Nanotechnology

The Technology for the 21st Century

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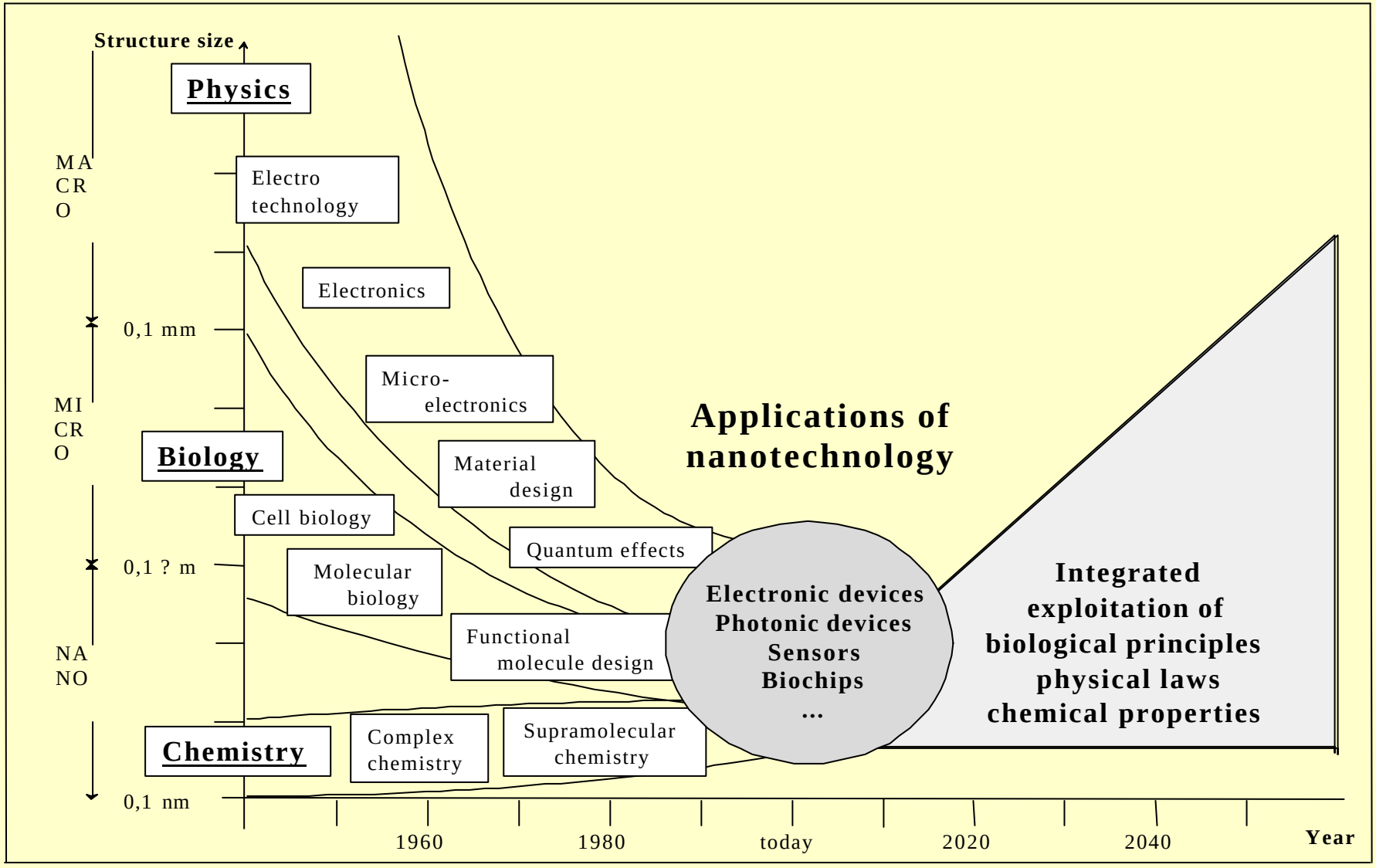
Origins of Nanotechnology

- Nanotechnology results from the convergence of the traditional fields of

  physics chemistry biology engineering

- concerned with the fabrication and use of devices at the nanometer scale
- 1 nanometer = 1 millionth of a meter
- considerable debate about boundaries

Nanotechnology is approached from three directions - (Bachmann 2002)

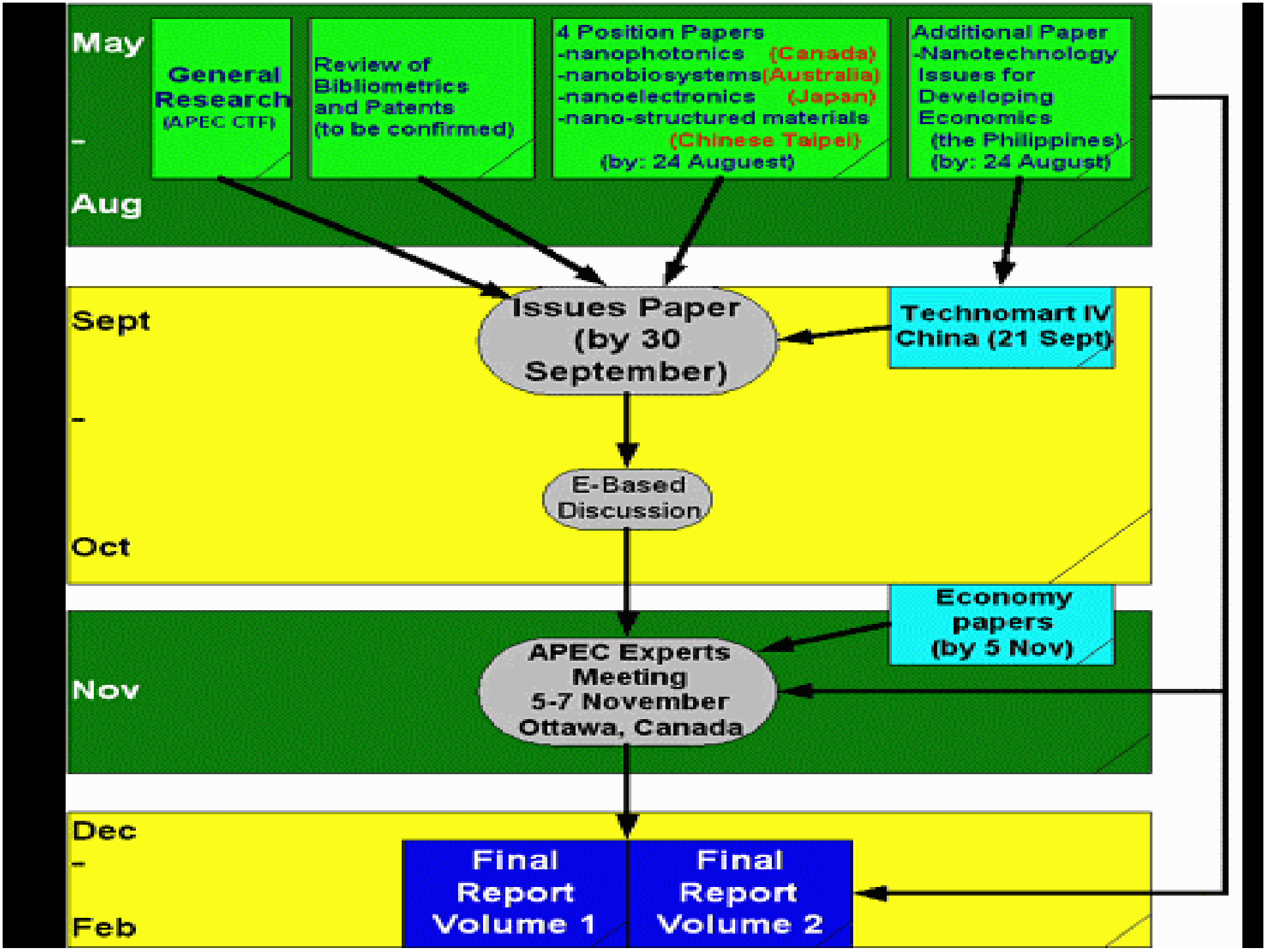


Definition of Nanotechnology

Materials and systems whose structures and components exhibit novel and significantly improved physical, chemical and biological properties, phenomena and processes due to their nanoscale size.

A crude division of areas contributing to nanotechnology

	Inorganic	**Organic**
Physics	• Mesoscopic physics • Lasers • Scanning electron microscopy • Electronics	Molecular electromics
Chemistry	• Inorganic chemistry • Aerosol science • Computer modelling	Supramolecular chemistry Physical chemistry
Biology	•	Biotechnology Medicine
	•	
	•	
Engineering	• Precision engineering • Materials science and engineering	


May
–
Aug
General Research (APEC CTF)
Review of Bibliometrics and Patents (to be confirmed)
4 Position Papers
-nanophotonics (Canada)
-nanobiosystems (Australia)
-nanoelectronics (Japan)
-nano-structured materials (Chinese Taipei)
(by: 24 Auguest)
Additional Paper
-Nanotechnology Issues for Developing Economics (the Philippines)
(by: 24 August)
Sept
–
Oct
Issues Paper (by 30 September)
Technomart IV China (21 Sept)
E-Based Discussion
Nov
Economy papers (by 5 Nov)
APEC Experts Meeting 5-7 November Ottawa, Canada
Dec
–
Feb
Final Report Volume 1
Final Report Volume 2

Opportunities for nanotechnology ….

…..can be divided into 3 main categories:

- molecular engineering inspired by biology
- electronic technology based on semi-conductors
- devices and processes based on new materials

Estimated timing of the realisation of some Technological Opportunities in Nanotechology, (from the APEC study)

In 3 years

- selective nano-biosensors
- specific drug delivery systems
- nanoelectronics based on miniaturised silicon devices
- novel devices based on magnetic spin electronics
- nanostructured materials as industrial catalysts
- self-cleaning surfaces on nanomaterials

In 10 years

- advanced medical diagnostics
- targetted human cells for organ repair
- single electron devices
- optical computing
- portable fuel cell and advanced battery
- artificial photosynthesis

Education and Training - critical needs

- People!
- New teaching approaches
- New academic structures
- Link between academic research and industry research
- Education for technicians and managers in industry

Government Expenditures on Nanotechnology R&D (US$ millions)

	1998	**1999**	**2000**	**2001**	**2002**
Europe	151	179	200	225	285
Japan	135	157	245	550	753
USA	190	255	270	422	518
Other	83	96	110	380	?
total	559	687	825	1577	?

Nanotechnology commercialisation

- Needs new approaches
- Needs venture capital
- Needs flexible strategies

Nanotechnology Measurement and Standards

- Vitally important for the development of nanotechnology
- Enormous challenges
- Need for particle size calibration standards
- Quantification of uncertainty of position

Societal and Ethical Implications

- Nanotechnology is a major transforming technology
- Need to learn from biotechnology and GMO debate
- Issues of equity

Scenario-based Futures

- Develop stories about possible and plausible futures
- Identify key drivers
- Identify critical uncertainties
- Use these to develop scenarios
- Examine implications for policy

Key Drivers for the Development of Nanotechnology (from the APEC study)

Society

- ageing population
- enhanced quality of life
- more effective health care

Technology

- scientific breakthroughs
- need for miniaturisation in production
- demands of ICT industry

Economics

- Novel / unique products to stimulate industry
- investment in high technology
- rise of knowledge society

Environment

- clean and leaner production processes
- improved air and water quality
- new energy sources

Policies

- National security issues
- Changing patterns of S&T expenditure
- public perception of technological change

Critical Uncertainties for the Development of Nanotechnology
(from APEC study)

Technical Uncertainties

Nanotechnology fails to deliver
Inability to solve standards issues
Breakthroughs in current technical paradigms

Environmental / Economic Uncertainties

Major financial crisis
Kyoto protocol ratified by all economies
Major disruption of energy supplies

Public / Societal Uncertainties

Lack of public acceptance of nanotechnology
Major nanotech-facilitated advances in human health
Terrorism and national security

Global **Uncertainties**

World War III
Epidemic

3 scenarios for 2015.

- Nano-paradox - things are more the same today than they have ever been;
- Green energy triggers collapse of energy markets
- Nanotech wins the war

All describe futures where intensive R&D enables significant advances in health care and in energy systems, but in the first one society rejects nanotechnology, while the in the second and third, society accepts nanotechnology

Range of Possible Future Developments and Effects of Nanotechnology