202 |
| Picanol | OMNIplu-6-J 250 + UNIVAL 100 Jacquard | Mattress Ticking and Table Cloth | 1,025 | 2,460 |
| Promatec h | MYTHOS TEC 340 | Sheeting | 780 | 2,496 |
| Sultex | L9400 P 540 N 2 L | Carpet Backing | 420 | 2,238 |
| Sultex | L5400 S 210 N 4 SP TL | Ladies Wear | 990 | 2,079 |

Broad range of fabrics

Air jet + jacquard = intricate fabrics at speed of commodity fabrics

Two new wide looms with new leno mechanisms

WEFT INSERTION RATES - ITMA 2003

| Company | Machine | Fabric | Speed, picks/min | RFI, m/min |
|---------|--------------------------|---------------|------------------|--------------------|
| Sultex | P7300 B 390 N 4 SP D12 | Cotton Sateen | 370x4 | 1,300x4 (5,200) |
| Sultex | P73 RSP B 360 N 4 SP D12 | Cotton Canvas | 330 | 1,205 |

Four insertions

WEFT INSERTION RATES- ITMA 2003

Fastest Rapier Weaving Machines

| Company | Machine Type | Fabric | Speed, picks/min | RFI, m/min |
|-----------|-----------------------------|-----------------------|------------------|--------------|
| Dornier | PTS 8/S | Fancy Dobby | 600 | 1,068 |
| Picanol | GamMax-6-R 190 | Shirting | 720 | 1,138 |
| Picanol | GamMax-4-R 360 | Denim | 420 | 1,482 |
| Picanol | GamMax-4-R 250 | Glass Fiber | 450 | 1,053 |
| Picanol | GamMax-6-R 340 | Voile | 420 | 1,260 |
| Picanol | GamMax-12-J 320 | Upholstery (Jacquard) | 400 300 | 1,168 876 |
| Promatech | ALPHA, 3.2 m | Upholstery (Jacquard) | 480 | 1,433 |
| Promatech | ALPHA, 2.2 m | Wool Apparel | 520 580 | 936 1,044 |
| Promatech | LEONARDO, SILVER FTS, 1.9 m | Industrial | 620x2 | 1,178x2 |
| Promatech | LEONARDO, DYNA TERRY, 2.6 m | Terry Towels | 430 | 1,132 |
| Promatech | LEONARDO, SILVER FTS, 2.1 m | Upholstery (Dobby) | 700 | 1,190 |
| Promatech | LEONARDO, SILVER FTS, 1.9 m | Shirting | 650 | 1,081 |

WEFT INSERTION RATES- ITMA 2003

Fastest Rapier Weaving Machines (Continued)

| Company | Machine Type | Fabric | Speed, picks/min | RFI, m/min |
|----------------|---------------------------------|-------------------------|-----------------------------|-----------------------|
| Smit | GS900-S 360 N8 SP | Curtain | 410 | 1,400 |
| Smit | G6300F TERRY-B 260 N8 SP | Terry Towel | 480 | 1,107 |
| Smit | GS900-S 190 N8 SP | Tie | 700 | 1,008 |
| Smit | G6300-S 230 N4 SP | Air Bag | 600 | 1,362 |
| Smit | G6300-W 220 N8 SP | Men's Wear | 600 | 1,094 |
| Smit | G6300F TERRY-B 260 N8 J | Terry (4 panels) | 480 | 1,241 |
| Sultex | G6200E W 190 N 8 SP | Men's Wear | 600 | 1,045 |

Broad range of fabrics

WEFT INSERTION RATES - ITMA 2003

- The **Sultex M8300 multiphase weaving machine**, which was shown for the first time at ITMA '95, has continued to be one of the main attractions at ITMA 2003.
- One machine was shown weaving dense twill fabric at a speed of 2,824 picks/min or 4118 m/min RFI. Sultex indicated that the machine can weave plain, 2x1, 3x1 and 2x2 weaves and warp density is limited to a maximum of 45 ends/cm.

OPERATIONAL PRODUCTIVITY

- The factors influencing the operational productivity of a weaving plant or weaving room, are given below:
 - Weft insertion rate
 - Production type (long run/mass production or short run/flexible production)
 - Yarn quality
 - Machine design related to the yarn manipulation and beam flanges
 - Saving in labor
 - Quick style change equipment
 - Automation level in preparation and weaving process

OPERATIONAL PRODUCTIVITY

- **Spatial Productivity:**

- Spatial productivity is an important consideration, particularly for new mill installations.
- Spatial productivity shows the production of weaving machine per unit area of the floor space, i.e., WIR/m² of the accommodation area.
- Sulzer Ruti L5200 air Jet:

Working width: 1,90 m

Loom speed:450 rpm

WIR:1260 m/min

Containing rectangle (width x depth=area):3,78 x 1,81 =6,84 m²

Total accommodation area per machine: 11,40 m²

WIR/m²:110,6

The ratio for spatial productivity: $6,84/11,40=0.6$

Installed weaving capacities of major textile manufacturers



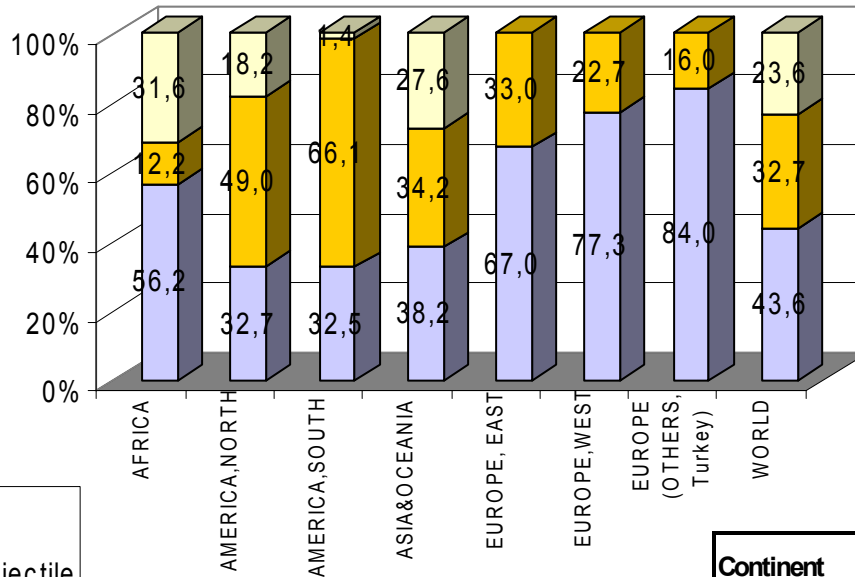
| Countries | Installed weaving capacity | | | | | |
|---------------|------------------------------|--------|--------|--------------------------|---------|---------|
| | Shuttleless Weaving Machines | | | Shuttle Weaving Machines | | |
| | 2001 | 2002 | 2003 | 2001 | 2002 | 2003 |
| Argentina | 4.900 | 4.900 | 5.300 | 17.300 | 17.300 | 17.300 |
| Brazil | 40.500 | 38.850 | 39.390 | 25.000 | 25.000 | 12.000 |
| Rep. Of Czech | 6.940 | 6.461 | 6.094 | 479 | 279 | 178 |
| | 8.700 | 8.231 | 7.604 | 1.417 | 1.162 | 775 |
| Egypt | 3.900 | 3.800 | 3.600 | 5.000 | 4.500 | 4.200 |
| France | 4.722 | 4.232 | 3.695 | 423 | 379 | 284 |
| Germany | 750 | 950 | 900 | 3.400 | 2.500 | 2.200 |
| Hungary | 419 | 397 | 365 | 175 | | |
| India | 7.629 | 8.400 | 9.210 | 116.341 | 137.000 | 105.280 |
| | 11.843 | 13.459 | 13.121 | 129.358 | 144.228 | 112.508 |
| Italy | 11.745 | 11.540 | 11.065 | 1.665 | 1.640 | 1.550 |
| | | | | | | |
| Japan | 17.680 | 16.380 | 15.220 | 25.800 | 27.660 | 24.840 |
| | 45.920 | 42.240 | 40.080 | 60.060 | 53.180 | 48.650 |
| Rep. Of Korea | 1.810 | 1.500 | 1.362 | | | |
| | | | | | | |
| Pakistan | 18.000 | 21.500 | 21.500 | 225.000 | 225.000 | 225.000 |
| | | | | | | |
| Portugal | 9.328 | 9.021 | 9.290 | 1.680 | 1.616 | 1.555 |
| | | | | | | |
| Russian | 96.000 | 87.000 | 85.000 | 7.800 | 7.100 | 6.600 |
| | 110.020 | 99.400 | 97.200 | 10.600 | 9.600 | 9.200 |
| South Africa | | | | | | |
| | 2.640 | 2.700 | 1.700 | 360 | 405 | |
| Spain | 6.691 | 6.489 | 5.671 | 1.932 | 1.752 | 1.549 |
| | | | | | | |
| Switzerland | 895 | 805 | 750 | 120 | 110 | 80 |
| | | | | | | |
| Taiwan | 15.243 | 13.982 | 13.922 | 1.223 | 624 | 624 |
| | 43.147 | 39.373 | 36.028 | 1.810 | 1.191 | 913 |
| Turkey | | | | | | |
| | 25.000 | 27.800 | 32.300 | 30.000 | 30.000 | 30.000 |
| USA | | | | | | |
| | 42.808 | 39.472 | 34.139 | 2.144 | 1.949 | 1.792 |

| | |
|--|--------------|
| | short staple |
| | all |

Shipments of Shuttleless Weaving Machinery in 2003

(Source :Reports of ITMF)

| | Rapier/ Projectile | Air Jet | Water Jet | ShuttlelessTotal | Shuttle Weaving Machines |
|-------|-----------------------|---------|-----------|------------------|--------------------------------|
| WORLD | 27.338 | 20.509 | 14.796 | 62.643 | 21.548 |



| Continent | Rapier/ Projectile | Air Jet | Water Jet |
|-------------------------|-----------------------|---------|-----------|
| AFRICA | 56,2 | 12,2 | 31,6 |
| AMERICA,NORTH | 32,7 | 49,0 | 18,2 |
| AMERICA,SOUTH | 32,5 | 66,1 | 1,4 |
| ASIA&OCEANIA | 38,2 | 34,2 | 27,6 |
| EUROPE, EAST | 67,0 | 33,0 | |
| EUROPE,WEST | 77,3 | 22,7 | |
| EUROPE (OTHERS, Turkey) | 84,0 | 16,0 | |
| WORLD | 43,6 | 32,7 | 23,6 |

Comparing Issues of Weaving Machinery

- The first filter: Textile technology (machine technical requirements)

| | | |
|---|------------------------------|--|
| 1 | The method of weft insertion | weft velocity, maximum number of weft colors, necessity for pick x pick insertion |
| 2 | Maximum weaving width | width range as well as maximum |
| 3 | Type or types of selvedge | i.e. ability to accept tucking-unit |
| 4 | Type of fabric | maximum cover factor capability, maximal fabric weight per 1sq.m., the weft sett range |
| 5 | Type of shedding | if cam configuration, how many picks to a repeat |
| 6 | Type of yarn | weft linear density range, any special yarn restriction or capability, e.g. hydrophobic, elastomeric, low tenacity, etc. |
| 7 | Fabric quality | control devices available to improve fabric quality |

Comparing Issues of Weaving Machinery

- The second filter-Operational aspects:

| | | |
|---|-------------------------|--|
| 1 | Noisiness and vibration | dynamic effects on the floor, environmental problems |
| 2 | Ease of use | |
| 3 | Maintenance | |
| 4 | Service | spare parts etc. |
| 5 | Working safety | |

- The third filter-Financial aspects:

| | |
|---|---|
| 1 | Output of the machine (WIR, labor productivity) |
| 2 | Investment cost |
| 3 | Power consumption |
| 4 | Floor space required |
| 5 | Other requirements such as conditioning, water etc. |
| 6 | Waste |
| 7 | Other erection and installation costs |

Comparative regional cost factors

- Purchase price of weaving machine
 - the relative geographical locations of maker and purchaser
 - currency considerations,
 - scale of operation,
 - financial strength,
 - the level of established negotiations.
- Inflation
 - it has a major effect on capital investment in weaving.
- Labor
 - Hourly wage rates paid to skilled, semi-skilled and unskilled employees including premiums and social charges,
 - labor productivity (total working hours).
- Power
 - Energy costs related to the machine drive, illumination, air conditioning, etc.

Comparative regional cost factors

- Auxiliary Materials
 - The costs for spare parts, lubricants and cleaning materials. Preparation costs are also included.
- Depreciation
 - It includes depreciation of plant, machinery, accessories and buildings. Machinery costs are inclusive of delivery, erection and, where appropriate, customs duty.
- Interest
 - Cost for capital interest.

Comparative regional cost factors

1991 Manufacturing Costs (Weaving)

| Cost Element | Units of national currency per yard of fabric | | | | | |
|---|---|---------|-------|-------|-------|-------|
| | Brazil | Germany | India | Japan | Korea | USA |
| | (Czs) | (DM) | (Rs) | (¥) | (W) | (\$) |
| Labour | 6.8 | 0.355 | 0.504 | 19.2 | 26.4 | 0.132 |
| | 7% | 38% | 6% | 29% | 12% | 36% |
| Auxiliary materials | 14.5 | 0.113 | 1.117 | 6.9 | 48.9 | 0.049 |
| | 14% | 12% | 13% | 10% | 21% | 13% |
| Depreciation | 40.3 | 0.230 | 2.763 | 20.7 | 81.9 | 0.099 |
| | 39% | 24% | 34% | 31% | 36% | 27% |
| Interest | 35.6 | 0.144 | 3.210 | 10.9 | 46.0 | 0.058 |
| | 34% | 15% | 39% | 13% | 20% | 16% |
| Total manufacturing | 103.9 | 0.944 | 8.226 | 66.1 | 227.6 | 0.369 |
| (Index:Germany=100) | 74 | 100 | 73 | 90 | 56 | 67 |
| Total Fabric Cost including raw materials US\$/yard | 1.155 | 1.302 | 1.010 | 1.321 | 0.979 | 1.103 |

As the technical conditions are identical, the cost differences shown in the table reflect the unit costs appropriate to the condition and practices of each country.

Comparative regional cost factors

Regional Cost Factors in Weaving (1991) US\$

| | Brazil | Germany | India | Japan | Korea | USA |
|--|---------------|----------------|--------------|--------------|--------------|------------|
| Skilled hourly rate | 2.77 | 18.95 | 1.14 | 21.51 | 3.97 | 12.97 |
| Machine minders | 1.47 | 17.24 | 1.10 | 10.90 | 1.92 | 11.83 |
| Unskilled hourly rate | 1.19 | 16.76 | 0.81 | 9.69 | 1.49 | 8.65 |
| Operating hours pa | 7180 | 5500 | 8420 | 5960 | 8300 | 7000 |
| Electric power / (k Wh) | 0.053 | 0.093 | 0.061 | 0.100 | 0.053 | 0.045 |
| Cost of water / (m³) | 0.706 | 1.279 | 0.580 | 0.260 | 0.263 | 0.702 |
| Steam / (lb. yarn) | 0.009 | 0.063 | 0.012 | 0.068 | 0.035 | 0.040 |
| Sizing / (lb. yarn) | 0.163 | 0.221 | 0.141 | 0.146 | 0.211 | 0.120 |
| Building / (m³) | 649 | 640 | 159 | 1358 | 409 | 656 |

A comparison of the relevant cost factors is shown in the above table, which is abstracted from the 1991 ITMF report. The local currencies were converted to US\$ to facilitate comparison.

Comparative regional cost factors

Total cost in 2003 : Woven fabric from ring yarns (USD/ yard)

| | Brazil | China | India | Italy | Korea | Turkey | USA |
|---|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| Waste | 0,033 %5 | 0,054 %8 | 0,030 %5 | 0,039 %3 | 0,039 %5 | 0,039 %5 | 0,030 %4 |
| Labor | 0,029 %4 | 0,022 %3 | 0,034 %5 | 0,378 %34 | 0,116 %16 | 0,050 %7 | 0,263 %31 |
| Power | 0,046 %7 | 0,089 %13 | 0,112 %17 | 0,146 %13 | 0,070 %9 | 0,098 %13 | 0,068 %8 |
| Auxiliary Material | 0,057 %9 | 0,055 %8 | 0,074 %11 | 0,084 %8 | 0,108 %14 | 0,077 %11 | 0,065 %8 |
| Capital (depreciation& interest) | 0,260 %40 | 0,178 %26 | 0,195 %29 | 0,205 %19 | 0,175 %23 | 0,228 %31 | 0,198 %23 |
| Raw material | 0,227 %35 | 0,293 %42 | 0,218 %33 | 0,248 %23 | 0,246 %33 | 0,246 %33 | 0,220 %26 |
| Total fabric cost (USD per yard) | 0,652 | 0,691 | 0,663 | 1,100 | 0,754 | 0,738 | 0,844 |
| (USD per meter) | 0,713 | 0,756 | 0,725 | 1,203 | 0,825 | 0,807 | 0,923 |
| Index (Italy:100) | 59 | 63 | 60 | 100 | 69 | 67 | 77 |

Comparative regional cost factors

Total cost in 2003 : Woven fabric from OE yarns (USD/ yard)

| | Brazil | China | India | Italy | Korea | Turkey | USA |
|---|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| Waste | 0,023 % 5 | 0,038 % 8 | 0,022 % 5 | 0,028 % 3 | 0,028 % 5 | 0,028 % 5 | 0,022 % 4 |
| Labor | 0,023 % 4 | 0,018 % 3 | 0,028 % 5 | 0,281 % 34 | 0,093 % 16 | 0,036 % 7 | 0,201 % 31 |
| Power | 0,041 % 7 | 0,077 % 13 | 0,097 % 17 | 0,127 % 13 | 0,062 % 9 | 0,086 % 13 | 0,060 % 8 |
| Auxiliary Material | 0,059 % 9 | 0,058 % 8 | 0,077 % 11 | 0,086 % 8 | 0,111 % 14 | 0,080 % 11 | 0,068 % 8 |
| Capital (depreciation& interest) | 0,227 % 40 | 0,163 % 26 | 0,172 % 29 | 0,183 % 19 | 0,156 % 23 | 0,199 % 31 | 0,175 % 23 |
| Raw material | 0,227 % 35 | 0,293 % 42 | 0,218 % 33 | 0,248 % 23 | 0,246 % 33 | 0,246 % 33 | 0,220 % 26 |
| Total fabric cost (USD per yard) | 0,600 | 0,647 | 0,614 | 0,953 | 0,696 | 0,675 | 0,746 |
| (USD per meter) | 0,656 | 0,708 | 0,671 | 1,042 | 0,761 | 0,738 | 0,816 |
| Index (Italy:100) | 63 | 68 | 64 | 100 | 73 | 71 | 78 |

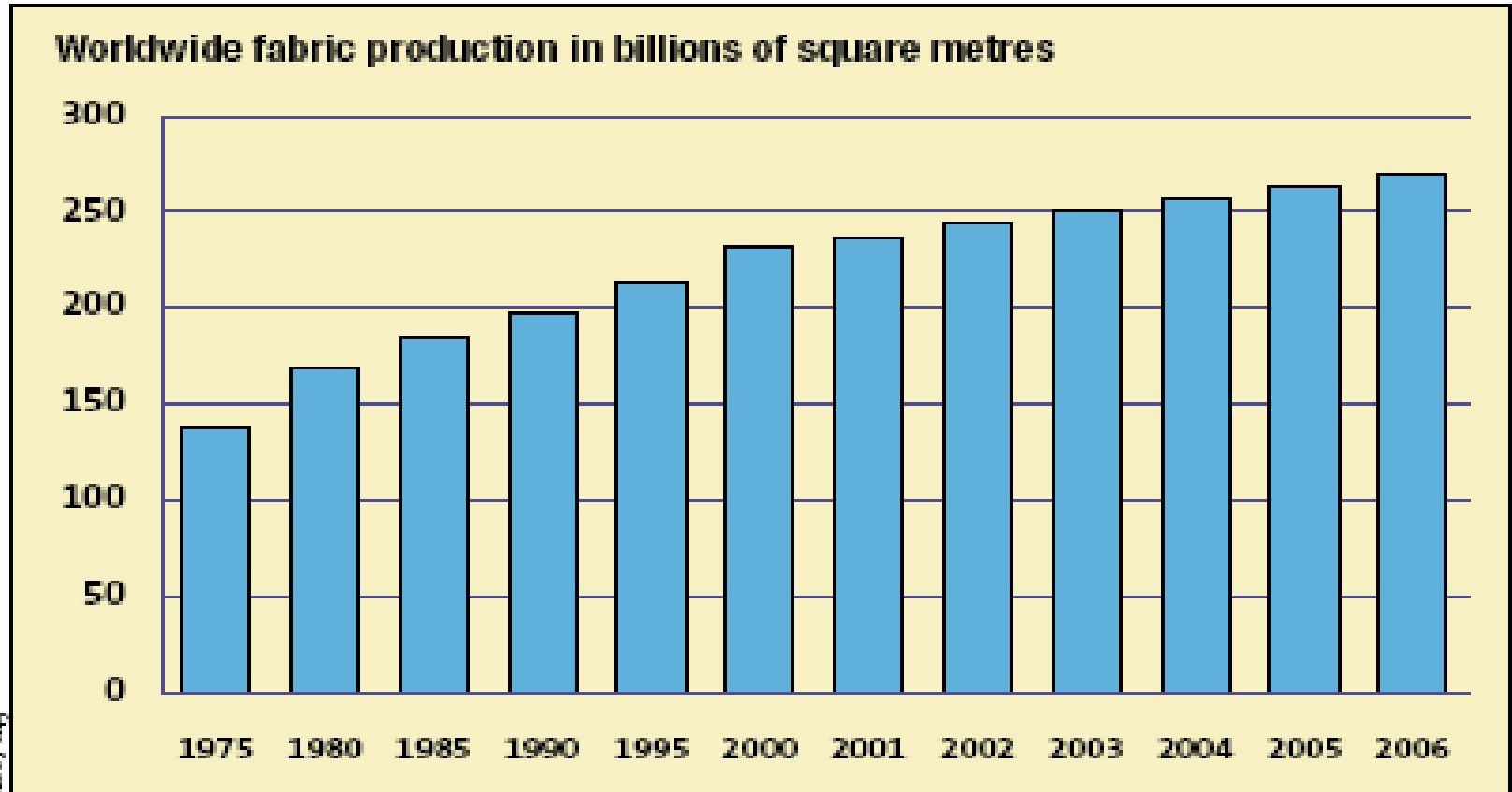
Comparative regional cost factors

Cost Factors in 2003:

Weaving

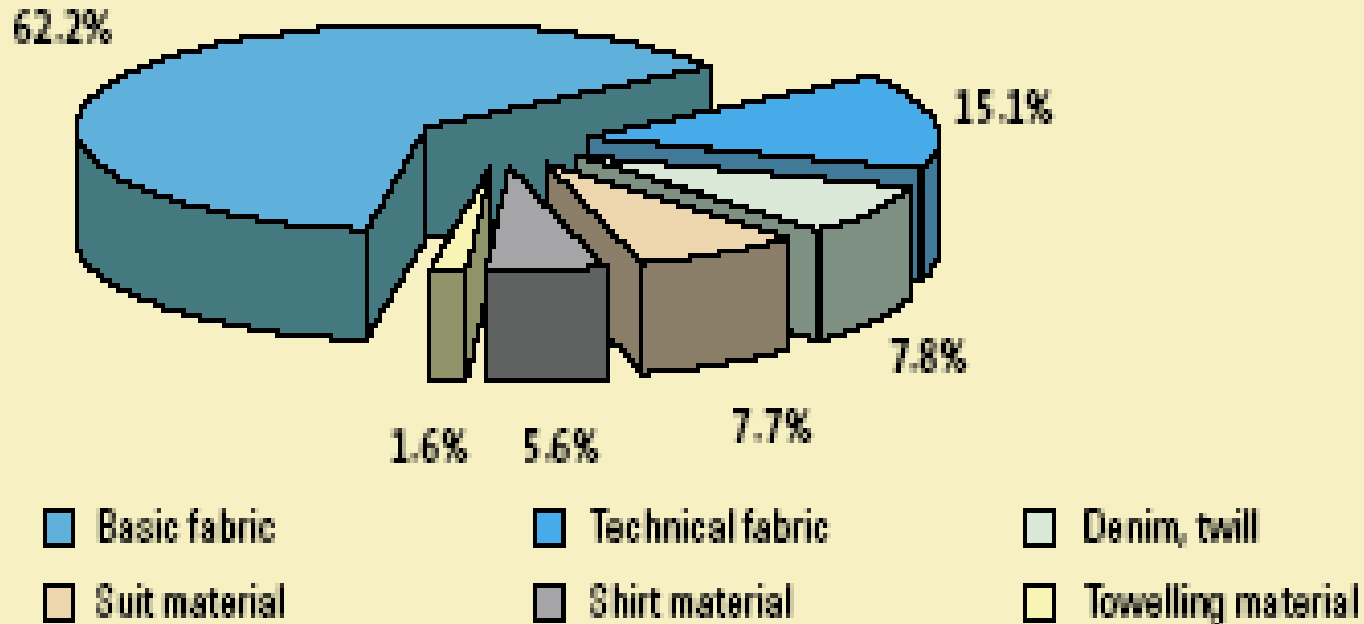
| | Brazil | China | India | Italy | Korea | Turkey | USA |
|---|--------|--------|--------|--------|--------|--------|----------------------|
| Skilled personnel hourly wages | 1.49 | 1.45 | 1.09 | 20.97 | 6.79 | 3.65 | 17.97 ^{2/3} |
| Unskilled personnel hourly wages | 0.82 | 0.66 | 0.71 | 18.49 | 3.78 | 1.64 | 12.50 ³ |
| Operation hours (annually) | 7618 | 7875 | 8402 | 6500 | 7144 | 7142 | 7800 |
| Electric power / (k Wh) | 0.03 | 0.07 | 0.08 | 0.10 | 0.05 | 0.07 | 0.05 ⁴ |
| Cost of water / (m ³) | 0.14 | 0.18 | 0.79 | 0.37 | 0.85 | 0.50 | 0.59 ^{4/5} |
| Steam / (lb. yarn) | 0.03 | 0.02 | 0.02 | 0.04 | 0.03 | 0.04 | 0.04 |
| Sizing / (lb. yarn) | 0.04 | 0.05 | 0.13 | 0.16 | 0.69 | 0.14 | 0.10 |
| Building cost / m ² | 142.40 | 108.70 | 133.38 | 553.76 | 217.85 | 104.36 | 760.00 |
| Total floor space req. (m ²)- M8300 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 |
| Total floor space req.(m ²)- G6300 | 4800 | 4800 | 4800 | 4800 | 4800 | 4800 | 4800 |
| Depreciation period (no.of years) | 10 | 5 | 10 | 8 | 9.3 | 7 | 7 |
| Depreciation period for the auxiliary equipment(no.of years) | 9 | 5 | 5 | 5 | 9.3 | 7 | 5 |
| Depreciation period for building (no.of years) | 25 | 12 | 28 | 30 | 34.7 | 25 | 39 |
| Cost of delivery, customs duty and taxes (the percentage of the machine cost) | 17.40 | 6.00 | 25.00 | 0 | 5.70 | 2.90 | 5.00 |
| Capital interest(%) | 18.52 | 5.50 | 14.00 | 6.50 | 5.80 | 10.00 | 5.25 |
| Raw material cost (woven cloth/yard) | | | | | | | |
| – cotton yarn | 0.227 | 0.293 | 0.218 | 0.248 | 0.246 | 0.246 | 0.220 |
| – textured yarn(75 den PET) | 0.142 | 0.104 | 0.164 | 0.145 | 0.122 | 0.212 | 0.164 |

The World Fabric Production



The World Fabric Production

Distribution of worldwide fabric production



Comparative regional cost factors

- Print cloth construction
 - Yarn type:
100 % cotton of 1–1/8" staple length, Ne 30/1, combed cotton
 - Densities:
70/70 per inch or 27,6/27,6 per cm
 - Grey cloth width:
66 inch or 167,64 cm
- Weaving machine construction
 1. 32 multi phase B190 weaving machine
production-53,40 m/h (58,4 yard/h)
machine efficiency: 87.6 %
 2. 60 rapier S190 N4 SP12/20.
Production: 12,44 m/h (13.6 yard/h)
machine efficiency: 91.9 %)

Some financial issues

- Weft insertion rate:
 - Cost per unit weft insertion rate or WIR per unit of capital cost is also useful indicator from the capital investment point of view.
 - All weaving machines, irrespective of weft insertion system, increase in cost with increased weaving width.
 - For determining the most economical weaving width relationships can be established for weaving width for minimum cost for some types of weaving machines.
 - $C = M + NW$ where C is the machine cost, W is the width, M and N constants, then the width for maximum weft insertion rate per unit cost is achieved when $W = M/N$.
 - A useful supporting index is WIR/unit accommodation area
 - total yarn conversion as warp and weft consumption

Some financial issues

- Spare parts cost:
 - Spare parts and maintenance costs of shuttleless weaving machines vary considerably depending on
 - the operating principle,
 - the degree of engineering refinement,
 - the type of fabric being produced,
 - the scale of activity and
 - the effectiveness of technical management and training
 - The variation of cost with time is difficult to predict.
 - Some machines show almost constant annual costs on fixed money value for several years,
 - they then incur considerable expense for two or three years at about half machine-life, and then
 - revert to almost the former level.
 - Projectile machines conform to this pattern, parts associated with picking having to be replaced after eight or ten three-shift years depending on weight and constructions of fabric produced.
 - Other machines have an exponential relationship with operating life from first installation.

Some financial issues

- Energy considerations:
 - Power is one of the major manufacturing costs
 - The energy for weft insertion is normally one third to one half of the total energy requirement of the weaving machine, thus, the method of weft insertion has a decisive effect on the specific energy consumption of the whole machine.
 - It is also important to consider the total energy requirement to maintain the machine in production. Such additional equipment as weft storage devices, suction units, blowing units, and any other ancillary unit with its own power source must be taken into account.

Some financial issues

- Energy consumption in kWh/m² of woven fabric
 - the Sulzer projectile weaving machine is the most effective converter of energy of all the weaving machines irrespective of weft insertion system,
 - the Sulzer Rütli air jet with a specific energy consumption two and a half times as great is the most wasteful,
 - the conventional shuttle and the 'two-phase' reasonably placed with respect to the projectile machine.

| Weft insertion system | | Energy consumption | |
|-----------------------|----------------------|---------------------|-----------------|
| | | kWh/ m ² | As ratio of (1) |
| 1. | Projectile | 0.261 | 1.00 |
| 2. | Air-jet | 0.652 | 2.50 |
| 3. | Conventional rapier | 0.517 | 1.98 |
| 4. | Conventional shuttle | 0.360 | 1.38 |
| 5. | 'Two-phase' | 0.303 | 1.16 |

Some financial issues

- **Accommodation costs**

- With building and power costs escalating, the fabric production per unit area of floor space must be an important economic consideration. The WIR/m² floor space for a number of different weaving machines employing different weft-insertion systems is shown below.

| (1) Weaving Machine | | | (2) Containing rectangle | | | (3) Total Accommodation Area Per machine(m ²) | (4) WIR (m/min) | (5) WIR/m ² (4) + (3) |
|--------------------------------------|--------------|----------------|-----------------------------|--------------|---------------------------|--|-----------------------|--|
| Type | Width (m) | Speed (ppm) | Width (m) | Depth (m) | Area (m ²) | | | |
| Sulzer Ruti Projectile P7200 | 3.88 | 310 | 5.60 | 2.04 | 11.42 | 19.04 | 1200 | 63.0 |
| Dornier Rigid Rapier | 2.00 | 425 | 5.00 | 1.90 | 9.50 | 15.52 | 850 | 53.72 |
| Sulzer Ruti L5200 Air-jet | 1.90 | 450 | 3.78 | 1.81 | 6.84 | 11.40 | 1260 | 110.6 |
| Saurer 500 'Two-phase' | 2x1.85 | 320 | 5.85 | 1.62 | 9.48 | 15.73 | 1184 | 75.2 |
| Günne Double Shed 'pick -a- back' | 2.00 | 430 | 5.25 | 2.21 | 12.68 | 20.92 | 860 | 41.1 |
| Somet Flexible rapier | 3.60 | 345 | 6.90 | 2.03 | 14.00 | 23.30 | 1173 | 50.3 |

Looking Ahead

- Machine developments during the next decade will be characterized by the following:
 - Greater machine versatility;
 - Increases in performance and productivity;
 - Economy of investment and operation (i.e. reduction in energy consumption etc.);
 - The introduction of electronics as elements of machine control and as elements of production and quality control;
 - Ecological cleanliness of the machines;
 - Reduction in environmental problems(vibration and noisiness);
 - Cloth-quality improvements.