The growing complexity & pace of industrial technological change are forcing firms to forge new vertical & horizontal alliances & to seek greater flexibility & efficiency in responding to market changes.

This leads to more strategically directed integration and networking with external agencies.

Leading edge innovators are beginning to take the fifth-generation (5G) innovation process.

**The five generations of innovation:**

1. First generation (1950s - Mid-1960s): economic growth largely through rapid industrial expansion & new technological opportunities. The first generation, or technology push concept of innovation assumed that “more R&D in” resulted in “more successful new products out”.

2. Second-generation (Mid 1960s - Early-1970s): Manufacturing employment was static, while manufacturing productivity increased. Industrial concentration increased. New products were introduced, mainly based on existing technologies. Supply & demand were in balance. “market-pull” let large and highly efficient companies fight for market share.

3. Third-generation (Early 1970s - Mid-1980s): High rates of inflation and demand saturation (stagflation). Growing structural unemployment. Companies were forced to adopt strategies of consolidation & rationalization, with growing emphasis on scale & experience benefits. Successful innovation process on the basis of a portfolio of wide-ranging and systematic studies covering many sectors and countries (“coupling”, model of innovation)

4. Fourth-generation (Early 1980s-Early 1990s): Companies were initially concentrating on core businesses and core technologies. Growing awareness of the strategic importance of evolving generic technologies, with increased strategic emphasis on technological accumulation. New focus on manufacturing strategy. Rapid growth in the number of strategic alliances between companies. Shortening product life cycles led to time-based strategies. integration and parallel development was important (integrated model).
5. Fifth-generation (From mid-1990s): Companies remain committed to technological accumulation, strategic networking continues, speed to market remains of importance; firms are striving towards increasingly better integrated product and manufacturing strategies, greater flexibility and adaptability. “Fast innovation” is an important factor determining a company’s competitiveness. The ability to control product development speed can be seen as an important core competence. The process 5G is essentially a development of the 4G (parallel, integrated) processes in which the technology of technological change is itself changing.

For 5G 24 factors were identified involved in increasing development speed & efficiency:

1. An explicit time-based strategy.
2. Top management commitment and support.
3. Adequate preparation: mobilizing commitment and resources.
4. Efficiency at indirect development activities.
5. Adopting a horizontal management style with increased decision making at lower levels.
6. Committed and empowered product champions and project leaders.
7. High quality initial product specification (fewer unexpected changes).
8. Use of cross-functional teams during development & prototyping (concurrent engineering).
9. Commitment to across-the-board quality control.
10. Incremental development strategy.
11. Adopting a “carry-over” strategy (use inventions for multiple products).
12. Product design combining the old with the new.
14. Economy in technology.
15. Close linkages with primary suppliers.
16. Up-to-date component database.
17. Involving leading-edge users in design and development activities.
18. Accessing external know-how.
19. Use of computers for efficient intra-firm communication and data sharing.
20. Use of linked CAD systems along the production filière (supplier, manufacturer, users).
21. Use of fast prototyping techniques.
22. Use of simulation modelling in place of prototypes.
23. Creating technology demonstrators as an input to simulation.
24. Use of expert systems as a design aid.

The characteristics of 5G, in terms underlying strategic elements & primary enabling factors are:

1. Underlying strategy elements:
   • Time-based strategy (faster, more efficient product development).
   • Development focus on quality and other non-price factors.
   • Emphasis on corporate flexibility and responsiveness.
   • Customer focus at the forefront of strategy.
   • Strategic integration with primary suppliers.
   • Strategies for horizontal technological collaboration.
   • Electronic data processing strategies.
• Policy of total quality control.

(2) Primary enabling features:
• Greater overall organization and systems integration:
  – parallel and integrated (cross-functional) development process
  – early supplier involvement in product development
  – involvement of leading-edge users in product development
  – establishing horizontal technological collaboration where appropriate
• Flatter, more flexible organizational structures for rapid and effective decision making:
  – greater empowerment of managers at lower levels
  – empowered product champions/project leaders/shusas
• Fully developed internal data bases:
  – effective data sharing systems
  – product development metrics, computer-based heuristics, expert systems
  – electronically assisted product development using 3D-CAD systems and simulation modelling
  – CAD/CAE systems to enhance product development flexibility & product manufacturability
• Effective external data link:
  – co-development with suppliers using linked CAD systems
  – use of CAD at the customer interface
  – effective data links with R&D collaborators

5G innovation process, its main characteristics are:
• greater overall organizational and systems integration (including external networking);
• flatter and more flexible organizational structures, including devolved decision making;
• fully developed internal databases;
• electronically assisted product development;
• effective external electronic linkages;

In short, the key aspects of the process are:
• integration;
• flexibility;
• networking;
• parallel (real time) information processing.
Internal learning
- R&D and D - Learning by developing
- Learning by testing
- Learning by making - Production learning
- Learning by failing
- Learning by using in vertically integrated companies
- Cross-project learning

External or joint internal/external learning
- Learning from/with suppliers
- Learning from/with lead users
- Learning through horizontal partnerships
- Learning from/with the S&T infrastructure
- Learning from the literature
- Learning from competitors' actions
- Learning through reverse engineering
- Learning from acquisitions or new personnel
- Learning through customer-based prototype trials
- Learning through servicing/fault finding

Diagram:
- S&T Infrastructure
- Key suppliers
- Literature, including patents
- Strategic partnerships, marketing alliances, etc.
- Acquisitions and equity investments
- Competitors
- Leading edge customers