# Engineers and Society

**PART 1**

**Lecture 1: History of Engineering**

What is Technology?

Technology is a form of human cultural activity (solving problems) for practical ends (meeting real world needs) & purposes. It involves forming & transforming the material world through ideas & thoughts. It typically done with the aid of tools & procedures.

**Timeline**

1. Early Technologies: Stone age: Technological actions such as making tools of wood and stone to survive. Example, cutting tools, grinding stones, weapons, fire, clothing, utensils.
2. Turning Point -> Agrarian Society: Fertile river valleys, domesticated animals. To accommodate this new lifestyle: Sledge for crop transport, balance beam, wheel, water resources.
3. Egyptians: Mesopotamians built with brick and Egyptians built using stone
4. Classical Antiquity -> Greeks: Built on Egyptian tech, but didn’t develop the practical crafting but the philosophical, rational and scientific.
5. Rise of the Roman Empire: Inherited Greek philosophy and math but went more engineering than abstract science. Example, Road systems for military, hydraulics
6. Fall of Roman Empire: Technologically stagnant, slaves made them avoid labour-saving technology, driven by imperial endeavours of war.
7. Post Roman Development: Chaos, population expansion -> New agricultural tech. Feudalism (kings gave land grants and nobles hired serfs) -> Primitive accumulation of capital(serfs) i.e. rise of middle class -> fall of political sovereignty -> Free cities!
8. Craft Based Tech: Medieval craft guilds, Commodity production, labour saving techs made
9. Major European Social Changes: Bubonic plague -> labour shortage. Town merchants backed monarchs shifting power from feudalism. Monarchy created: Better military, printing, standing armies, taxes, laws, unified markets, merchant capitalism
10. Preamble to Renaissance: Rediscovery of Greek and Roman tech, America! Humanist perspectives, Law/Med schools open.
11. Scientific Revolution: 16th century end, Galileo revolves around sun, Inductive & Deductive approach, Separated science from religion. 17th Century and capitalism -> practical orientation of knowledge, knowledge widespread and controls nature even, Newton’s laws
12. Exploration and Empire Building: Spain, Portugal then Netherlands then Britain. Conquered and traded and colonised with their tech.
13. Capital Accumulation & Agricultural Revolution: Monarchs granted monopolies. 1624 – Fuck royalty says UK, land holding abolished. AR due to farming scientifically wilding for expanding markets.
14. Industrial Revolution – Merchants do commodity production, capitalism forms new social class, want to trade and invest freely so support individual freedom, plunder and exploit colonies. Take off: Anti-monopoly legislations weakened guilds, smelt iron, division of labour, things are replaced by machinery => Modern industrial production
15. The Machine Age: Profusion of machines, machine minders, employment, population growth further fuelling industrial revolution i.e. market expansion
16. Steam Power, early 17th century: Mr. Watt improved efficiency => mech engineering. Railway Age: First steam engine locomotive, wrought iron rails, opened markets. Railroads helped colonisation.
17. Peak UK: 1851
18. US Challenge: Knowledge as a commodity, utilitarian mindset, inventive, less dependence on labour, machine shop techniques e.g. grinding, milling. Highly standardized products of interchangeable parts. More military equipment, America railroads expanded. Then, American Civil War (1861-1865), then, more railroads.
19. Britain’s Loss of Industrial Leadership: Aristocracy -> capitalism caused industrialisation to accommodate to existing social structure, in the sense its values were resisted by the ruling elite. It undervalued commercial application, discouraged standardization, steam engine to dominant.
20. Spread of Industrialisation: France & Germany: internal combustion machine; US: mass production, more industries, same, innovative machine tools and parts used over all industries.
21. 1860-1900: Manufacturing replaced agriculture, products produced for producers instead of consumers, heavy industry grew, price of raw materials fell = new demands & tech changes.
22. In Germany, Bismarck was wild about industrialisation. Opened internal market by building national railway. Expand foreign trade, promoted industrialization education, industrial research labs, surpassed Britain.
23. Engineering education and Rise of the profession: Post 1850 UK but other countries got there with science-based education for technologists. Networking was imp to exchange ideas, experience.
24. Early leader: 1771, Smeatonian Society of civil engineers, ICE – 1818. 1928 It obtained royal charter for ICE.
25. 1676: French Corps of Engineers, 1747: Ecole Nationale des Ponts st Chaussees, 1794: Ecole Polytechnique.
26. 1802: US Military Academy, 1823: Rensselaer Polytechnic Institute
27. 1809: Germany Berlin University, 1825: polytechnic
28. Japan: Meiji restoration dismantled feudals, set up Imperial college of engineering 1873. By 1912 there were 4 engineering unis. Military training centres were imp too.
29. The history of the engineering profession reflected the transformation wrought by technological changes. In 17th and 18th century civil and military engineering split, by 18/19th century mechanical engineering was important. Over time specialisation added, science and engineering interacted more. Previously scientists only explained what engineers did, now they helped, leading to large scale R&D.
30. 1851: Crystal Palace exhibition 1869: Railroads 1876-78: Electricity 1900 Radio 1903: Biplane 1913: Ford moving assembly line 1926: TV 1942: Computer 1957: Space travel 1996: Cloning

**Lecture 2: Engineering Ethics**

Engineering is a profession and that implies it involves providing a service (to improve life) with the specialised education you possess. Thus, to do so, they warrant special privileges and trust from the public. A professional engineer acts in a morally responsible way while practicing engineering, otherwise there are serious consequences e.g. Chernobyl, Plane crashes.

Ethical responsibilities are placed on engineers because they provide services or make judgments that are not easily understood by the general public (because of their high technical nature). Furthermore, the results of their work impact society as a whole.

So, we must reflect constantly on the products and processes that we make.

Engineering ethics has **two** types: Social Responsibility requires taking into consideration the needs of society & Professional responsibility (duties and obligations on us individually).

**Interactions Rules of Behaviour**:

1. Etiquette: Acceptable social behaviour, hurts professionalism
2. Law: Rules and rights to maintain safe/orderly social environment, has penalties.
3. Morality: Personal rules of right and wrong, making choices with reasons
4. Ethics: Code defining moral behaviour for a particular society (e.g. engineering). Also the study of morality of human actions i.e. how choices are made. Requires strength of character and are usually written.

**Ethics vs Law** -> Actions can be both, neither or either.

A recurring ethical dilemma: Engineering commitment to safety vs other management factors. Dilemmas rarely have definitive answers, so we adopt standards set by Singapore Professional Engineers Boards & USA NSPE

**Professional Engineers Rules**: Code of Professional Conduct and Ethics A set of rules relating to the code of professional conduct and ethics that applies to a registered professional engineer, licensed corporation or partnership. You must register to engage or supply PE services

**Professional Engineers Act:** An Act to establish the Professional Engineers Board, to provide for the registration of professional engineers, to regulate the qualifications and conduct of PE and to regulate corporations, partnerships limited liability (pll.) which supply professional engineering services.

**Key Areas**

¬ Establishment of the PE Board

¬ Registration of professional engineers

¬ Licensing of corporations, partnerships, limited liability partnerships (LLP)

¬ Regulating conduct of professional engineers

**Register with PEB**

1. Qualification Hold an approved degree or qualification
2. Experience 4 Years of relevant practical experience
3. Examinations: a. Fundamentals of Engineering Exam (FEE): Tests knowledge

b. Professional Practice Exams (PPE): Apply knowledge in practice + knowledge of rules and regulations

1. Interview

**USA NSPE: USA National Society of PE**

Fundamental principles:

1. Hold paramount the safety, health and welfare of public -> **Paramountcy Principle**, most imp
2. Perform services **in area of competency** (ensure you are qualified for the task at hand, communicate clearly expected outcomes of assignments, call for consult if needed)
3. Issue public statement in an objective and truthful manner: honest and realistic in stating claims or estimates.
4. Act for employer or client as a faithful agent and trustees: disclose conflicts of interest, reject bribes, compensation from 1 source per project.
5. Avoid deceptive acts: E.g. falsify or misrepresent qualifications, don’t bribe to secure work for anyone.
6. Conduct themselves honourably, responsibly, ethically and lawfully to enhance the honour, reputation and usefulness of the profession.

The code is to protect each professional from certain pressures from clients, employers or their own self-interest. Ford Pinto gas tank was hit, exploded, 3 died, gas tank design was flawed. Federal Safety standards approved but not engineering standards.

Note: Professional Engineer (PE) should therefore not sign documents such as specifications, reports etc unless he has actually prepared them, or they are prepared under his direct supervision.

**Whistle blowing**: the act of one who, believing that the public interest overrides the interest of the organization he serves, publicly “blows the whistle” if the organization is involved in corrupt, illegal, fraudulent, or harmful activity. Always the LAST RESORT.

Causes –

* Incompetence
* Criminal behaviour
* Unethical policies
* Threat to Public safety/environment
* Injustice to workers

Types of Whistle Blowing

* Internal: Blows to people within organisation:
* External: blows outside org media, other authorities: But before you do: ensure harm is serious, concerns are known to superiors, exhausted all internal channels, have documented evidence

**BIG picture**:

* Codes of ethics are not a law so ethical behaviour is not always protected by law
* Frequently ethical behaviour may be perceived as disloyalty
* Many companies realize that ethical behaviour is essential for their long-term prosperity
* Ethically-aware companies providing help to employees facing ethical conflicts
* Allow employees to raise ethical concerns anonymously
* Explicitly prevent any forms of retaliation for reporting unethical behaviour

**Lecture 3: Case Studies in Engineering Ethics**

Morality is about the action we need to do or to avoid, the rules to follow in order to do right by other people, whereas ethics is what we need to do in order to flourish ourselves.

**The Socratic Method** is a form of cooperative argumentative dialogue between individuals, based on asking and answering questions to stimulate critical thinking and underlying presumptions. He believed human choice was always motivated by an inner desire for happiness. An engineer can use the Socratic method to analyse a situation to derive ethical judgement based on the inner self. Believe in expert advice not opinions of the many. Public opinion is of no matter only if it is just or unjust to escape.

The Socratic Method works to clarify a person's own beliefs by:

• Evaluating their worth • Clarifying the concepts of good and justice.

“A person can find the answer to any problem by breaking it down into a series of questions and then finding the answers.”

**CASE A: The Disaster at Bhopal**

December 2, 1984 a leak developed in a storage tank at a Union Carbide chemical plant in Bhopal, India. • Tank contained 10,000 gallons of MIC (methyl isocyanide). • The leak sent a toxic cloud of gas over the surrounding slums of Bhopal, hurting more than 210,000.

**Causes**

The leak was attributed to the leakage of water (valve not properly closed) into the MIC storage tank during maintenance. Water reacts very vigorously with MIC, causing heating of the liquid. • Mixing of water with MIC increased the temperature of the liquid in the tank to 4000F causing MIC to vaporize, leading to a build-up of high pressure within the tank. • When internal pressure became high enough, a pressure-relief valve opened, leaking MIC vapored into the air.

1. The MIC storage tank had a refrigeration unit on it, which should have helped to keep the tank temperatures closer to normal. However, this had stopped working five months before the accident and hadn’t yet been repaired. -> Cost saving

2. The tank was equipped with a alarm that should have alerted plant workers to the dangerous temperatures: this alarm was improperly set, so no warning was given. -> Irresponsibility

3. The plant was equipped with a flare tower, which was designed to burn vapours before they enter atmosphere, and would have been able to reduce, if not eliminate, the amount of damage. The flare was not functioning. -> Cost saving

4. Finally, a scrubber that was used to neutralize toxic vapours was not activated until the vapour release was already in progress. -> Small scale accident design, not automatic so cost saving

Management, maintenance, Indian government (should evacuate) and Union Carbide (mostly) are at fault.

**CASE B: The Challenger Disaster**

January 28, 1986, seven astronauts were killed while piloting the Challenger space shuttle. - Challenger exploded seconds after take-off due to failure of rocket booster O-rings. A key aspect of the booster design are the joints where the individual cylinders come together.

The joints are sealed by two O-rings. The O-rings which are made from synthetic rubber are designed to prevent hot gases from the combustion of the solid propellant from escaping.

**Causes:**

Failure of O-ring due to several factors, faulty design, lack of testing in low temperatures, etc.

Due to pressure from Congress hurrying things since European Space Agency was making cheaper version. Also, weather too cold. Engineers spoke up but management overrode them. NASA engineers did not know that the final Morton Thiokol “Launch” decision was not unanimous. (Communication issue)

Apply creative solutions when can: Example, fix O rings on time.

**Lecture 4: Engineering Practice in Singapore Workplace Safety and Health**

MOM and Workplace Safety and Health Advisory Committee (WSHAC) employers, self-employed persons and principals (including contractors and sub-contractors) are (**personally) responsible** for identifying safety and health hazards at workplaces and to take appropriate actions to eliminate or reduce the risks associated with the hazards.

The **Workplace Safety and Health Act** replaces the Factories Act from 1 March 2006. Key changes include:

1. It specifies liabilities for a range of persons at the workplace instead of focusing on the occupier.
2. It focuses on effective management of workplace safety and health to achieve a safe outcome instead of prescribing rules
3. It stipulates greater penalties for compromising safety and health.

In general, WSHA defines: Responsibilities of stakeholders, Which substances are hazardous, Machinery and equipment

The 3 principle of the new framework of WSHA are:

1. Reducing risk at source by requiring all stakeholders to minimise or eliminate risks which they create.
2. Instilling greater industry ownership of OSH standards. The focus will be shifted from complying with the prescriptive requirements to making employers responsible for developing work and safety procedures suited to their particular situations. => Proactive Planning to Achieve a Safe Workplace
3. Preventing accidents through higher penalties for poor safety and health management.

=> Aim: This places responsibility on stakeholders. Focuses on outcomes rather than compliance. Facilitates enforcement through remedial orders.

**Stakeholders**

* Employer – protect safety
* Principal – engages another to supply labour
* Occupier: Has control of premises regardless of ownership, has cert of registration
* Manufacturer/ Supplier: Equipment safe
* Employees and Self-employed people

To ensure the Act works we must handle certain critical areas

A.) To ensure Effective Governance and Enforcement

* Delivering Practical Assistance: Set preferred work practices using Approved code of practice (ACOP), Provide guidelines and non-tech advice, Technical advisories
* Robust Inspection Framework: ensure basic safety standards are not compromised

B.) To Create a progressive and pervasive WSH Culture

* Exemplary: Internalise as a non-negotiable value > Progressive: Stakeholders motivated to progress ownership and promote WSH at all levels > Proactive: Pre-emptive address of WSH is routine and self-sustaining > Participative: Stakeholder participations and engagement > Reactive: Top down management and direction
* Posters and PM speeches
* Elevating WSH awareness in new sectors: Face to face outreach: guerrilla style awareness building and performances in company events

C.) To embrace new challenges in Safety and Health

* WSH Institute
* MOM/WSH Council should make informed policies
* Businesses be equipped with solutions and info to address issues faced
* Leaders and WSH Pros: Be effective in managing and influencing safety and health aspects

Better Defined Liability Regime to Reduce Risks at Source

Factories Act imposed liability primarily on the registered factory occupier. The WSHA assigns legal responsibility to those who create and have management and control over safety and health risks (Occupier / Employer / Principal / Employee / Manufacturer & Supplier / Erectors & Installer).

Legal Requirement WSHA: It requires every person at the workplace to take “**reasonably practicable**” steps to ensure the safety and health of every workplace and worker i.e. when it is capable of being done. Balance the measures versus the risk (severity of injury, likelihood, what is known, how to safeguard). Be in the safety margin of the Protection versus Production.

Definitions:

* Safety: A state of being away from physical harm
* Risk: A possibility that something unpleasant or undesirable might happen
* Hazard: Something which could be dangerous to you, your health or safety, or your plans or reputation
* Threat: Something or someone that may harm a person, thing, organisation or system
* Possibility - Something that might be true or might happen
* Probability - A mathematical measurement of how likely that an event will happen, expressed in a ratio

**Hazard Identification and Risk Assessment**

Risk assessment is divided into 3 –

* Risk determination the probability of occurrence of risky events and the likely consequences
* Risk evaluation may be further divided into risk avoidance and risk outcome
* Risk measurement usually involving complex quantitative measures of risk.

Risk Categories

1. Identified risk: That risk that has been determined to exist using analytical tools. The time and costs of analysis efforts, the quality of the risk management program, and the state of the technology involved affect the amount of risk that can be identified.
2. Unidentified risk: That risk that has not yet been identified. Some risks are not identifiable or measurable, but are no less important. Mishap investigations may reveal some previously unidentified risks.
3. Total risk: The sum of identified and unidentified risks. Ideally, identified risks will comprise the larger proportion of the two.
4. Acceptable risk: The part of identified risk that is allowed to persist after controls are applied. Risk can be determined acceptable when further efforts to reduce it would cause degradation of the probability of success of the operation
5. Unacceptable risk: That portion of identified risk that cannot be tolerated but must be either eliminated or controlled.
6. Residual risk: The portion of total risk that remains after management efforts have been employed. Residual risk comprises acceptable risk and unidentified risk.

Hidden risks: Examples in order of difficulty:

**Equipment failures < External Conditions < Human Errors < Organisational Factor**

Organisational Factors: Staff Morale, Inadequate manpower, insufficient training, unsafe industrial culture, reporting culture, admin policy – Just culture, Succession Planning. It should instead encourage, and reward providing safety, learn from unsafe acts and share it, trusting atmosphere.

Benefits: Less mishaps/injuries, increase in efficiency & effectiveness, reduces reliance on intuition for risk management as it provides a reasoned a repeatable process.

Acceptability of risk: Risk management costs > benefits, opposite of unnecessary risk. Determining this has high uncertainty.

Types of Societal Risk

* Real risk to an individual: Determined on basis of future circumstances
* Statistical Risk: Meant for other people
* Predicted Risk: For models
* Perceived Risk: Intuitively felt by individuals

Voluntary Risks – Known or assumed exposure probabilities vs Involuntary Risks

Safety Risk Components –

1. Hazard identification
2. Risk assessment and mitigation: Assess potential harm using 3 considerations then eliminate/mitigate

* Probability: of it causing adverse effects
* Severity: of effects
* Exposure: rate of exposure

1. Internal Safety Investigation

Principle of Risk Management: The eradication or minimisation of the adverse effects of risks to which an organisation is exposed.

Take 5 = Stop and LOOK, think through the task, Identify hazards, Control +communicate, DO safely

**Stages of Risk Management**

1. Identifying Hazards: Most important: Equipment, Procedures, Agents, People, Environment. Analyse each step.

2. Assessing their implications: what adverse conditions may arise. E.g.: Admitted in hospital, glassware breaking

3. (Manage it) Deciding on a course of action: Control, monitor, communicate risks

4. Evaluating the results: Categories (Risk points)

* Severity: Minor (1), Moderate (long-term reversible) (2), Major (3)
* Likelihood: Remote (1), Possible (1/year) (2), Frequent (3)
* <3: no additional changes / 3 – 4: Review but keep working, Supervisory oversight, interim control measures, low priority changes / >4: Stop working, eliminate, substitute and engineer controls

Risk Assessment: account for the probability and severity of any adverse consequences of risk. Use **risk matrix**. Risk Mitigation should start as low as reasonably practicable. Must be balanced against the **time, cost and difficulty** of taking risk mitigation measures. The level of risk can be lowered by reducing the **severity** of the potential consequences, reducing the **probability** of occurrence or by **reducing exposure** to that risk.

**Hierarchy of Control Measures:**

**Eliminate and Substitute >> Engineering Controls** (Installing another machine guarding or enclosing the dangerous machine: Focus on source and consist on substitution, isolation, ventilation, equipment modification) **>> Admin Measure** (work habits to reduce exposure, sanitation) **>> Personal Protecc Equipment, Safe work Procedures**

**Additional Controls**

For Mid and High risks: Responsible person to implement identified measures + Timeline to complete and update risk assessment

**2 Trilogies**

Safety Interventions: Safety management system: culture changes, take time, Behaviours, Engineering Controls: Change equipment

Safety Culture: Safety Attitude, Human Factors and Error Management Skills, Discipline

**SAFETY MANAGEMENT SYSTEM INTERVENTION:** 7 Key Areas

1. Management leadership

• vision, values, commitment

• safety goals & objectives

• costs of safety performance

1. Responsibility & accountability

• defined for management & employees

• accountable for performance

1. Safety organization

• safety committees

• safety staff resource

• safety budget

1. Safe work practices & procedures

• general & job specific

• housekeeping

• contractors

• Emergency

1. Safety review & improvement

• a Plan / Do / Check / Act process

• accident investigation process

• safety audit / inspection process

1. Safety training

• Based on needs assessments

• Designed & presented effectively

• For both management & employees

• Results in observable changes in behaviour on the job

1. Safety communications

• Internal & external

• Appropriate for audience

• Effectiveness of communication methods

* “A thing is safe if, were its risks fully known, those risks would be judged acceptable by reasonable persons in light of their settled value principles.”

**Lecture 5: Sustainable Issues: Mental Model & Systems Thinking and Human Factors**

Solving Sustainability Issues:

**Causes -> Problems -> Symptoms** (only these are visible)

We cannot expect to be able to resolve any complex problem from within the same manner of thinking that created it in the first place. We must target causes not symptoms, solve on a higher level. Due to these barricades in thinking we require Higher Order Thinking and use mental models.

**Mental Model: Ladder of Inference**

**Data/Facts => Observation** (Collect that information) **=> Beliefs** (Selective with Data) **=> Prior Experience** (Selective with Data) **=> Existing Assumptions** (Understanding what it means based on these then making or testing assumptions) **=> Conclusions** (deciding what to do and why)

Sometimes, we act on our pre-existing beliefs which made lead to us ignoring the truth and skipping steps. To avoid this tracing back down the other. We can make out thoughts visible to others or invite others to test our assumptions. We can ask open non-judgmental questions and explore impasses.

Mental Models: It is an explanation of the thinking process. In general, they go like, Actions create results which create thoughts further influencing out actions. Our thoughts affect our results, so our mindset is very important.

**The Fifth Discipline**: Used for Positive Thinking. Components of learning Organisations. How to make a company a learning organisation. 5 components –

Personal Mastery: It is the personal need to learn and the generation of sustainable creative tension. Personal mastery is a discipline of continually clarifying and deepening our personal vision, of focusing our energies, of developing patience, and of seeing reality objectively.

Shared Vision: having shared goals in an organisation that foster genuine commitment and enrolment rather than compliance.

Team Learning: collaborating as a focused group to learn together and develop group intelligence and ability greater than the sum of individual ones.

Mental Model: Awareness of our own biases and assumptions, be more honest and accurate in identifying underlying issues. These determine what we see and what we don’t, and thus our actions. Mental models are deeply ingrained assumptions, generalizations or even pictures or images that influence how we understand the world and take action.

System Thinking: Integrate the other 4, example: Everything one thinking I am engineer but I am good at humanities

Through learning we can recreate ourselves and our relationship to the world, do things we couldn’t and extend our capacity to create.

A difference between reality and vision creates creative tension. To breach the gap we need policies, processes and organisation, which require values and mental models to work effectively.

**Iceberg Mental Model used by Systems Thinkers**:

**Event level** (tip): An occurrence at a moment in time. Solutions which address these are short-lived, be must instead anticipate and shape events. They are crises & tasks, symptoms level, only what is visible then we can only **React**/ Firefighting

**Trends/Patterns:** Changes in events over time, help understand the underlying systemic structure of inter-related events. These create those events -> **Respond**/Anticipate

**Structure/ Behaviours** which created those trends. The way system components are interrelated -> **Design** (Creative and can influence the future)

**Mental Models**/Worldview which are the root cause -> **Transform**

**Seven Thinking Skills of a Systems Thinker** by Barry Richmond

Systems Thinking skill vs Dynamic Thinking

1. **Dynamic Thinking**: Focusing on patterns of behaviour (trends) over time vs **Static Thinking**: Focusing on specific events
2. **System-as-Cause Thinking** – Choosing to focus on the system within the organization’s control as responsible for performance issues vs **System-as-Effect Thinking** – Choosing to focus on forces outside the organization’s control as generating the performance issues (creating “victimitis”)
3. **Forest Thinking (big picture)** vs **Tree-by-tree** Thinking
4. **Operational Thinking** – Looking for causality (How is this behavior generated?) vs **Factors Thinking** – Developing a list of factors associated/correlated with the behavior
5. **Closed-loop (Feedback) Thinking** – Understanding the feedback and ongoing process responsible for behavior vs **Straight-line Thinking** – Believing causality is a one-way, linear relationship
6. **Qualitative Thinking** – Understanding how to represent non-physical, immeasurable variables in analysis vs **Quantitative Thinking** – Including only those variables believed measurable
7. **Scientific Thinking** – Building the most useful, entertainable theory of causality vs **Proving** **Truth Thinking** – Looking for “The Answer”

**State transition: The Blame Game**

From ‘Injured’ don’t go to ‘Blaming’ but to ‘Causes known’ through careful analysis, then through corrective action to ‘Loss Mitigated’ and finally preventive action to ‘OK’. Blaming to Causes Unknown is okay too just don’t go in the Vengeful cycle.

Shifting the Burden: When the underlying problem is obscure or costly to confront, people shift their burdens.

Murphy’s Law: If something can go wrong it will. To err is human. Humans do, however, occasionally mismanage task and/or situational factors and fail in balancing the compromise (between production and safety goals), thus contributing to safety breakdown

**James Reason’s Swiss Cheese Model of Accident Causation**

• The Swiss Cheese model of accident investigation is based on the premise that an accident is not caused by a single error or event.

• There is usually a series of errors which managed to break through the defences in an organization, i.e. holes in safety barriers.

• These defences **include Regulations, Design and Manufacture Processes, SOP, Training and finally the Operator** (see diagram in next page)

**Human Factors**: study of human capabilities and limitations in the workplace.

Managing Human Factors: Error management and HRM, optimising human and system relationship to improve safety, quality and efficiency

Why focus on Human Factors?

* Enhance **awareness** so we improve safety
* Acquire human factors skills like **communication**
* Makes a positive impact on **safety** and efficiency of maintenance operation

Attributes of Human Factors • Human **physiology** Mechanical, physical and biochemical functions of humans in good health **• Anthropometrics** The scientific study of measurements of the human body • **Psychology** Perception, cognition, memory, social interaction, error **• Work place design** • **Environmental conditions • Human-machine interface**

Psychology

* Input characteristics: Sensory organs can degrade
* Information Processing: Poor manuals, instrumentation and warning system design exist because people overestimate human info proc abilities
* Short and long-term memories

Human Error: planned activity fails to achieve its intended outcome, and when these failures cannot be attributed to the intervention of some chance agency

**Sources of Error**

A **mismatch of software, hardware, environment and liveware** can be a source of human error.

Error Chain: Error gets carried forward unless someone spots it.

**Types of error**

* 1. **Slips**: actions not carried out as intended or planned. Focusing on something so much you miss something else
  2. **Lapses**: missed actions and omissions, e.g. memory failures
  3. **Mistakes**: brought about by a faulty plan/intention, person did what they intended but goal/plan was wrong

Violations are not errors as they are deliberate illegal actions. By distinguishing errors from violations, companies can develop a “Just Culture” to assign appropriate culpability to employee & management.

**Lecture 6: Contribution of Engineers in the New Economy**

**Challenges faced:**

* Increase speed/efficiency in problem solving ◦ Computer/Info-Comm Engineering
* Use of resources ◦ Materials/Nano Engineering
* Clean potable water ◦ Environmental Engineering
* Alternative sources of Renewable Energy ◦ Solar Engineering and Clean Technology
* Healthcare ◦ Life Science/Biomedical Engineering
* Underground space (Singapore context) ◦ Civil Engineering

**Overcoming Challenges**

We need: Innovative Solutions, technologies, scientists/engineers

Contributions by Engineers to SG

Economy ◦ Create jobs to boost economy such as in aerospace, precision engineering and many others; } Diplomacy and Deterrence ◦ Develop integrated solutions to strength the Singapore Armed Forces (SAF); } Social and others ◦ Build houses and MRT system to improve lives

Due to historical reasons SG was in an economic debacle but it became an economic miracles through hard work, bold leadership, determinations and promotion and development of technical education on all levels for the industrialisation of SG.

Economic Development Strategies

Take off Phase (1965-84) Export led industrialisation: economic fundamentals of prudent public finances, sound monetary policies, co-operative industrial relations, outward orientation, and marketbased strategies took root.

Economy grew by 10% annually and became export led not import substitution to attract MNCs

Transition from 3 rd World to 1 st World Phase 1985 to 2010: Resource constraints and diminishing returns to investment began to set in and the cost advantage that Singapore enjoyed began to narrow. In response, SG liberalised and rise of modern services: enhanced wage flexibility, focus on regional markets, increase pace of industrial upgrade, promote innovation, enterprise & entrepreneurship, liberalize finance, telecom, utilities.

Transition towards productivity-led growth Phase 2011 to 2025:

Demographic slowdown; need to overcome resource constraints through restructuring of the economy, GDP drop to 3.6% yearly. By 2025, the economy had matured, with productivity growth accounting for virtually all of economic growth.

Regional integration and offshore economy Phase 2026 to 2040:

Singapore’s high-end manufacturing and modern services benefitted significantly from trade and investment links with these Asian giants, US and the North Euro Area; Iskandar-Singapore Economic Zone (ISEZ) in 2028; ASEAN Free Economic Zone (AFEZ) in 2020.

Climate change mitigation and adaptation Phase 2040 to 2065:

Adapting to climate change thus became as important a consideration as mitigating it; carbon tax By 2055, the green industry emerged as the largest contributor to GNI

**Importance of research**, innovation and tech dev for survival

* Sustains **economic growth** by rooting high value-added activities in economy
* Gives **stronger manufacturing** capabilities
* Help **upgrade** and restructure existing industries. This enables SG to be a competitive hub//allows shift from low-added assembly activities to high tech stuff//Makes attractive to MNCs//More competition for SMEs
* Preposition and grant **comparative advantage** for new emerging clusters
* Help **maintain prominent, strong industries** and business clusters which serve as anchors

**4 Main Challenges** against accelerated R&D

* **Industries able to afford it** themselves/ Make conducive for industry to undertake it

Government actions: co-investment through grants, manpower-related grants, fostering it in universities, promoting innovative culture, establish network of international linkages for collaborative R&D

* **Need to Strengthen technological capability**

Government Actions: Strategic development and funding of 15 Research Institutes and Centres in 5 broad categories, University and Industry R&D grants, Tech acquisition, Tech sourcing through joint ventures/licensing/manufacturing, Tech Capability Planning

* Fostering innovation and commercialization: **Need to translate tech to money**

Integrated centres for both, Tech start-ups, Environment for high-tech industries and start-ups to flourish

* Meeting the demand for **manpower**: SG is small but wants to do a lot

**Solutions to Manpower Needs**

Multi-pronged approach –

1. **Grooming local R&D Manpower**: Raise profile of RSE (Research scientists and engineers). Primary education: Interest in science Secondary: do hard sciences and engineering Tertiary: encourage more with talent searches and scholarship Post Grad: Promote challenge and attractiveness of R&D careers, raise social recognition, upgrade and train RSEs
2. Reliance on **Foreign Talents**: Provide scholarships for post-grad, Attractive terms and conditions for RSEs, Special programme to attract experienced research professors
3. **Internationalization**: Draw on strengths of other countries and collaborate. What govt do: Set up overseas R&D programmes/centres to augment Singapore’s limited resource and talent base ◦ Encourage prominent overseas R&D centres and universities to set up branches/linkages in Singapore

**Population and Economy**

1. SG is located in a fast growing region: More economic opportunities but more competition. So need to grow at sustainable rate and stay competitive
2. Workforce will become old, shrink and be more educated: job aspirations will shift, how to sustain lower skilled jobs
3. Demographic shifts require multi-pronged approach: raise productivity through business restructuring and workforce retraining, more residents need to work, calibrate rate of immigrants

**Focus of Singapore education since independence**

* Knowledge and ingenuity help overcome geographical and population limitations.
* All levels education emphasized

**Knowledge Based Economy**

* Strengthen and broaden the **overall education of its people to face global competition**
* Nurture **entrepreneurship** and build a technopreneur society
* Learn to think (outside the box**)** rather than just learn to carry out instructions
* Life-long learning and upgrading to remain relevant/useful
* Use the knowledge-based economy to help make it more acceptable to its people in importing foreign talent to face the global competition

**PART 2**

**Lecture 7: Pre-Independence history of Singapore**

Timeline

* Founding of modern Singapore (1819–1826)
* Straits Settlements (1826–1942)
* Crown Colony (1867–1942)
* Battle of Singapore (1942)
* Japanese Occupation (1942–1945)
* Post-war period (1945–1955)
* First Legislative Council (1948–1951)
* Second Legislative Council (1951–1955)
* Internal self-government (1955–1962)
* Hock Lee bus riots (1955)
* Chinese middle schools riots(1956)
* Merger with Malaysia (1962–1965)
* Merger referendum (1962)
* Operation Coldstore (1963)
* Race riots in Singapore (1964)
* Republic of Singapore (1965–present)
* 1969 race riots of Singapore

**Origins:**

East India Company: Originally this British company only traded with India and China but in 1819 Raffles established a post in Temasek to break the Dutch monopoly on Java. The initial inhabitants were Malay, Chinese and Orang Laut. The Sultan of Johor and Temenggong ruled place and agreed to build a Trading Settlement for money.

Raffles decided policies and regulations to make SG into a free port due to its strategic geographical location. A Town Plan and its committee was established with ethnicities separated and Farquhar, his assistant was put in charge of the project. There was wide-spread crime and pests.

1823-1826: Crawford brought the plan to reality. He came with Raffles and in 1823 he became the Resident (Governor) of SG until 1826.

Other achievements of Raffles

* **Law and Order: Local magistrate** was instituted ensuring peace and order. Members were selected from the British inhabitants to act under the Resident (Brit rep).
* **Singapore educational institution**: Intended for higher learning but used as elementary school. Had the first NLB.

**Crawford’s achievements**

* Increase in population, trade, revenue
* More government revenue, free trade
* Legal, regulated gambling
* Licenses for gunpowder and pawnbrokers
* Abolished anchorage and port fees i.e. free port
* Used convict labour to widen/level roads, English street signs, street lighting
* Troops moved northwest from central
* Land given to religious buildings

**Early Settlers**

* Europe: British as well as Portuguese and Dutch -> government officials, merchants
* Middle East: Arabs
* India: Mainly Tamils from South India -> Milkmen, policemen
* China: Hokkiens, Cantonese, Teochews, Hakkas & Hainanese -> tailors etc. Traders, merchants, plantation owners
* Malay Archipelago: Malays, Javanese, Boyanese & Bugis

**Growth of Singapore: Trade factors**

* Geographical Position
* Free port
* Free Trade
* Good trading services
* Safe
* External: British Industrial revolution, Demand for raw materials, Suez Canal
* Cash crops: By Chinese and british

Early Government: 1826: Straits Settlements with Penang and Melaka whose governor was based in SG and reported to Governor general of India.

1867-1942: Straits Settlements came under British Colonial Office in London due to European merchants nagging and became a Crown Colony, so proper admins would be provided now.

**Law & Order**:

1. Lack of Concern for People -> While under EIC as it was for profit
2. Weak Police Force: initially too small to control all immigrants, no common language. Then many Sikhs joined and helped but Chinese sucked and Chinese Protectorate was set up.
3. Trouble Makers: Business rivalries between ethnic groups, gangs

**The Chinese Protectorate**

* Secret societies in early 19th century was problematic. Pickering head it first and tried to get societies to register to know leaders who can help maintain law and order.
* SG became a centre for coolie trade in mid-19th century and Pickering registered them too.
* Domestic Servants-> young girls were ill-treated and registered

**Social Services:**

Education: Different ethnic groups taught their own people.

Medical Care: 4 notable places e.g. Medical College 1905

**How did WW1 affect SG?**

**The Emden Incident**: Emden was a German warship which attacked the "Allies" ships in and around the region. The Emden's presence near Singapore affected the shipping and trade.

**WW2**

Japanese attacked Manchuria creating anti-Japanese feelings so such movements were organized. British used SG as naval base against Japan.

**British Naval Base**:

Well equipped with war supplies, docks to service and repair ships, etc. Setting up a naval base in Singapore would enable the British to protect its overseas empire and trade routes. Base in Sembawang was very developed, called the Gibraltar of the east but this was an illusion.

**1942**: SG fell as Japanese attacked from north through Malaysia instead of south through the sea. Britain couldn't spare more naval power and surrendered to Japan to focus on Germany.   
Japanese occupation sucked balls for everyone with uncooperative Malays and Indians being sent to work on the death rail. Cool dude called: Lim Bo Seng who rebelled against the Japanese secretly but died.  
**Sook Ching massacre**: systematic killing of hostile elements in the Chinese community. A purge.

After the war British returned to sg. Post war problems include shortage of food, water, housing, education, electricity and presence of communism

**Communism: 1945-48: Malayan Communist Party**

* Was made synonymous with anti-Britain/colonialism.
* Frequent trade union strikes, but this didn’t make workers happy. So, Communism couldn’t take root, so MCP turned violent or just left.
* **The Emergency**: 1948: MCP attacked rubber plantations and tin mines in Malaya and began an armed revolution. 1949 Special Branch conducted a raid on Singapore Town Committee through spy and brought down collapse of MCP in SG.
* 1948-60: British appointed Gerald Templer who through dictatorial means brought down communism and allowed for independence of Federation of Malaya in 1957. CPM signed peace agreements in 1989 with the Malaysian Government.

**Strikes in Singapore**

Communists tried to take independent SG through fostering disorders. They tried to take control of trade unions so workers could be made to strike and also Chinese schools. The Chinese were unhappy as they didn’t get as good jobs or education during the British rule.

Riots in SG: By students and workers. E.g. Hock Lee Bus Riots 1955: Bus workers and middle schoolers stopped buses from moving and got injured by police; Chinese Middle Schools Riots 1956: Sittings, demonstrations, shutting classes down. On a greater scale due to new CM suppressing communism, deregistering and banning pro-communist organisations. Government issued ultimatum for the students sitting in the Chinese Highschool in protests which broke into a riot, 900 arrested, 100 injured, 13 dead. They were released when Lee Kuan Yew from the People’s Action Party came into power and SG was self-ruled.

**Road to Independence:**

1948: Sg’s first election (Legislative council 6 seats elected)

Separated from Straits settlements in ’46 and ruled by British governor who controlled who was in his Advisory Council. Not a democracy. Then Legislative council came with 6 people who were allowed to be elected by Singaporeans.

1955: Limited self-government (Legislative assembly 25 elected for health and housing)

Other 7 seats appointed by Governor. David Marshall’s party (Labour Front) occupied max seats and he became CM. Tried to get full independence – Merdeka (Freedom) Talks – but failed and resigned. There was growing tension between progressivism and radicalism (anti/pro brit). After Marshall failed, Lim Yew Hock came and pushed for independence, and was mean to communists, and he got complete internal (domestic affairs) autonomy. However, he was harsh and he alienated the public, wasn’t re-elected

1959: Full Self-Governement -> Lee Kuan Yew – First Prime Minister of SG

People’s Action Party: Founded in 1954, anti-colonial, anti-communist, Yew belonged here. In ’59 voting was compulsory.

1963: SG part of independent Malaysia

1965: Independent SG

**Significance of British Colonialism on Modern Founding of Singapore -IMP**

* Introduced rule of law and English language
* Invested in large infrastructure, town planning and development
* Allowed mass immigration to turn it from a fishing village to a free port handling huge trade regionally and internationally
* Opened it to the outside world, especially the West
* Brought in industrial revolution technology
* Made Singapore into a free port and modern city
* Positioned Singapore to be a pre-eminent global metropolitan state in the future

**Lessons Learned from this Colonial Episode - IMP**

* Singapore should continue to allow (high-quality) immigration to strengthen its talent pools and diverse skills for future economy
* Remains open as a global trading and business hub, with good connectivity for free trade and investment
* Embrace and promote science and technology to become 1st world country
* Entrepreneur to expand its economic space through overseas investments and globalization (to grow its GNP)
* Promote racial harmony and social integration
* Promote fair and equitable employment, not labor exploitation
* Build strong self-defence to protect sovereignty, against foreign aggression like in the WWII.

Lecture 8

**Singapore Parliament Structure 2016**

Members:

* 89 Members of Parliaments (MP)
* 3 Non-Constituency Members of Parliaments (NCMP)
* 9 Nominated Members of Parliaments (NMP)

Political Groups:

* People’s Action Party (PAP) – 83 MPs -> Held power since 1959
* Workers’ Party (WP) – 6MPs and 3 NCMPs
* 9 NMPs from various walks of life

There was a communist dude in PAP who was in Marshall’s assembly called Lim Chin Siong. He left and made Barisan Sosialis when he was dismissed along with other leftists by Lee Kuan Yew.

Operation Coldstore:1963: security operation where left wingers detained including Barisan. An anti-communist sting authorised by internal Security Council. At that time, SG was self-governing under Britain but wanted to merge with Malaysia which leftists opposed. STUC also broke into SATU (leftist) and NTUC (pro-PAP) -> Trade unions. SATU got deregistered after its leaders were arrested.

Internal Security Act (ISA): For Malaysia but extended when SG became state of federation of Malaysia. Government conducted shady business under this name. Its affairs were revealed after the Marxist Conspiracy or Operation Spectrum in 1987. Conducted to “nip Communist problem(s) in the bud”.

Singapore in Malaysia: Malayan PM proposed a merger in 1961. Discussed with LKY that central-government responsibility for defense, foreign affairs and internal security, but local autonomy in education and labour. People referended for it. Malaysia formed: Malaya, SG, Sarawak, North Borneo.

**Merger with the Federation of Malaya (Singapore’s View)**

* For Merger: Rightists
* Easing of Trade Barrier (Economic Ties) – provide raw material, market for manufactured goods, economic growth
* Reduce Unemployment
* Contain Communist Insurgency
* Independence through Merger
* Against Merger: Leftists: Malayan was anti-communist, tried to influence trade unions and PAP branches against merger
* Loss of Free Port Status (source of wealth)
* Loss of Control over Economic Development & Education (Language Differences)
* Issues:
* Equal Merger
* Removal of racial and language politics

**Merger with the Federation of Malaya (Malaya’s view)**

For Merger:

1. Did not want Singapore to fall to the leftists

* feared that the communists might use Singapore as a base to conduct activities/attack Malaya

1. Alarmed at weakening power of PAP

* if PAP government fell, leftists might form the next govt

Against Merger:

1. Too many Chinese in Singapore

PAP promoted the merger through: Radio talks, discussions, booklets, exhibitions

1962: Only National referendum ever

Issues negotiated between Malaya and SG

* Common Market: Malaya was against it as they didn’t want SG competition. They agreed to establish it gradually, SG gave more revenue to KL and KL grants pioneer status to new industries
* The Borneo Loan: Sabah and Sarawak needed money for development, but SG needed money for themselves. Malaysia wanted M$50 million gift but SG wanted to loan. SG loaned 150 mil over 15 years no interest for first 100 mil
* Constitutional: Sg can control its own labour policy (keep communism in check) and education policies but gained only 15 Malaysia Federal Parliament seats instead of 24.
* Citizenship: Malaysian citizens couldn’t vote in SG maters and SG citizens had to stay SG citizens but Malaysia nationals (can’t vote).
* Malay Rights: Special Malay rights not for SG Malays who are recognised as indigenous inhabitants, free education for SG Malays to help socio-economic position.

The Malaysia Agreement: Brunei opted out, declared 1963

Confrontasi: 1963-66: Indonesian and Philippines (wanted Sabah) raided Malaysia and SG.

Expulsion of SG from Malaysia 1965 (IMP)

1. Distrust and ideological differences between leaders => frequent disagreements
2. Major racial riots in 1964 SG: series of riots between Chinese and Malay. PM blamed Indonesian & communist provocateurs. SG blamed ultra nationalist faction of United Malays National org. (UMNO)
3. 1965 Malaysian PM expelled SG
4. Economic reasons: KL saw SG as economic rival delaying common market and SG responded by not loaning money to Sabah and Sarawak. Due to Indonesian contribution KL also wanted 20% more money from SG. Dispute over bank of china.
5. Political Reasons: 1963 SG General Election – Malaysian political parties formed Singapore Alliance to take part in SG elections but wanted PAP to not compete in those positions. SA lost all seats and were upset and the PM supported SA and promised to do so more. – 1964 Federal Election of Malaysia: PAP only managed 1 seat, SA got offended PAP’s Malaysian Malaysia.

Just before Separation: PAP brought together 4 Malaysia opposition parties to form MSC (Malaysia Solidarity Convention); Aim for a Malaysian Malaysia where everyone would be treated equally regardless of race and religion while UMNO saw this as Malay rights and privileges and ased for LKY arrest. SO, to prevent racial conflicts they separated.

Separation: Malay people wanted to leave, abut SG didn’t so they voted to leave when SG people weren’t there.

Republic of SG: 1965 constitutional amendments SG become an independent republic and although there were talks of common currency it split. After Independence, 9th August 1965.

May 13 incident: Sino-Malay sectarian violence in KL, riots due to aggressive affirmative action policies e.g. NEP.

1969 Race riots Singapore: post-independence, rumours about Malay atrocities in China led to these with Malaysian triad societies coming to SG

\*Path to Nationhood Socio-political issues\*

* Housing – HDB (1960 – large scale public housing development)
* Nation & Community Building – CCs
* Corruption – Very common in 40s and 50s
* Utilities: Water, electricity, sewage
* Education
* Transportation

People’s Association: Racial & Political tensions 50s – 60s were helped by the group participation of social, cultural, educational and athletic. More social cohesion.

CPIB: Prevention of corruption act, anti-corruption law by providing in investigative. CPIB investigates corruption offences and aims to prevent corruption in both the public and private sectors

Singapore: Democratic Society

* Presidency is a popularity contest

**Lecture 9: Secrets of SG Success & Survival: Security & Development**

ECONOMIC DEVELOPMENT STRATEGY OF SINGAPORE

The Strategy: A Historical Perspective

Phase 1: Import substitution (1959-65)

Phase 2: Export orientation (1966-78)

Phase 3: Industrial restructuring (1979-84)

Phase 4: Economic diversification (1985-92)

Phase 5: Further restructuring (1993-99)

**Phase 6: Knowledge-based economy/KBE (>2000)**

* Into the borderless world of knowledge-based economy (KBE)
* Globalization (WTO) & hyper-competition
* Liberalizing service industries: telecoms, banking (healthcare, education, tourism etc.)
* Develop manufacturing & services clusters
* Enlarge external economy
* Diversify FDI (foreign direct investment) destinations to non - traditional countries like Middle East, Latin America, Eastern Europe, (South) Africa etc.
* Integrate domestic & external economies for bigger GNP (M&As by GIC, Temasek, Singtel, PSA, DBS, CapitaLand)
* Continue to attract foreign talents in IT, AI, life-sciences, environment technology, electronics, digital services (media, commerce and finance, data analytics, cybersecurity etc.) and other knowledge industries (creative, venture capital etc.)
* Maintain economic resilience, spearhead economic redevelopment & reduce vulnerability

**US Recession of 2009**

Response: Immediate Economic Measures - ‘Resilience Package’

- Save Jobs with a Job Credit Scheme giving direct cash grant to subsidize wage bill.

- Provide Loans for Businesses with a Special Risk-sharing Initiative and a new Bridging Loan Program to meet working capital needs of mid-sized companies; loan scheme for SMEs.

- Cutting Cost for companies (rebates and various tax cuts).

- Help Families with rebates on HDB services charges and rentals.

- Invest for the Future through increased spending on infrastructure e.g. roads, MRT networks, HDB upgrading etc, and other sustainable development projects.

**KEY CHALLENGES FACING SINGAPORE ECONOMY**

* **Lower workforce growth** due to decline in fertility rate and aging population
* **Lower workforce productivity**
* **Higher rental and business cost** (higher property prices, COEs and manpower cost etc)
* **Lack of certain skills in identified growth sectors** (banking and finance, FinTech, healthcare, biomedical and pharmaceutical, clean energy, digital media, tourism and hospitality etc.)

**Road to recovery**

Economic Strategies Committee Report (2010)

**Goals**

* Higher productivity growth 2 to 3% per year.
* Improve skills and less reliance on cheap foreign labour.
* Increase spending on R&D to 3.5% by 2015.
* Help SMEs grow. Doubling SMEs with revenue > $100m to 1000 by 2020.
* Distinctive Global City – new waterfront city; underground space; a cultural capital and home to diverse talents.

**Strategies to Fulfil CFE Vision**

1. Deepen and diversify Singapore’s international connections: Press on with trade and investment cooperation; Set up a Global Innovation Alliance (GIA); Deepen knowledge of our markets
2. Acquire and utilize deep skills : facilitate and acquire deeper skills; strengthen nexus between acquiring and using
3. Strengthen enterprise capabilities to innovate and scale up: Strengthen innovation ecosystem, support enterprises to scale, catalyse private sector to grow more
4. Build strong digital capabilities: Help small and medium enterprises (SMEs) adopt digital technologies ; Build deep capabilities in data analytics and cybersecurity ; Harness data as an asset
5. Develop a vibrant and connected city of opportunity: Invest in our external connectivity Continue to plan boldly for growth and city rejuvenation, Build partnerships for a vibrant city, Develop exportable capabilities
6. Develop and implement Industry Transformation Maps (ITMs) : Tailor ITMs for each industry , Adopt a cluster approach to maximise synergies across industries
7. Partner each other to enable innovation and growth: A greater role for TACs (Trade Associations and Chambers) and unions, Create a regulatory environment to support innovation and risk-taking, Use Government lead demand to support the development of promising industries, Review and reshape Singapore’s tax system, Create a sustainable environment

**Characteristics of future economy of SG**

1. A **globalized economy**, a key node in global network, linked to all major economies and emerging regions
2. **A creative and entrepreneurial** nation, taking risks to start new businesses
3. A **diversified** economy, powered by twin engines of manufacturing and services
4. A growing **global footprint**- intensifying overseas investment and growth of Singapore-based companies
5. Singapore companies complement MNCs, new start-ups co-exist with traditional businesses, exploiting new and **innovative ideas**

**Roles Engineers /Professionals in SG economic development**

* + Infrastructure development
  + Hi-tech, value-added manufacturing & services
  + Support services to MNCs
  + Technopreneurs & SMEs
  + R&D & innovations
  + International ventures

**Lecture 10: National Cohesion and Total Defence**

**Security & Development**

**Total Defence**: Defence in totality, not only military. This must be internalised well. It provides Security, Survival and Success; assures economic success => defence capability (a virtuous cycle)

How to TD: 2 pronged -> External Diplomacy: Improve foreign relations && Internal Deterrent: Built through the 5 components.

5 + 1 components of total defence:

Military (most tangible/hardware):

* strong deterrent against predators
* first-strike military superiority

Economic:

* must go on during hostility
* protect sea/air routes
* keep facilities/installations operational
* foreign reserve for importing resources for 1 year for the whole nation
* strategic food and oil reserve for 6 months
* Civilian resources can be mobilised quickly
* water sufficiency

Civil:

* **protection of major installations** (utilities, hospitals)
* **Air raid** **shelters, MRT stations**
* **emergency water and food** **rationing**
* **medical relief and blood donation**
* **emergency rescue**
* **overseas rescues to build friendship**
* **CD drills on safety**

Social (intangible/software):

* national cohesion
* racial and religious fault lines
* communal tolerance for **national harmony**
* **Internal** Security Act & Religious Harmony **Act** to safeguard internal security
* rich and poor divide
* go **global stay anchored**
* **care for aged and sick** (old population)
* **ethnic self help** (SINDA)
* **Westernisation of Singapore** society, changing values, weakening of traditional ties, more individualistic & self-centred
* to build a caring society, the *5Cs*: ***compassion*, *cohesion*, *community*, *contribution* & *commitment***
* inculcation **of care-giving starts from family**, school, workplace, community and society, a lifelong personal effort/attribute
* **tripartite cooperation** of public, private, people
* **Managing and integrating foreign talents**/new immigrants

Psychological (most intangible/heartware), Digital

* Takes generations to build
* Refers to will, courage, unity, loyalty and commitment
* Know what and why we fight for
* Altruism, idealism, patriotism
* Build self-confidence, con overcome all odds eventually
* Protect integrity and sovereignty of SG
* Sense of national belonging, not afraid of external threats
* Eliminate Kiasu & Kiasi syndrome
* Face adversity courageously, nothing is impossible!

Impact of Cyber-attacks on SG national security

* SG is comparatively less prepared although they can be just as disastrous. They can paralyze critical infrastructure and causes in losses property and lives. Everyone is vulnerable to Internet scams and security breaches. Fake information also causes social consequences. Cyber threats affect the 5 pillars of TD.

How to deal?

* Incorporate digital defence as a 6th pillar.
* Set up **National Cyber Security Agency**
* Mindef is working in
* Recruiting **cybersecurity experts** and opening **cyber training school**
* All stakeholders: citizens, businesses, organisations work with government to help

ISIS: 4 inter-related threats

1. Terrorist attack is when not if
2. Threat of radicalization
3. Muslim population growing distant from rest
4. Islamophobia

Sources: ISIS plots against SG; Home grown lone actors, Radicalised foreign residents

Responses: SGSecure is a strong community to sensitise, train and mobilise terror threat. Run, hide, tell. Report, counsel, rehabilitate radicalised people. Stay alert, united, resilient.

The software (social defence) is founded on the heartware (psychological defence) (-most imp) which in turn drives the hardware (military, economic and civil defence). The 5 components form the chain to strengthen Total Defence.

**Lecture 11: Our Political World (Our Neighbours & International Relations)**

International politics and economics keep evolving, and they keep changing at a faster pace. Also, they become increasingly inter-twined. International relations have always been important to Singapore due to our small size. It is also very vulnerable due to its accessibility, and a Muslim majority. Foreign relations depend on national interests. A country is strong if armed forces and economy strong.

Strategies for Survival: (1) Ensure TD (2) Continual economic growth + foreign reserve (3) Be pro-active about keeping regional environment balanced (4) Have clean, committed top public leaders

Malaysia: Although there is history of riots, slow start but economically stable, holds different social and political beliefs, led by a muslim party. Recently tense due to airspace and territorial waters disputes. Closest neighbor, bigger size + population.

Indonesia: Konfrontasi but otherwise long, steady and good. Economy not very good due to Asian financial crisis of 97. Now must handle muslim extremists.

**ASEAN (IMP)**

* Founded in ‘67 by Indonesia, Malaysia, Philippines, Thailand & Singapore. Brunei in ’84. Vietnam ’95. Myanmar and Laos ’97. Cambodia ’99. (Total 10)
* Initially to promote regional economic cooperation, stop communism. Later, after ’90 (cold war) also actively promotes regional stability & solidarity.
* Non-interference policy in each other’s internal affairs.
* ASEAN regional forum in ’92 with other major powers for annual summits on regional security issues
* Now wants to become EU, single market, more regional integration.

Importance of ASEAN to SG

* Stability and security achieved which helps in political and economic imperatives
* Raised SG’s profile and influence despite smallness

Achievements

* Creating and sustaining **regional stability**
* Strong stance **against terrorism** (+Australia)
* **Neutral** with US, China, India
* Help members **resolve disputes** from territorial claims and economic issues
* Create environment for **foreign investors and tourists**
* Established **ASEAN Common Market** to promote regional trade
* Signed charter, advocating **democratic ideas and human rights**

Key Issues faced

* **Terrorism**: SEA is recruiting ground for ISIS, SG homeland security works with neighbors to exchange intelligence, SPF strengthens border control, Sg does rehab with neighbors, SG security and intelligence share best counter-terrorist ideology practices.
* **Trans-Boundary Haze**: Sg shares weather and hot spots of forest fires, deepens cooperation and shares info to make errant companies accountable, advocates early operationalization of ASEAN sub regional haze monitoring system
* **South China Sea dispute**: China, Malaysia, Brunei, Philippines and Vietnam have land claims, SG urges them to not fight, non-militarization and accident prevention measures. She is transparent, object coordinator. Works to achieving code of conduct for SCS to create win-win outcome.

Importance: SEA peace for economy and security; China largest trading partner for AEC, Avoid US-China confrontation, SCS is valuable navigation pathway for 40% world trade, united ASEAN

* **AEC (ASEAN Economic Community) Integration**: End of 2015, Sg facilitates economic integration for single market production base, with free movement of goods, services and skilled labor. Still requires work, deepening economic ties between AEC and China, ratifying ASEAN Open Skies Agreement.

Importance: ASEAN’s strategic partnership with US, needs to get advantage of one barrier free market like US, create greater value through capital flow +innovation +entrepreneurship, make ASEAN significant, spur intra-ASEAN trade, help members

How ASEAN safeguard interest and sovereignty

* Emphasize unity and centrality by **increasing interdependence among members**
* Increase interdependence **between ASEAN and external partner**s for more win-win outcomes
* **Practice decision-making through consensus**
* Adopt **neutrality** with superpowers

**USA**

Most important for trade, investments, technology. SG’s only gateway to it is though ASEAN. USA also wants to contain communism. Clinton pushed very hard for open markets, open economy, western liberal democracy, & human rights. He tried harder to intervene in internal affairs of countries not sharing in these crusading values. Singapore was very concerned about this, & openly propounded alternate sets of values, leading to frictions. Bush was okay though. Then 9/11 happened and then the world recession (similar to great depression, sub-prime financial crisis) when SG was very affected. Obama was also cool. We are being nice to Trump too.

**China**

SG was concerned as China communist. But ’71 it joined UN and improved relations. ’79, opened economy and economic relations and activities with SG flourished.

’89: turning point due to Tiananmen incident and Soviet Union collapse. Began to prioritize fast economic growth and territorial integrity.

1990: SG and China established diplomatic relations. China has been going forward since.

**Our Troubled World Since 2001**

Violence world-wide has intensified.

* US in Iraq and Afghanistan. Arab Spring (2011). ISIS (2014).
* After 2001, major economies went into recession, except China which become the world’s workshop. Now turning from production based to service based.

**Overall Regional Outlook**

* ASEAN has expanded to ASEAN +3 (china, japan, south korea) and further to East Asian Summit adding India, Australia, New Zealand. Hopefully, we will work together on not only economic, but security issues too.
* Four possibilities to fuck the future: 1. **Souring of US-China relations** due to trade imbalance, US protectionism, New Asia doctrine by Trump, China’s domestic considerations (internal stability) 2. **Upheaval in Middle East due to Syrian conflicts** + ISIS threats, US Iran nuclear sanctions, Israel – Palestine conflicts 3. **Disputes over SCS** due to potential disruptions to sea lines of communication for trade-dependent countries (SG) 4. **Disputes over East China Sea** due to China and Japan claiming Diaoyu + Japan and South Korea over Takeshima. This ways down booming Asian economy.

**Lecture 12: Our Economic World (Globalisation and the New Economy)**

1. **unusual changes in the world economy (90s)**

* Biggest economy USA, 2nd Japan
* SEA Economies crashed 1997 despite Asian Miracle before this. Spread due to contagion effect. Indonesia super affected.
* IMF lent money to help but anti-globalisation protests harassed them
* SG government pushed for knowledge-based economy (KBE)
* => world change fast, get small, connect, difficult to predict

1. **Economic Globalisation (world getting smaller)**

Spread from globalised manufacturing (Coca-Cola) to services (universities). Due to end of Cold war (no superpower rivalry + no tariffs/barriers +WTO +FTAs+ no capital flow/manpower movement restrictions) and development of Info-Comm tech (Telecommunication + Information: better voice and data transmission, small and cheap, fast processing)

* Global businesses, markets global, competition intense, local competition reduced

1. **How the World became flat**

* Fall of berlin wall, New age connectivity (WWW), Workflow software (machine to machine communication), Uploading (online projects Wikipedia), Outsourcing, Offshoring, Supply Chaining (horizontal collaboration), Insourcing (companies helping within themselves), Informing (search engines), The Steroids (personal digital assistants)

1. **From Capital Based Economy to Knowledge Based Economy**

Humans have evolved from Hunting -> Agriculture -> Production -> Services

SO, now knowledge has become an important resource like tools, land, labour, capital. Increasingly, having financial ‘capital’ is less important than having wealth- creating ‘knowledge’ from human talents.

1. **The New Knowledge-Based Economy**

* Knowledge helps modern companies/economies grow
* ***Knowledge in KBE means ‘the book knowledge plus the ability to add & create values i.e. create new wealth. Includes education + research but also intrinsic and acquired abilities.***
* Therefore, it is important to have knowledge & abilities in new frontier technologies + Creative, entrepreneurial, visionary, agile, & persevering aptitudes.
* Ideas are cool but people are cooler a.k.a. talents, since higher-skill services are now the engine of growth not manufacturing.
* Reasons for the paradigm shift: **new equipment & technology increases manufacturing productivity sparing manpower for services, ICT technology brings global connectivity.**
* In SG in ’97 tried to make twin engines of growth (manufactured exports & services). But they weren’t fast enough. By 2001 they knew they had to do it quickly. Now SG is very globalised

1. **Positive Impacts of Globalisation**
   1. It creates **greater opportunities for firms in less industrialized places**
   2. **More access to capital flows, technology, human capital, cheaper imports and larger export markets**
   3. It allows **businesses in less industrialized countries to become part of international production networks** and supply chains that are the main conduits of trade.
   4. It **contributes to develop health and education** systems in developing as they pressured to get higher skills set. Economic growth helps to raise health standard
   5. **Raise business productivity** as firms compete
2. **Negative Impacts of Globalisation**
   1. International trade exacerbates **income inequality**, between and within nations
   2. Global commerce dominated by **profit hungry transnational corporations**, not country development hungry
   3. **Protectionist policies** in industrialized countries stifle less developed countries
   4. The volume and volatility of capital flows increase the **risks of banking and currency crises**, especially in countries with weak financial institutions
   5. **Competition among developing countries to attract foreign investment** leads to a environmental standards being compromised
   6. **Cultural uniqueness** is lost in favour of homogenization, American culture
3. **Impact of US-China Trade Conflict** 
   1. They are in a trade war caused by the US trade deficit with China
   2. US firms encounter unfair treatment with China and feels it gives too much concession in their trade agreement, so they started imposing tariffs in 2018.
   3. It affects Asia as **ASEAN has trade with China and USA, and more-so SG as it so trade-dependent**. It impacts **due to the inter-connectedness of global supply and value chains system in trade and investment**.
   4. Bilateral trade between US and China affects SG GDP (1.1%)
   5. **US tariffs will be on SG** too, and our exports will be less competitive. **SG’s intermediate goods** used for China manufacturing also affected as China has less places to sell.
   6. Greatest impact due to **tit for tat mindset**, causing sustained and sharp **fall in business and consumer confidence, tightening global liquidity**
   7. Creates need for SG to **move from MNC led to local participation and BRICS**. SG can also join RCEP and CP-TPP, multi-lateral trade agreements

In conclusion, globalisation has been beneficial due to its opportunities. The downsides have been mitigated through economic policies. So macroeconomic objectives achieved.

1. **What does it mean to us as individuals?**

We need to keep up with new and current events, local and international, business and technological trends and analyse them. Economies change quickly and competition is intense. cultivate your mind to be *adaptable, nimble, open-minded, far-sighted*.

Practice being *innovative & creative. Look for opportunities and business ideas and start early. Be hungry, be curious and be persistent.*

**Extra Notes**

Part 2: Lecture 8

British- ww2 – japan – British (IMP) - 48-55: elections – 59 onwards independence – join Malaysia, leave Malaysia – What have the British done? Good and bad.

Social and Political Development: Generally, know what’s happening; struggle against communists, British rule. What made us join Malaysia? Why did we separate? Struggles of young SG -housing, races, public transport etc…

Lecture 9: Economy: Basics of what is happening now. The restructuring of economy. UKB, problems strategies to overcome, and what more can be strategized. READ the 7 strategies report thing attached, get gist. Get the 5 objectives and 7 strategies. CFE

Lecture 10: National cohesion and Security: 5 threats – military, economic, civil, social psychological, digital. What can we do as a country?

Lecture 11:

ASEAN relations. China is big ass bitch.

Lecture 12

How economy changed. Effect of globalisation? Knowledge base economy onwards. Trade between US and China.

Tips

* Do only 1 year before past year paper
* Write as much as you can but 15 min per question
* DO NOT misinterpret Q. Answer to the point, clear concise and target.
* Can write point form
* Give example when asked for