

Garment Production Management

Week 15

Application of Digital Technology in Apparel Production Management

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Recap-previous week

- Just-in-Time (JIT)
- Lean Manufacturing concepts
- JIT inventory
- JIT implementation

Lecture Learning Outcomes

- Understand key digital technologies transforming garment production
- Differentiate between IT, Digital, and SMART technologies with examples
- Analyze real-world applications in production planning, execution, and control
- Evaluate benefits, challenges, and ROI of digital adoption
- Identify future trends of Industry 4.0 and Industry 5.0 in garment industry

Session outline

- Introduction to Garment Production Management
- Role of IT in Production Management
- Digital Technologies Overview
- SMART Technologies in Depth
- Integration & Case Studies
- Future Trends, Challenges & Takeaways

Traditional garment production-limitations

- Manual pattern making and grading – **low productivity and quality problem**
- Paper-based cutting markers – **high fabric waste**
- Communication gap between design, production, and logistics
- No real-time visibility of work-in-progress (WIP)
- Difficulty in tracking defects, rework, and machine downtime

Traditional garment production-limitations

- **Department isolation:** Design team does not see cutting room constraints; cutting does not know sewing bottlenecks
- **Paper-based handoffs:** Physical documents travel between desks, causing delays and loss
- **Delayed problem detection:** A defect found at sewing may trace back to a cutting error 3 days earlier
- **Duplicate data entry:** Same order information entered separately into design, production, and inventory systems
- **Reactive management:** Supervisors solve problems after they occur, not before

Digital garment production-key advantages

- Automated cutting and spreading – reduces fabric waste by up to 10%
- Digital patterns and markers – instant modification and reuse
- Real-time production tracking via dashboards and alerts
- Faster sampling through virtual prototyping (days instead of weeks)
- Improved collaboration across global supply chains via cloud platforms

Defining IT, Digital & SMART technologies

- **IT (Information Technology):** Backend systems for data storage, processing, and communication
- **Digital Technology:** Converting analog processes (e.g., paper patterns) into digital formats
- **SMART Technology:** Systems with sensing, analysis, and autonomous action capabilities
- **Overlap:** IT enables digital, digital enables SMART; all three work together
- **Example:** ERP (IT) + digital pattern (Digital technology) + IoT machine (SMART)

IT application-ERP in Garment industry

ERP Benefits

- Integrates order processing, inventory, procurement, and production
- Real-time visibility of raw material, WIP, and finished goods
- Automates production planning based on order priority and capacity
- Reduces manual data entry errors and duplication
- Supports multi-location, multi-supplier coordination

IT application-Manufacturing Execution system(MES)

- **MES** tracks every production order from cutting to packing
- Collects real-time data on machine status, operator output, and quality
- Triggers alerts when production deviates from plan
- Integrates with ERP for **closed-loop planning and execution**
- Provides detailed OEE (Overall Equipment Effectiveness) reports

IT application-warehouse management system (WMS)

- Uses barcode or RFID to track fabric rolls, trims, and finished goods
- Enables real-time inventory counts and location mapping
- Automates put-away, picking, and shipping processes
- Reduces stockouts, overstocking, and misplaced inventory
- Integrates with ERP and MES for seamless material flow

IT application-Product life cycle management(PLM)

- Centralizes design specs, BOM (Bill of Materials), and **tech packs**
- Manages version control for patterns, samples, and approvals
- Tracks sample comments and revisions from multiple stakeholders
- Reduces lead time from design to production launch
- Improves compliance with customer and regulatory requirements

IT application-Supply chain management(SCM)Software

- Manages supplier onboarding, performance scoring, and communication
- Tracks purchase orders, shipment status, and customs documents
- Provides demand forecasting based on historical sales data
- Enables collaborative planning with fabric and trim suppliers
- Reduces material shortage and production delays

Digital CAD for pattern making

- 2D CAD software is used for precision patterns
 - Examples Gerber Accumark, Lectra Modaris, etc.
- Automatic pattern grading across multiple sizes from a base pattern
- Digital marker making to optimize fabric utilization (90–95% efficiency)
- Instant pattern modifications without re-drawing
- Export directly to automated cutting machines (no paper needed)

Digital technology-3D virtual sampling

- Creates photorealistic 3D garments from digital patterns
 - CLO 3D, Browzwear, etc
- Simulates fabric drape, stretch, color, and texture accurately
- Eliminates time taking physical sample iterations cost
- Allows instant color, material, and fit changes in software
- Reduces sample shipping costs and carbon footprint

Digital technology-Digital fabric printing

- Direct-to-fabric inkjet printing without screens or color separation
- Enables short runs (1–500 meters) cost-effectively
- No water, dye paste, or screen cleaning chemicals
- Supports mass customization and personalized designs
- Rapid design-to-print cycle (hours vs. weeks)

Digital technology-Digital Cutting room

- Automated spreading machines with tension control
- CNC cutting systems (e.g., Gerber, Lectra, Bullmer) follow digital markers
- Nesting software optimizes marker efficiency automatically
- Cuts multiple plies accurately with minimal operator intervention
- Reduces cutting error rate to less than 0.5%

Digital technology-Digital work instructions

Digital sewing operators with images, videos, and annotations

Displayed on shop floor tablets or screens at each workstation

Real-time updates to instructions when design changes occur

Reduces language barriers with visual guides

Tracks operator compliance and training gaps

SMART technology-IoT sensors on machines

- Vibration, temperature, and current sensors on sewing, cutting, and finishing machines
- Real-time data sent to central dashboard via WiFi/5G
- Predicts machine failures before they happen (predictive maintenance)
- Monitors thread break, needle break, and bobbin status
- Reduces unplanned downtime

SMART technology-AI for automated quality inspection

- High-resolution cameras and computer vision detect fabric and stitching defects
- AI models trained on thousands of defect images (hole, stain, skip stitch, puckering)
- Inspection speed: 60+ meters per minute, far faster than human
- Real-time rejection or rework alerts at each inspection point
- Consistent defect classification and data logging for root cause analysis

SMART technology-Digital twin of production line

- **Virtual replica** of entire factory layout, machines, operators, and material flow
- Simulates what-if scenarios (new product, machine breakdown, demand spike)
- Identifies bottlenecks before physical changes are made
- Optimizes line balancing and manpower allocation
- Updates in real-time using IoT data from physical factory

SMART technology-wearables for operators

- Smart watches or bands for **fatigue and posture monitoring**
- Haptic feedback for ergonomic alerts (e.g., improper lifting)
- **RFID-enabled gloves** for scanning operations without barcode readers
- **Real-time productivity** feedback to individual operators
- **Reduces repetitive strain injuries** and improves efficiency

SMART technology-Autonomous material transport

- Automated guided vehicles (AGVs) and Autonomous Mobile Robots (AMRs)
- Transport fabric rolls, cut pieces, and finished bundles between stations
- Navigate using LIDAR, floor magnets, or vision-based mapping
- Integrated with **ERP/MES** for demand-based material movement
- Reduces manual material handling time and errors

Integration of IT, digital technologies & SMART workflow

- **ERP** (IT) receives sales order → triggers **PLM** (IT) for tech pack development
- **CAD** (Digital) creates patterns → **MES** (IT) schedules cutting
- **IoT** (SMART) monitors cutting machine → reports real-time status
- **AI** (SMART) inspects cut pieces → sends pass/fail to ERP
- Benefit is seamless, automated, data-driven production

Case study- Zara's integrated digital ecosystem

- Real-time sales data from stores triggers automated replenishment orders
- Digital pattern library enables rapid style modifications
- RFID (SMART) tracks every garment from factory to point-of-sale
- **MES and WMS** integrated for just-in-time production
- Benefit is **short (2 weeks) design-to-store lead time** (industry average is more than six months)

Case study-Levi's Laser finish technology

- Digital laser system replaces manual sanding, scraping, and distressing
- Operator creates fade/whisker design in software → laser executes in seconds
- Saves 75% water and 100% chemicals per pair of jeans
- Consistent results across thousands of units
- Integrated with digital pattern and finishing line MES

Case study- Addidas speedfactory (SMART+ robotics)

- Highly automated, localized production in Germany/USA (now transitioned)
- Robotic knitting, cutting, and assembly with minimal human intervention
- Digital twin simulated entire production flow before factory build
- Real-time AI quality check at every station
- Result: 24-hour prototype-to-production for certain shoe models

Benefits of digital technology adoption

- Lead time reduction: 4–8 weeks down to 5–10 days
- Fabric waste reduction: 15–25% lower via digital marker optimization
- Quality improvement: 30–50% fewer defects via AI inspection
- Labor efficiency: 20–40% higher with digital work instructions
- Sustainability: lower water, chemical, energy, and physical sample waste

Challenges in technology adoption

- High upfront investment: CAD, IoT, ERP, robotics (\$100k–\$5M+)
- Skill gap: operators need digital literacy; IT support required
- Data integration: legacy machines lack connectivity interfaces
- Cybersecurity risk: connected systems vulnerable to attacks
- Change resistance: workers and managers may fear automation

Lessons for industry managers

- Start with a pilot line or single process (e.g., digital cutting room)
- Invest in **training and change management** before technology
- Ensure **IT infrastructure** (network, cloud, security) is ready
- Choose **open-architecture platforms** for future scalability
- Measure ROI: reduced waste, faster speed, higher quality, lower labor cost

Lessons for industry managers

Technology Categories & Key Applications

- **IT (Information Technology):** Backend systems (ERP, MES, WMS, PLM, SCM) for data storage, processing, and communication across production
- **Digital Technology:** Converts analog processes to digital formats – CAD pattern making, 3D virtual sampling, digital fabric printing, digital cutting room
- **SMART Technology:** Self-monitoring systems with analysis and autonomous action – IoT sensors, AI quality inspection, robotics, digital twin, wearables, AGVs
- **Integration Impact:** IT provides data backbone, Digital transforms manual workflows, SMART enables autonomous decisions
- **Industry 4.0 Result:** Connected, real-time, predictive production from design to delivery

Summary

What is Lean Manufacturing?

- Systematic elimination of waste (Muda) from all processes
- Maximize customer value while minimizing resources
- Broader philosophy that includes culture, flow, quality, and people

What is Just-in-Time (JIT)?

- Produce and deliver exactly what is needed, exactly when needed, in exact quantity
- Originated at Toyota as a key pillar of the Toyota Production System
- Focuses on timing, precision, and inventory reduction

References

1. Nayak, R., & Padhye, R. (2018). Application of digital technologies in garment manufacturing: An overview. *Journal of the Textile Institute*, 109(5), 684–695.
<https://doi.org/10.1080/00405000.2017.1362138>
2. Büyüközkan, G., & Göçer, F. (2018). Digital supply chain: Literature review and a proposed framework for future research. *Computers in Industry*, 97, 157–177.
<https://doi.org/10.1016/j.compind.2018.02.010>
3. Goworek, H., & McGoldrick, P. (2019). Sustainability and digitalisation in the fashion industry: A systematic review. *International Journal of Fashion Design, Technology and Education*, 12(3), 278–289.
<https://doi.org/10.1080/17543266.2019.1612947>
4. Nayak, R., & Padhye, R. (Eds.). (2020). *Digital transformation in the textile and garment industry*. Springer Nature.
<https://doi.org/10.1007/978-3-030-50458-2>
5. Majumdar, A., & Das, A. (Eds.). (2021). *Industry 4.0 for the apparel sector: Technology, applications and challenges*. Woodhead Publishing (Elsevier).



Thank You !

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