Globalization of knowledge work: Notebook PC design & development

Kenneth L. Kraemer
Jason Dedrick
Personal Computing Industry Center
University of California, Irvine

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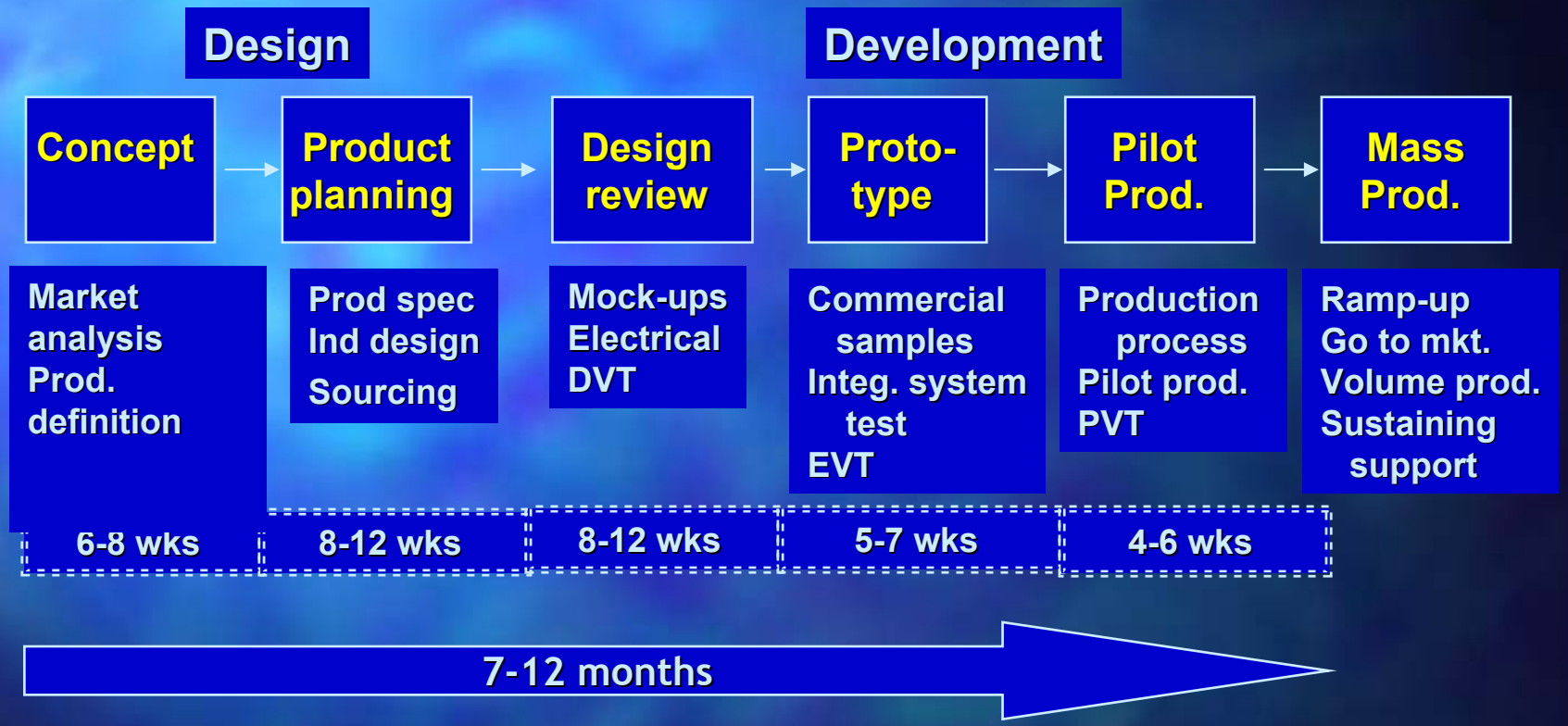
Notebook PC design & development

- Modularity
  - ✓ Distinct phases with defined outputs and gates.
  - ✓ Individual phases can be separated across organizational boundaries or by geography
- Complexity
  - ✓ Notebook design more demanding than desktop design. Size, heat, ruggedness and other features require technical capabilities.
- Form factor
  - ✓ Small, lightweight, high value make air logistics feasible. Quite different from desktops and servers.

Notebook development process



Outsourcing development

- Most PC makers rely on Taiwanese ODMs for product development.
  - ✓ Dell: Quanta, Compal, Wistron
  - ✓ HP/Compaq: Quanta, Inventec, Compal, Arima
  - ✓ Exceptions are IBM and Toshiba, who have internal design teams and only outsource low-end products
- ODMs have deep specialized knowledge of notebook design, test facilities and rich connections with component suppliers.
- PC makers retain control of major decisions.
  - ✓ Conceptual design, brand image, look and feel
  - ✓ Product management, marketing
  - ✓ Architecture, key technology choices

Coordination and management

- PC makers coordinate the entire process
  - ✓ Sign off at each gate after on-site meetings. Weekly calls, face-to-face when necessary
  - ✓ Dell and HP set up design centers in Taipei to work with ODMs
  - ✓ Less oversight needed as ODMs and PC makers work together over time and projects.
- Management across cultures
  - ✓ Taiwanese companies want to avoid conflict and look for alignment quickly.
  - ✓ Americans more comfortable with debate, conflict and negotiation. Trained in team environments.
  - ✓ Chinese have weaker analytical skills.

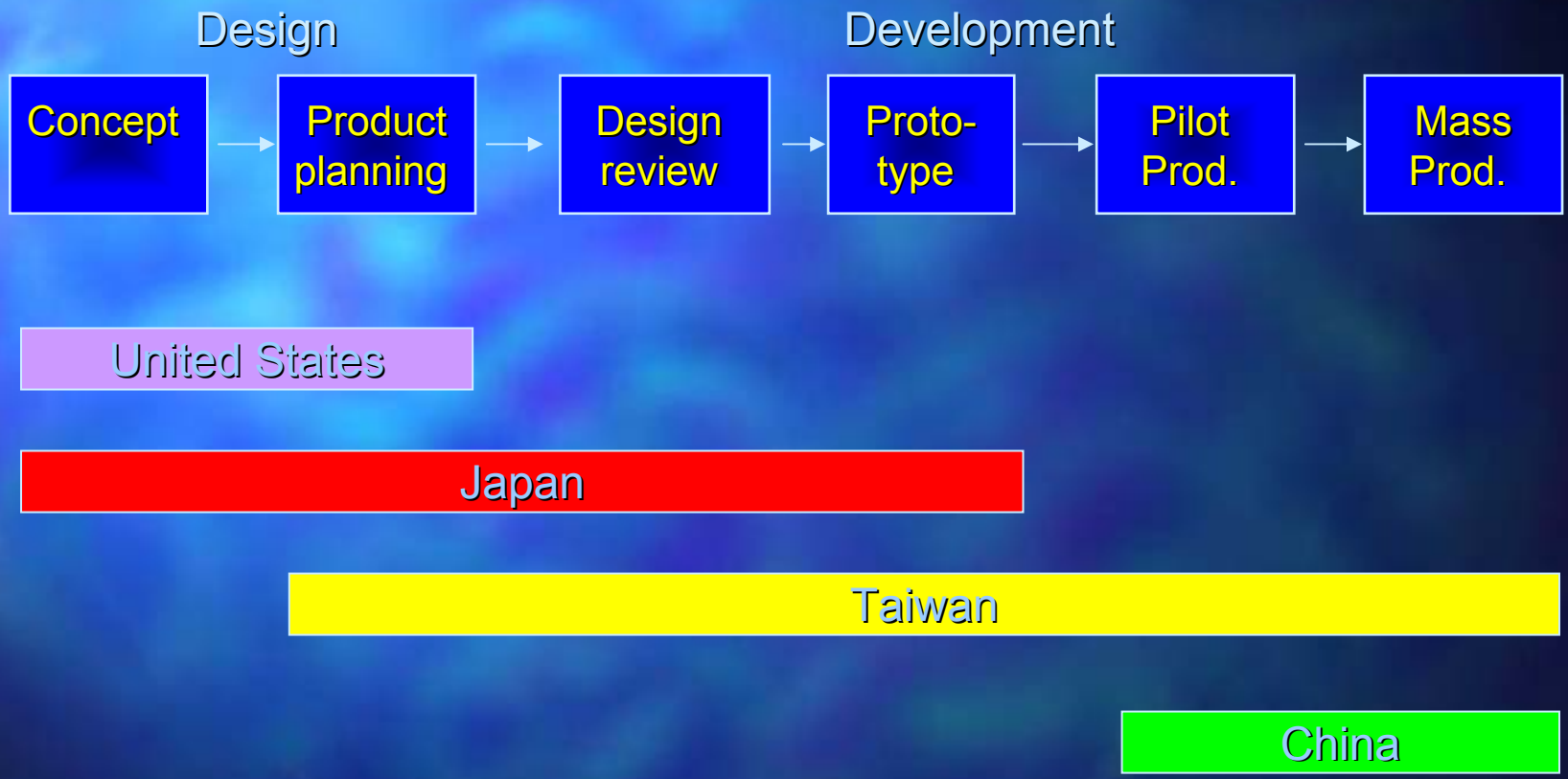
Use of information technologies

- **Communication**: E-mail, phone, fax, videoconferences, NetMeeting
- **Product management databases**: official record for product spec's, engineering change requests, product review meetings and decisions
- **Design tools**: Vendors and ODMS becoming aligned on tools for design, either using the same tools, or viewing capabilities for each others' tools

Skills and location of activities

- Concept design and product planning.
  - ✓ Requires knowledge of market and skill in translating market needs into product concepts
- Development
  - ✓ Requires specialized skills, e.g. thermal, EMI shock and vibration, power management, materials, radio frequency, software
- Production and sustaining support
  - ✓ Requires process engineering skills and proximity to production processes

Location of activities, 2003



China's capabilities

- Cost of engineers, including indirect costs
  - ✓U.S. or Japan: $120,000 per year or more
  - ✓China: $40,000 per year for MNCs, less for local or Taiwanese firms
- Weaknesses
  - ✓Lack hands-on experience, problem solving skills
  - ✓Rapid turnover
  - ✓Skill levels vary greatly

Location of activities, 2006

Trends and implications

- Notebooks becoming commoditized. Vendors losing ability to differentiate on design.
- Vendors unable to raise/hold prices.
- Cost control is driving outsourcing and shift to low-cost locations, especially China.
- ICTs (Internet, collaboration tools) making outsourcing easier.
- Production “pulling” some activities, e.g., post-production support and prototyping. No backflow yet.

Trends and Implications

- Specialized knowledge and strategic concerns will keep some knowledge work in the U.S., Japan and Taiwan.
- Overall, number of jobs is small (<20K).
  - ✓ High end concept/design jobs = 20%
  - ✓ Notebook market growing
- But, findings may apply to other knowledge work, e.g., design of other componentized, small form factor, high value products.