

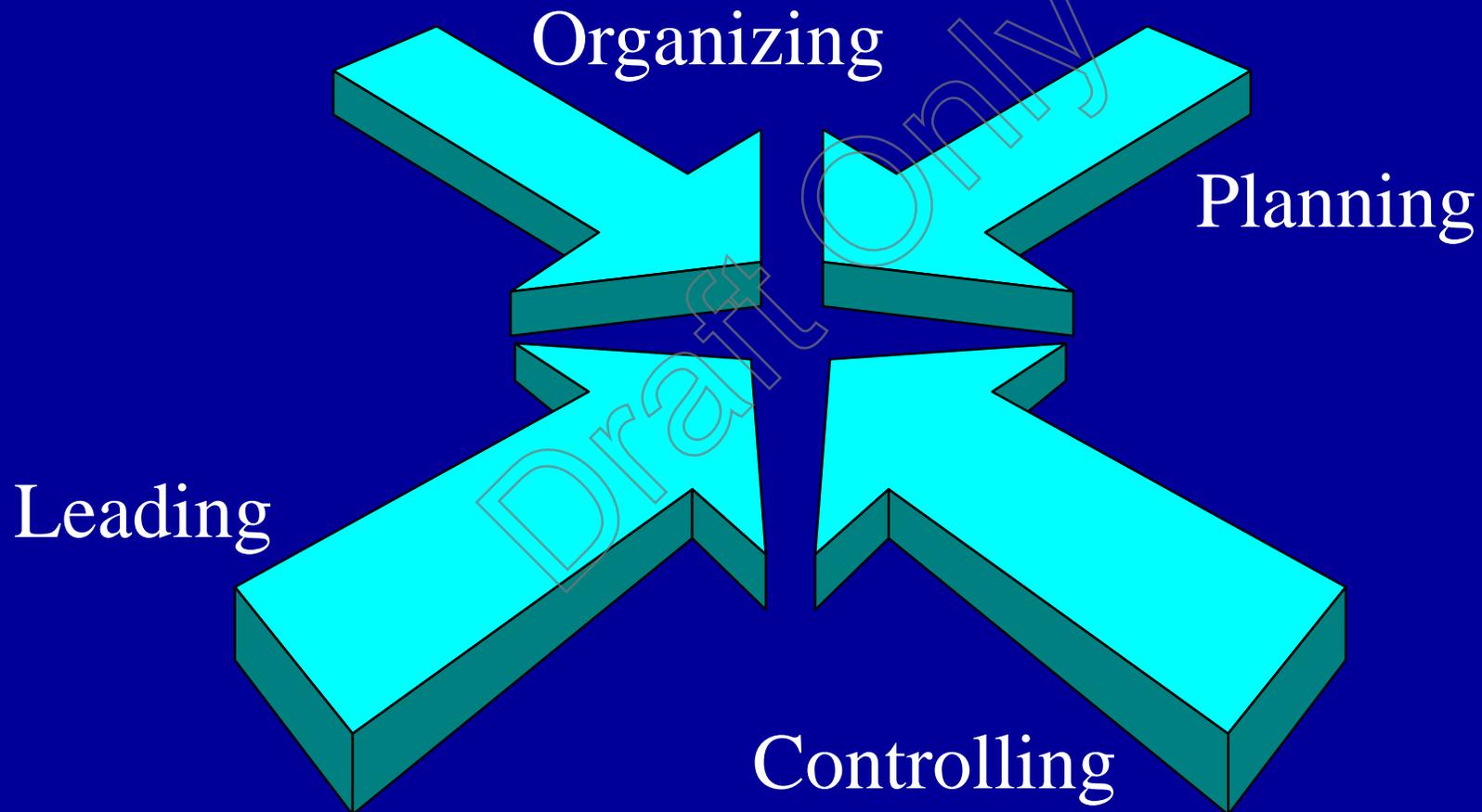


Chapter 2 - Planning

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Engineering

Engineering Management Functions

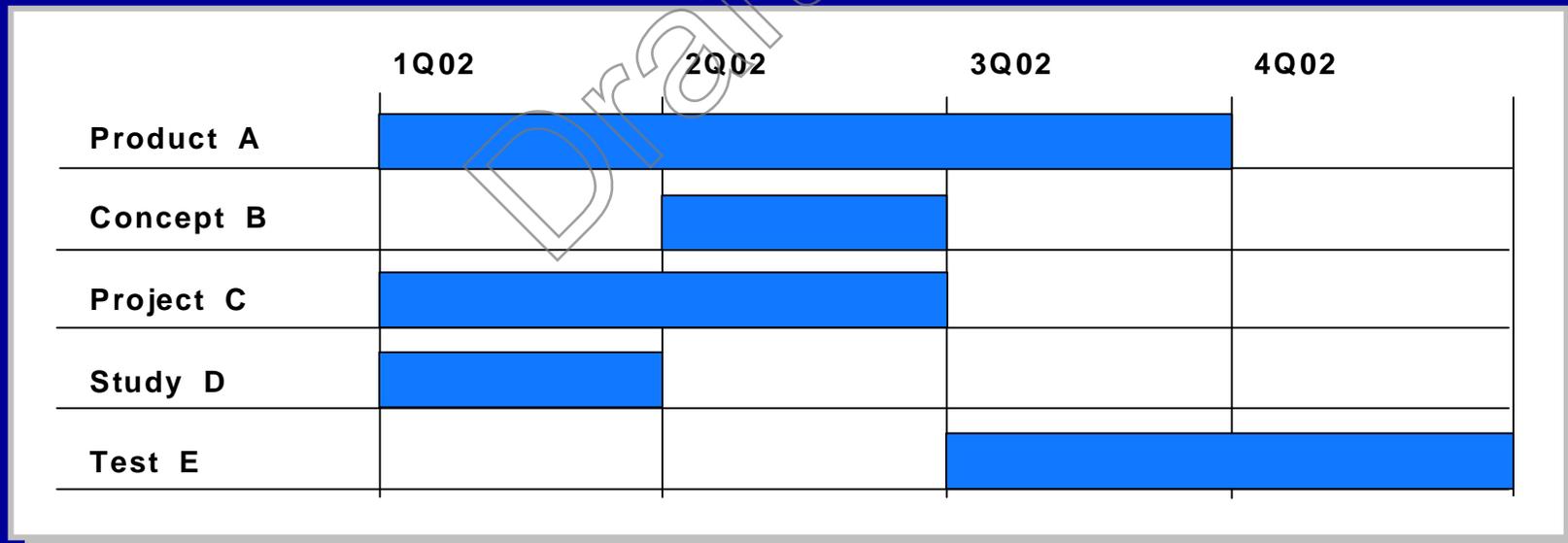


Engineering Management Functions

- **Planning** (forecasting, setting objectives, action planning, administering policies, establishing procedures)
- **Organizing** (organizing workplace, selecting structure, delegating, establishing working relationship)
- **Leading** (deciding, communicating, motivating, selecting/developing people)
- **Controlling** (setting performance standards, evaluating/documenting/correcting performance)

Planning

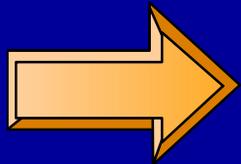
- Planning is the work done to predetermine a course of action, in order to provide focus and direction for enhancing the efficiency and effectiveness of the company



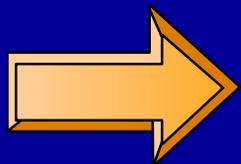
Planning

- Planning is made necessary by rapid change of
- (a) **Technology** (Big Data, Artificial Intelligence, broadband communications options, mobile access),
- (b) **Environment** (globalization, competition, marketplace), and
- (c) **Organization** (mergers & acquisitions, networks, outsourcing and alliances)
- Planning defines who, how, where, when and using which resources to do what work

Planning

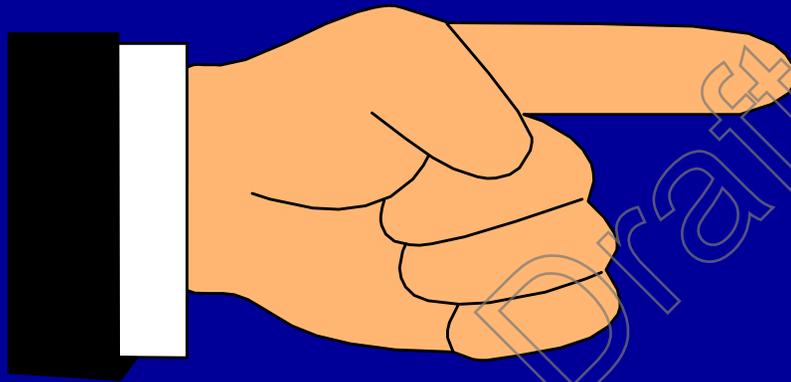


Strategic Planning



Operational Planning

Strategic Planning

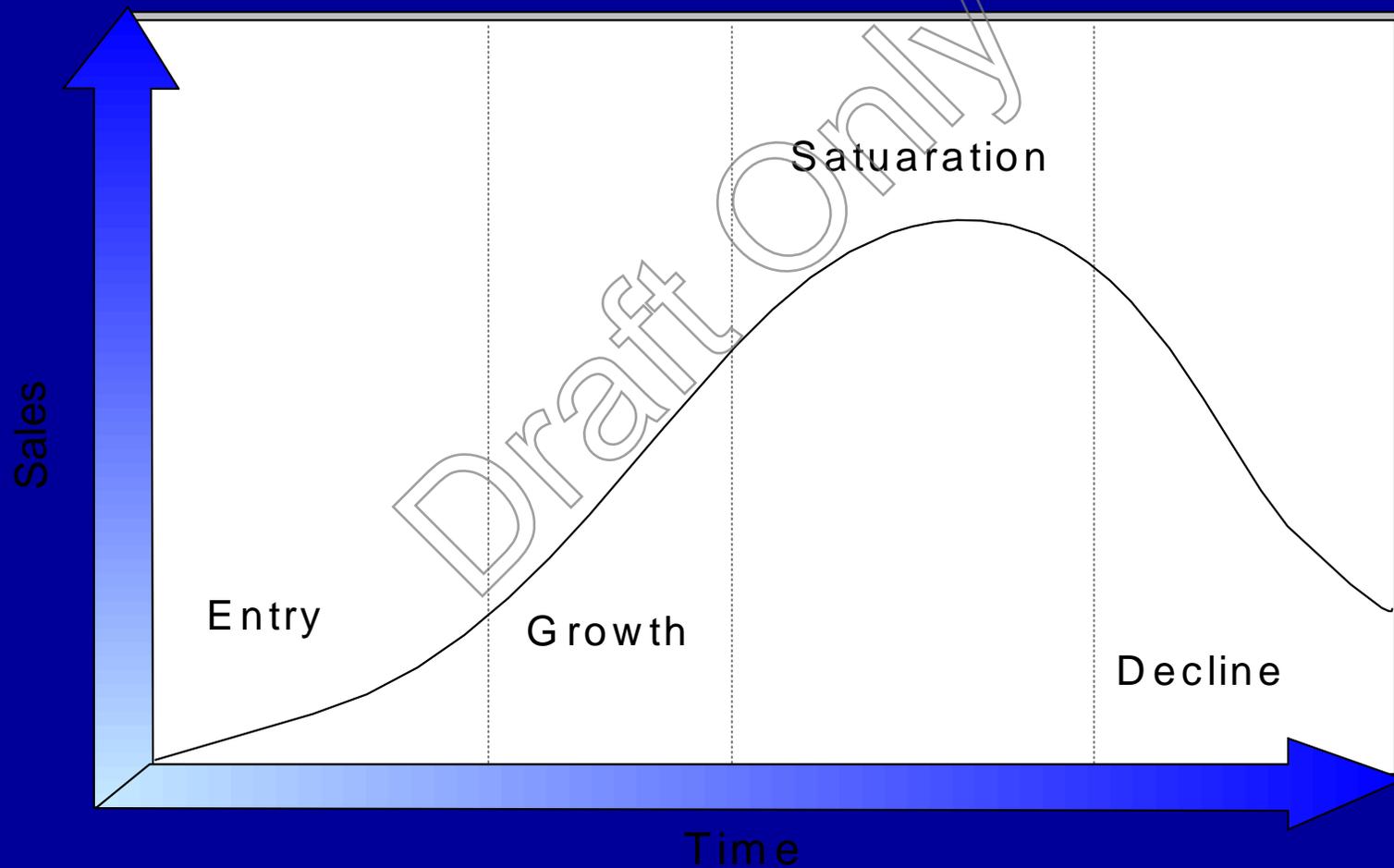


- Define future activities which are worth doing by the unit/company to assure that the company applies its resources (skilled manpower, time, money, physical resources -equipment, facilities, business relationships) effectively to achieve its short-term and long-term goals

Strategic Planning Questions

- What are the company's vision, mission and value system?
- What specific goals (profitability, market share, sales, technology leadership position, global penetration) to accomplish by when, with what investment and which technology?
- Which new/improved product streams to offer by when (considering product life cycle)?

Product Life Cycle



Mission and Vision

- Mission
- Why do we exist?
- Whom are we serving?
- What do we do to serve them?
- Vision - Company Aspiration
- Market capital
- Business standing
- Ranking in industrial sector
- Market share
- Others

Sample Corporate Values

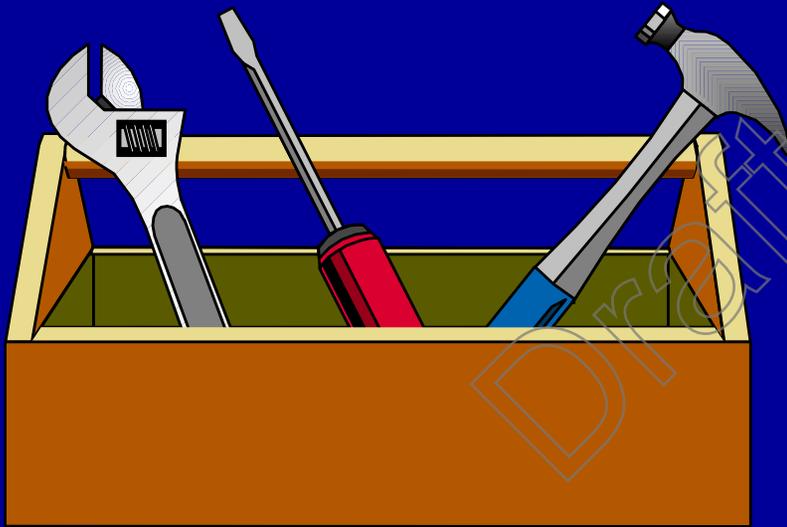
- **Innovation**
- **Honesty**
- **Quality**
- **Social responsibility**
- **Continuous improvement**
- **Stability**
- **Collaboration**
- **Accountability**
- **Trust and openness**
- **Quality of work Life**
- **Empowerment**
- **Initiative**
- **Diversity and equal opportunity**
- **Respects for others**
- **Open communications**

Source: James A. McComb, "Moving From Planning to Progress," Credit Union Executive Journal, Madison (July/August 2001)

Strategic Planning Questions (cont'd)

- What core technologies (design, production, distribution, service) to maintain, develop, acquire and/or apply?
- Which business networks/partnerships to create (suppliers, co-marketing, production, logistics, service)?
- With which performance metrics to monitor corporate progress?

Tools for Strategic Planning

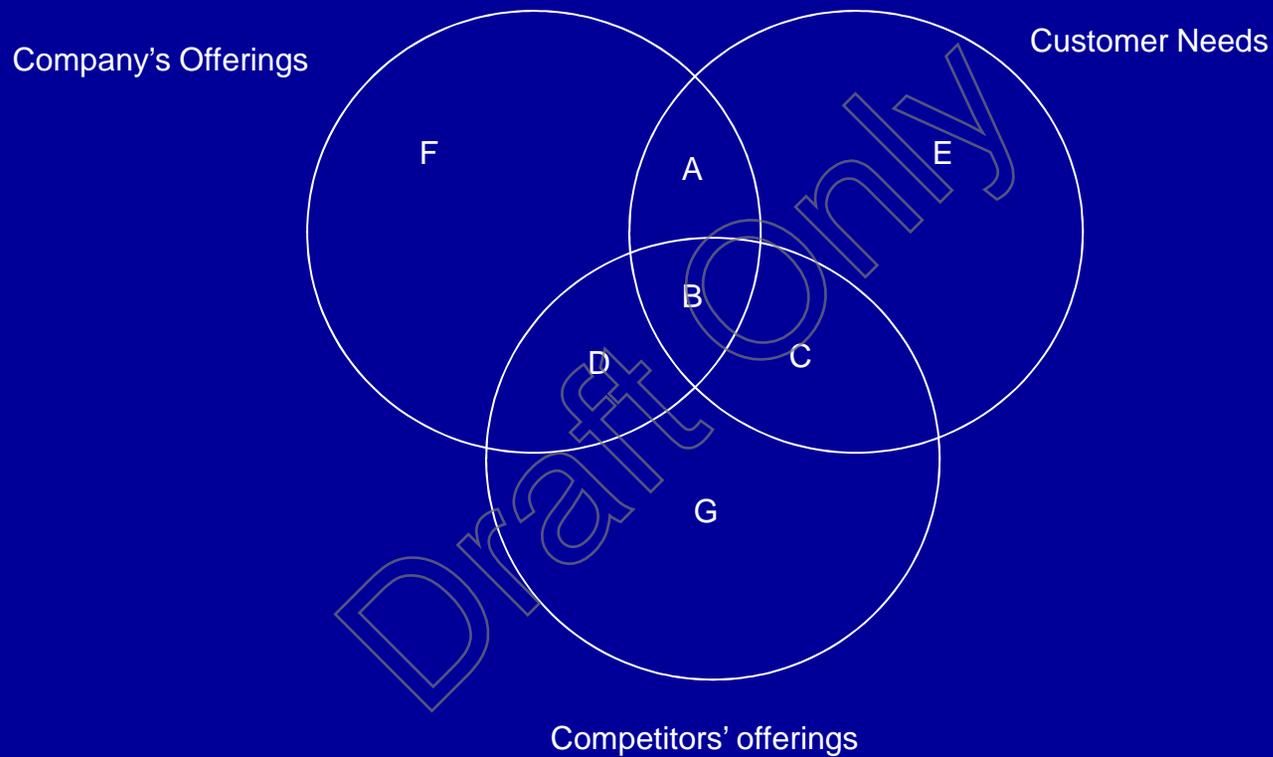


- Market research
- SWOT analysis
- Sensitivity analysis (what-if, scenarios, Monte Carlo)
- External benchmarking
- Technology forecasting
- Product life cycle analysis

Apply Analogy in Strategic Planning

Dimension	Major/minor	Source Case	Target Case	Is Target similar to Source?
		(Attributes)	(Attributes)	
1	Major	(a), (b)		Yes
2	Major	(c), (d)		Some-what
3	Major	(e), (f)		No
4	Major	(g), (h)		Yes
5	Minor	(i), (j)		Maybe
6	Minor	(k), (l)		No

Strategic Insights in Three Circles



Recourses: Urbany and Davis. 2007)

Three Circles Technique to Develop Insights

How to gain strategic insights when considering customers needs, the competition and the company's own product offering ?

A – Area of our advantages (how to enlarge it and using which technologies?)

B – Area of points of parity. Are we delivering effectively in this area?

C.- Area of competition strength. How can we do more to counteract?

E- This is an area for growth.

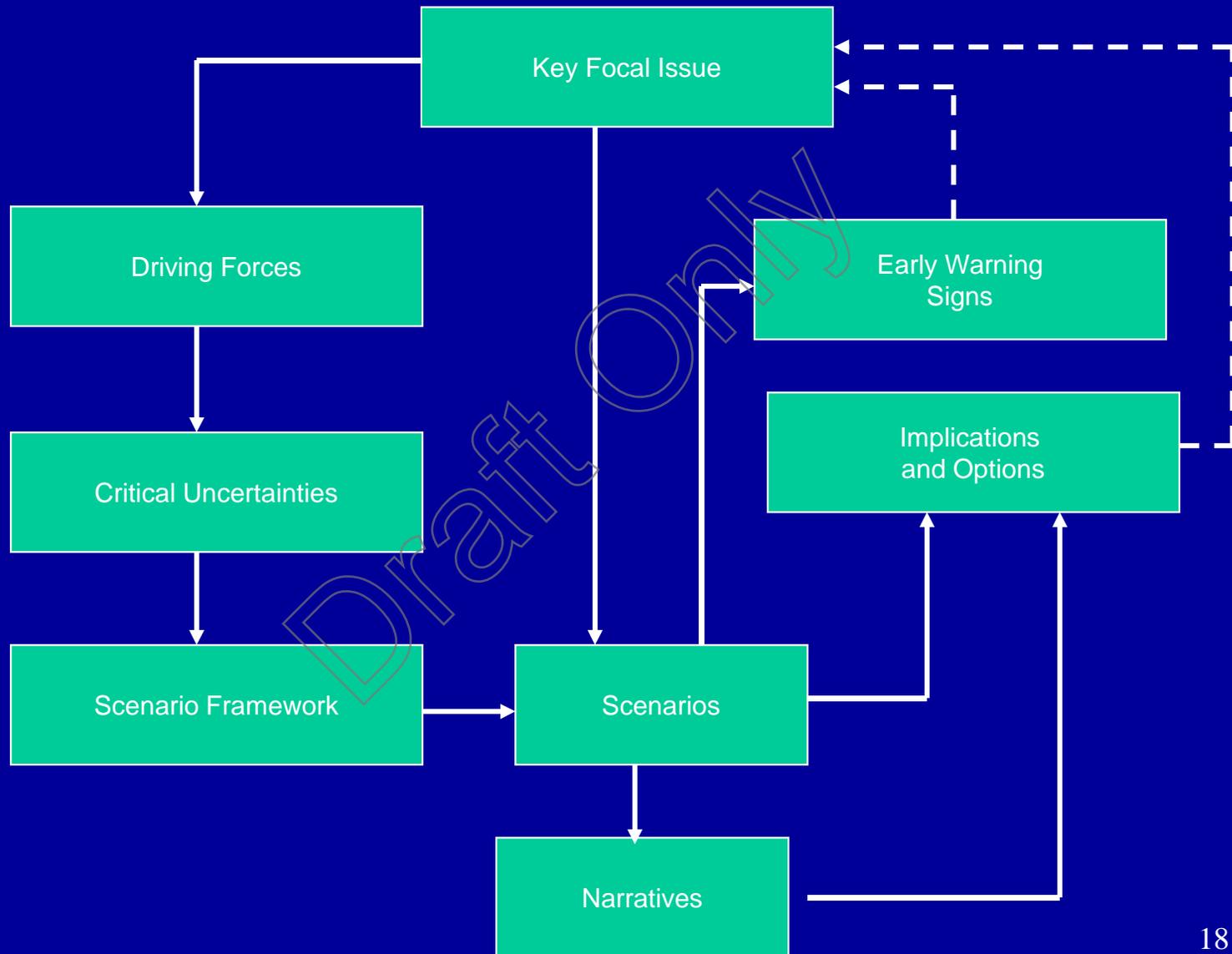
D,F,G are areas of no interest to customers

Scenario Planning

It defines the major forces affecting the direction of a company's future, by

- (1) Mapping out a small number of alternative futures (scenarios),
- (2) Defining narratives to describing these scenarios, and
- (3) Developing options for managing these futures.

Scenario Planning Process



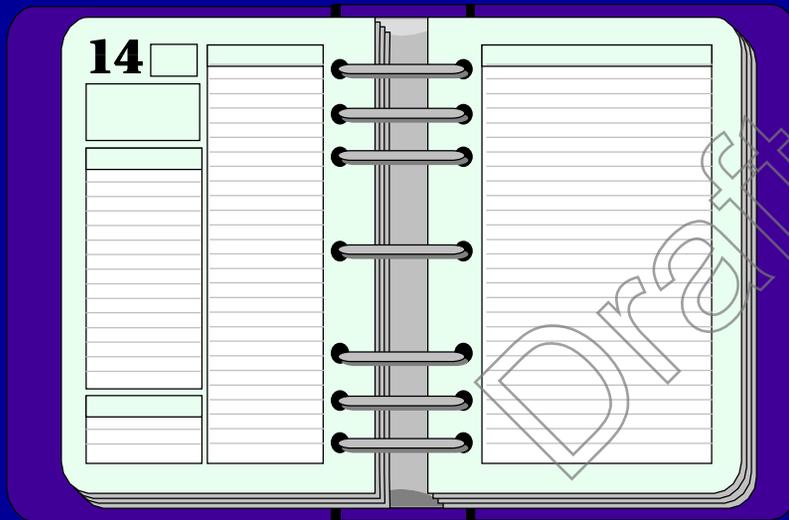
Scenarios Planning Example

- Company needs to make a significant decision = Strategy uncertainty
- Driving forces = Themes and trends impacting on decision
- Define the top two driving forces = critical uncertainties & make a 2x2 Scenario framework , identify 4 futures
- discuss implication of 4 futures on key decision to gain insights

Eight Scenarios for Three Critical Uncertainties

#	Uncertainty 1	Uncertainty 2	Uncertainty 3
1	High	Low	Low
2	High	High	Low
3	Low	Low	Low
4	Low	High	Low
5	High	Low	High
6	High	High	High
7	Low	Low	High
8	Low	High	High

Operational Planning



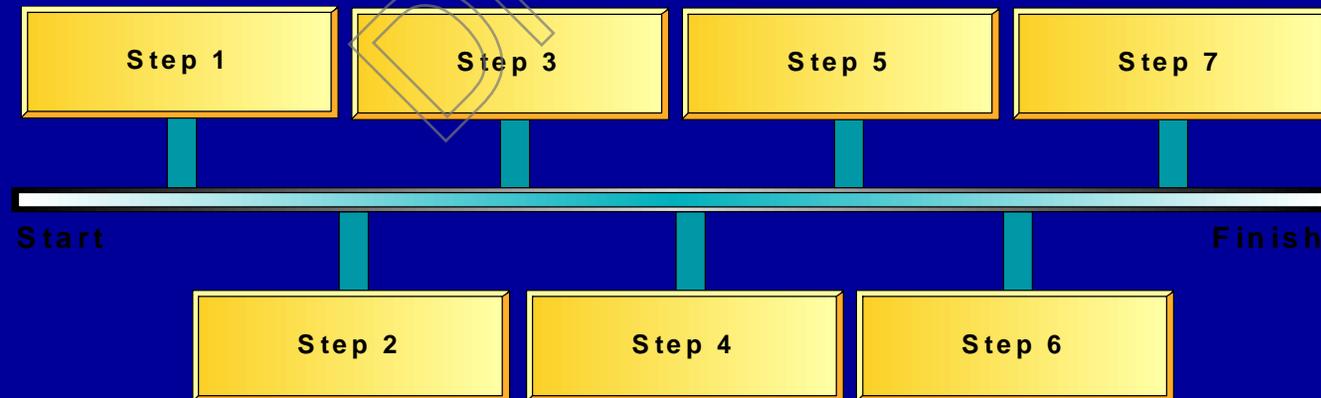
- Define tasks/events to be accomplished with the least amount of resources within the shortest time, to assure that the company applies its resources efficiently to achieve its short-term and long-term goals

Operational Planning Questions

- What is the most efficient way of accomplishing a project/task with known objectives (doing things right) ?
- How to link up with three best suppliers in the marketplace for parts needed?
- What are the operational guidelines for performing a specific work process?

Tools for Operational Planning

- Project management including action planning
- Design, test and analysis procedures
- Operational guidelines



Sample Performance Metrics

- **Customer-Related** (product defect count, satisfaction score, product life cycle cost)
- **Process-Related** (time to market, unit product cost, # new products per year)
- **Financial** (gross margin, profitability, ROE)
- **Employee-Related** (turnover ratio)
- **Competition-Related** (market share, cost of innovation, growth rate)

Question #2.6

- Quality may be defined differently by different people in a company. Explain why that is usually the case. Which quality definition is the correct one for the company to adopt?

Activities Related to Planning



Forecasting

- To estimate and predict future conditions and events (e.g., technology, products, marketplace - customers, competition and economy, global supply chains, manpower, capital and facilities)



Purposes of Forecasting

- Set bounds for possibilities to help focus on specifics
- Form basis for setting objectives
- Promote inter-group coordination
- Provide basis for resources allocation (manpower, budget, facilities and business relations - alliances, joint ventures)
- Induce innovation through forecasted needs

Steps to Forecast

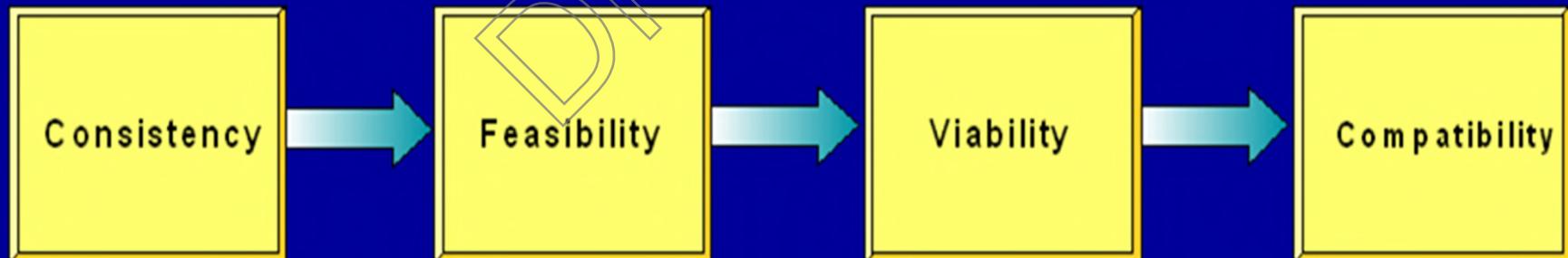
- Identify critical success factors for achieving company goals
- Determine forecasting horizon (short, intermediate and long terms)
- Select forecasting techniques (e.g., trend analysis, statistics, intuition, judgement)
- Predict future states and their probability of occurrence

General Comments on Forecasting

- Major economic events tend to change gradually over time
- Future events tend to result from current and past occurrence, in the absence of disruptive changes (e.g., wars, natural disaster, technology break through)
- Important sources of market information:
Customers, sales, production, service people

Criteria for Future-Oriented Ideas

- Consistency with company's objectives
- Technical feasibility to implement
- Financial viability
- Marketplace compatibility



Technology Forecast

- Impact of new technology on business performance is difficult to forecast
- Engineering managers are in the best position to do forecasting
- Teams of people with divergent experience, exposure and broad perspectives may have a better chance to accurately forecast the future technology impact



Examples of Challenging Questions

- Will the next waves of new products be the smart appliances? What will be the impact, if many products are made smart, as the processors are getting more powerful and intelligent devices getting smaller and more mobile (e.g., RFID)
- What might be the impact of nano-technology?
- How about the “info-imaging” technologies?
- Any value of the “molecular computing” companies like Hewlett Packard and IBM are working on?

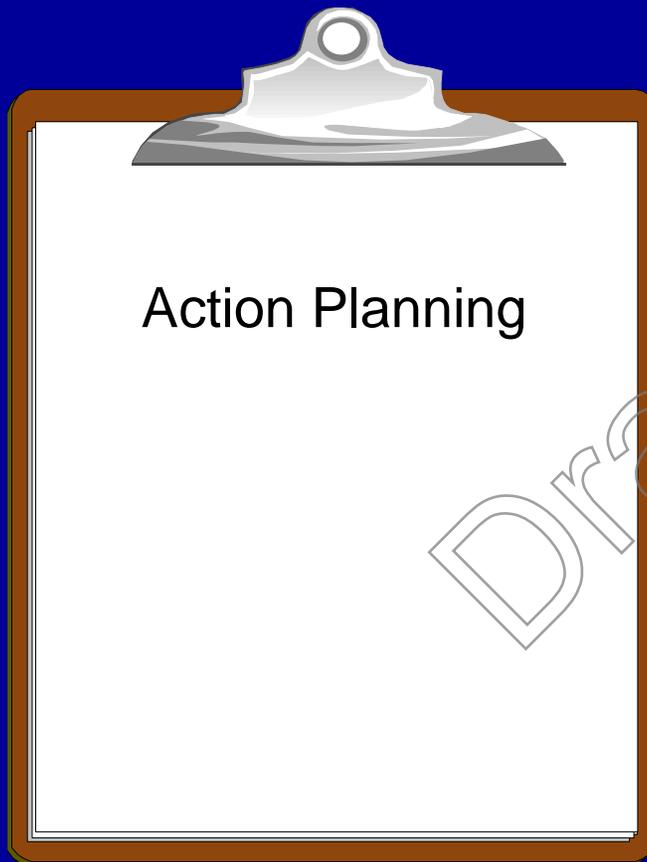
Examples of Challenging Questions (cont'd)

- How to gauge the impact of “cloud computing” on the consumer markets, as Apple is developing watches, iPhones and other miniature devices to provide access to Internet?
- How quickly has PCs been losing market values, once alternative devices are becoming available to access internet and home appliance, purchase goods/services, and activate entertainment programs remotely?

Technology Forecasting - Some Guidelines for Engineers

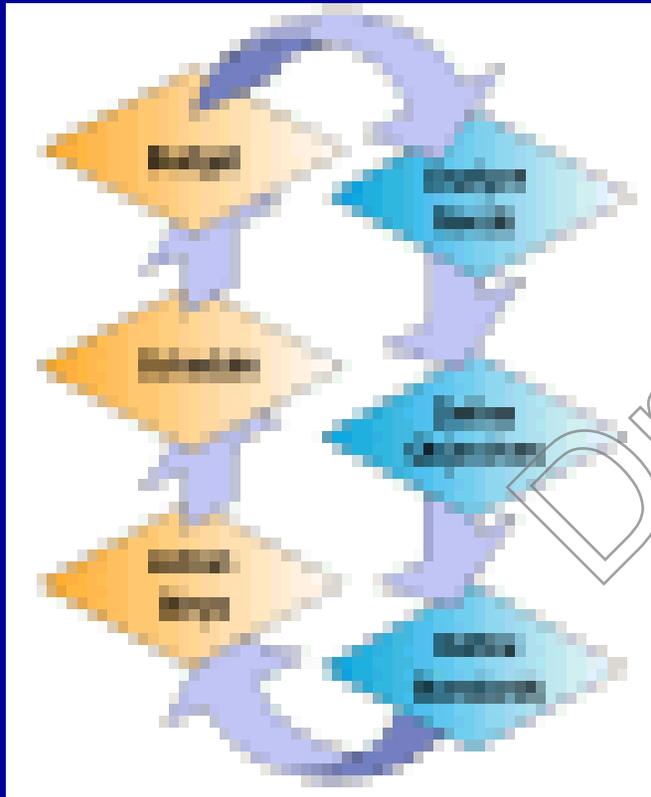
- *Read* broadly and *think* deeply
- *Remain* curious about new technological inventions and innovative applications
- *Ask* critical questions and *exchange* ideas with networked professionals
- *Focus* on potential applications of new technologies which could add value to future customers

Action Planning



- Benefits: (1) **Focus** on critical areas in need of management attention, (2) **Select** specific results to be accomplished, (3) **Set** metrics to facilitate measurement and control, (4) **Clarify** accountability and permit delegation, (5) **Encourage** teamwork, (6) **Ensure** the continuation of overall performance evaluation

Action Planning



- Planning Process
 - (1) **Analyze** Critical needs,
 - (2) **Set** Objectives (what results to be accomplished),
 - (3) **Define** metrics to measure performance,
 - (4) **Specify** actions steps (sequence and priority of tasks to perform),
 - (5) **Determine** dates of task initiation and completion,
 - (6) **Develop** a budget (resources to allocate)

(A) Analyze Critical Needs

- Needs are to be defined with respect to position charter, duties, management expectations, and company goals:
 - (1) development needs,
 - (2) maintenance needs,
 - (3) deficiency needs, and
 - (4) strategic needs
- Short-term and long-term needs

(B) Set Objectives

- Objectives are set to satisfy the critical needs: Write results statement (e.g., what desirable future state to be in and by when)
- Objectives need to be specific and measurable, in order to be useful

(C) Define Metrics

- Metrics are what takes to measure the attainment of the objectives (be reasonable and pertinent) - Write standards statement
- Metrics need to be quantitative (using numbers, percentages, cost figures, resources parameters) - external and internal
- Metrics need to be defined with doers' participation and consent

(D) Specify Action Steps

- List major action steps, identify work contents, define sequential relationship between steps, determine resources requirements for each, specify expected results, and assign people to each action step (getting doer's to agree)
- Evaluate risk for completing the steps planned, define contingencies to manage risks

(E) Determine Schedule

- Determine dates of initiation and completion of each task
- Allow scheduling flexibility (slag) to account for contingency, emergency and other difficult-to-predict deviations from plan
- Focus on management of critical path tasks to avoid any overall delays

(F) Develop Budget

- Determine the basic resources units (man-hours, man-weeks) to accomplish each steps
- Define other resources (computation, travel expenses, materials, experiments, equipment usage, pilot tests, contract services, support staff, management review, etc.)
- Revise action steps, if projected cost exceeds value expected

Remarks on Action Planning

- Involve doers in action planning
- Apply computer-based tools (e.g., Microsoft Project, Timeline) to generate PERT or GANTT charts
- Include risks and contingency steps
- Iterate planning process until all parties (top management, doers, team leader, service providers, etc.) involved are satisfied

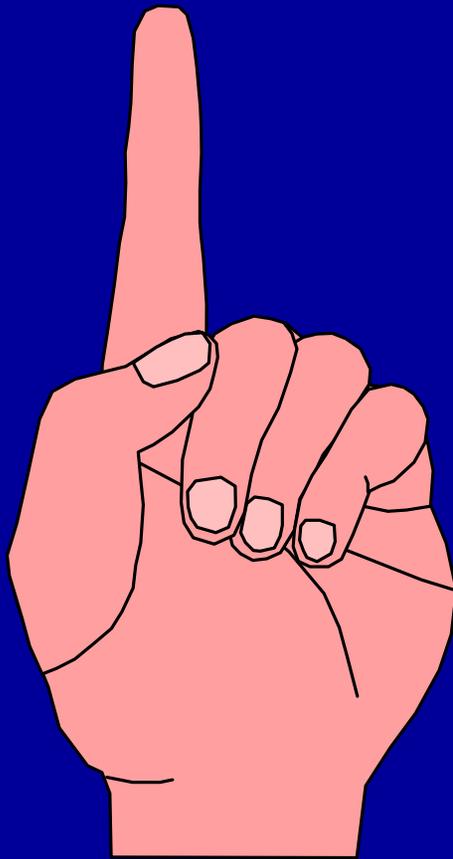
Question # 2.1

- On the eve of leaving his alma mater, Joe Engineer remembers the encouraging words of the commencement speaker, “Graduation is the happy beginning of an exciting life ahead.” He is of course excited about his new Master of Engineering degree, which he received with honor. But he is also a bit confused about what to do now to make his new life exciting and happy. Apparently, what he needs is a road map into the future. How can you help him?

Question # 2.2

- Joe Engineer took a course while going to graduate school at SUNY-Buffalo. There, he learned the importance of planning. He knows that luck plays a big role in one's life. But he is convinced that a proper planning will help him to have an orderly progression in his career. He thinks that it would be cool to become an CEO at the age of 60 and retiring at 65 with a net worth of \$10 MM. He wants some guidance on career planning. How can you help him?

Issuing Policies



- **Policies** are directives, promulgated to address repetitive questions and issues of general concern
- **Examples:** Hiring/firing guidelines, EEO, performance appraisal, drug policy, savings program, medical insurance, retirement benefits, educational refunds, travel expenses and trip report, technical publications, plant safety, progress reports, staff meeting, etc.

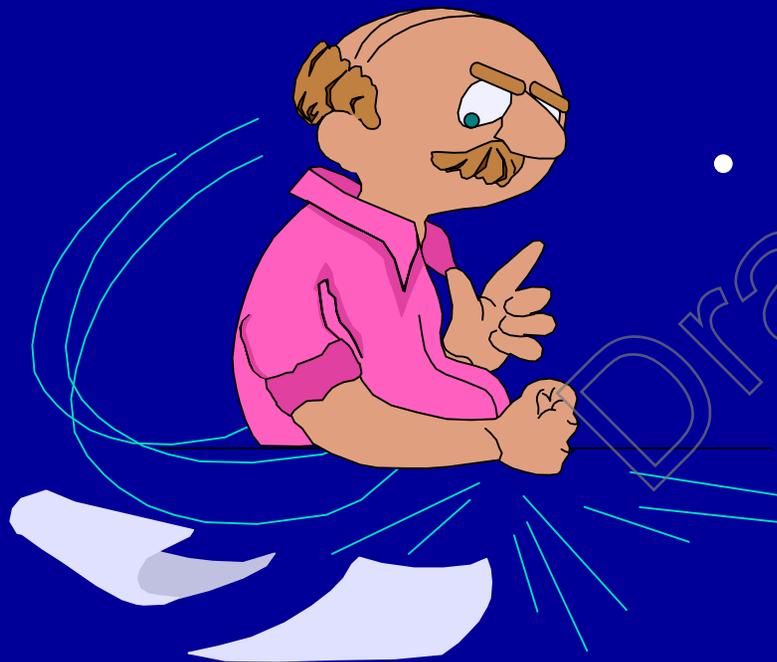
Purposes of Policies

- *Save* management time and efforts, as they address the common and repetitive questions of interest to a large number of employees (policy manuals, web posting)
- *Capture* the distilled experience and past learning of the company
- *Facilitate* delegation (administered by the secretaries, or human resources group)

Characteristics of Policies

- **Apply** uniformly to all employees
- **Being** relatively permanent, when in force
- **Foster** corporate objectives (assure equal treatment of all, encourage skills building via education and seminar attendance, reducing conflicts due to interpretation difference, encourage teamwork, free managers to focus on important work, etc.)

Establishing Procedures

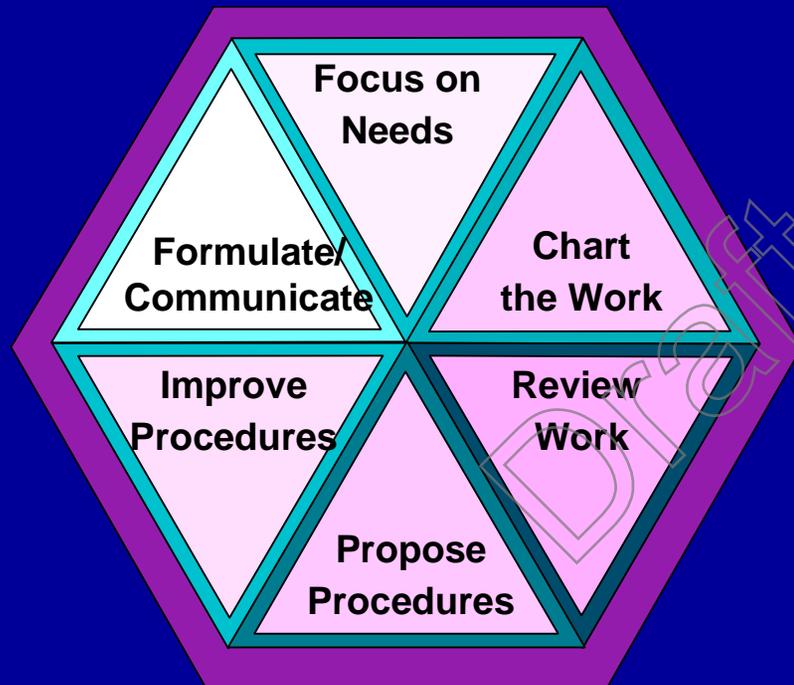


- **Procedures** are standardized (tried-and-true) method of performing work
- **Examples:** Product design, project management, equipment operation, facility maintenance, installation, procurement, ISO 9002 certification, manufacturing, waste disposal, customer service, customer order processing, and others

Importance of Procedures

- **Preserve** the “best” way to perform repetitive work (efficiency-focused)
- **Provide** the basis for method improvements
- **Insure** standardized action (quality control, resource conserving, work reproducibility)
- **Simplify** training
- **Save** corporate memory (know-how, knowledge, heuristics, proven practices)

Developing Procedures



- (1) Concentrate on critical needs
- (2) Chart the work
- (3) Review work
- (4) Propose procedure
- (5) Improve procedures
- (6) Formulate/
communicate procedures

Developing Procedures

- (1) *Concentrate* on critical repetitive work of time-consuming and high demand nature
- (2) *Chart* the work (inputs, workflow, outputs, skills, resources)
- (3) *Study* work characteristics (Why is it necessary? What results to get? When is best time, where is best place, and who is best person to develop it?)

Developing Procedures (cont'd)

- (4) *Propose* procedures (keeping to a minimum to avoid being restrictive, and enable its consistent administration)
- (5) *Define* regular improvements to procedures
- (6) *Formulate* procedures and communicate widely to assure understanding and acceptance by all involved

Ingredients of Good Planning



Key Ingredients

- (1) *Assumptions* - Get information, forecast future states, and study/select alternatives, check validity frequently
- (2) *People* - Consider involving doers and introduce changes gradually to avoid resistance.
- (3) *Benefit versus Cost* - Efforts to implement plan must be commensurate with value expected of the plan (effectiveness doctrine)

Key Ingredients (cont'd)

- (4) *Small but Sure Steps* - Design a series of small steps to reach the expected results, allow timely control and mid-course corrections
- (5) *Change in Future* - Anticipate changes in future conditions and include contingency steps with fallback strategies
- (6) *Commitment* - Secure commitment of sufficient resources to achieve plan objectives

Question # 2.7

- There are always risks associated with the experimentation of a new manufacturing process or with the entry into a new global market, the risks of failure. How should one decide to proceed or not to proceed with a risky venture? What is the proper level of risks to take?

Question # 2.8

- The Marketing Director needs to submit a strategic plan for entering a new market. He knows he needs long periods of uninterrupted time. He considers two options: (1) Staying at home to develop the plan, (2) Delegating some parts of the plan to subordinates. What are the factors the Director needs to consider when he picks the best way to create this plan?

Summary

- Planning is an important engineering management function, involving (1) forecasting, (2) action planning (3) issuing policies and (4) establishing procedures
- Forecasting and strategic planning are difficult, with performance being unpredictable
- Others planning activities are administrative/operational in nature and should appear relatively easy to everyone

Question # 2.3

- The company has always been focused on the high-quality high-price end of the market. Now, market intelligence indicates that some competitors are planning to enter the low-price low-quality end of the market. What should the company do?

Question # 2.4

- Mission and value statements are indicative of the directions to which a company is headed. What are typically included in the statements of Mission and Value of some well-known companies in the U.S.? Please advise.

Question # 2.5

- What are included in the operational guidelines some industrial companies have developed? Please advise.

Question # 2.9

The Office Equipment Company is headed by Glen Jordon, President, who is supported by four people: Ray Fisk, VP Sales, Terry Buford, VP Manufacturing, Fred Hunter, Director of Research, and Bob Christian, Director of Corporate Planning. The company has produced typewriters, calculating machines (desktop with paper tape), accounting machines, and tabulating equipment in the last 40 years. Until two years ago, the company performed well, based on

- A. Reputation for quality products and services.
- B. Sales increases over the years.
- C. Rate of return better than others.
- D. Engineering research concentrated on improving existing machines, with new models every few years by introducing small incremental changes.

However, there had been some significant changes in the last two years. For example:

- A. Typewriters sales continued to increase.
- B. Sales of accounting machines and tabulating equipment become stagnant.
- C. Sales of calculating machines dropped more than 50%, due to the low cost hand-held calculators.
- D. Customers hold off purchases of traditional products to evaluate minicomputers.

The company is at a crossroads. Two strategic plans were presented to the Board of Directors for review, including budgets.

1. Plan A (Ray Fisk and Terry Buford)

A. Continue with company's current products. Improve sales through a National Promotion Program:

- Increase advertising budget by 50% to expand market share by 15%, including price cut, if needed.
- Delay a plant modernization for one year.
- Cut R&D by 15%.
- Restore plant modernization and Engineering Research through sales increase in one year.

B. Supporting Arguments

- Projected sales of calculators will remain at present level.
- Company's overall sales will rise by 10 % per year for the next ten years.
- Customers will want special-purpose transistorized equipment, not complicated minicomputers.
- Full utilization of present resources (e.g. marketing organization and approach, production facilities and skills, management experience, etc.)

C. Opposing arguments

- Ignore the roots of company's problems being technology obsolescence and customer's changed needs.
- Advertisement addresses only the issue of product awareness, not technology obsolescence and performance deficiency (e.g. size, convenience, integrated operations, etc.).
- Plan's assumption is not supported by data available.
- Cycling Engineering Research by 15% is impractical.
- Plan represents only a one-year program, not a long-term strategy.

2. Plan B (Fred Hunter and Bob Christian)

A. Change company's business by entering the fields of microprocessors and minicomputers.

- New line of minicomputers (large scale integrated circuit microprocessor) for office, financial and data processing use in small to medium size organizations.
- New line of typewriter, using integrated circuits and internal memory.
- Double Engineering research staff in two years.
- Continue engineering research on typewriters and drop work on other three.
- Delay plant modernization indefinitely.
- Make major corporate commitment to raise new capital through bond or preferred stock.

B. Supporting Arguments

- Revolutionary impact of microprocessor on company business is forecasted:
 - (a) Rapid reduction of microprocessor cost.
 - (b) Significant increase in the use of microprocessors.
 - (c) Sales of company's current products are projected to reduce to zero in eight years.
 - (d) Sales of typewriters to drop 50% in ten years.
 - (e) Company is already 5 years behind.
- Company's long term survival depends on a timely entry into the minicomputer market.

C. Opposing Arguments

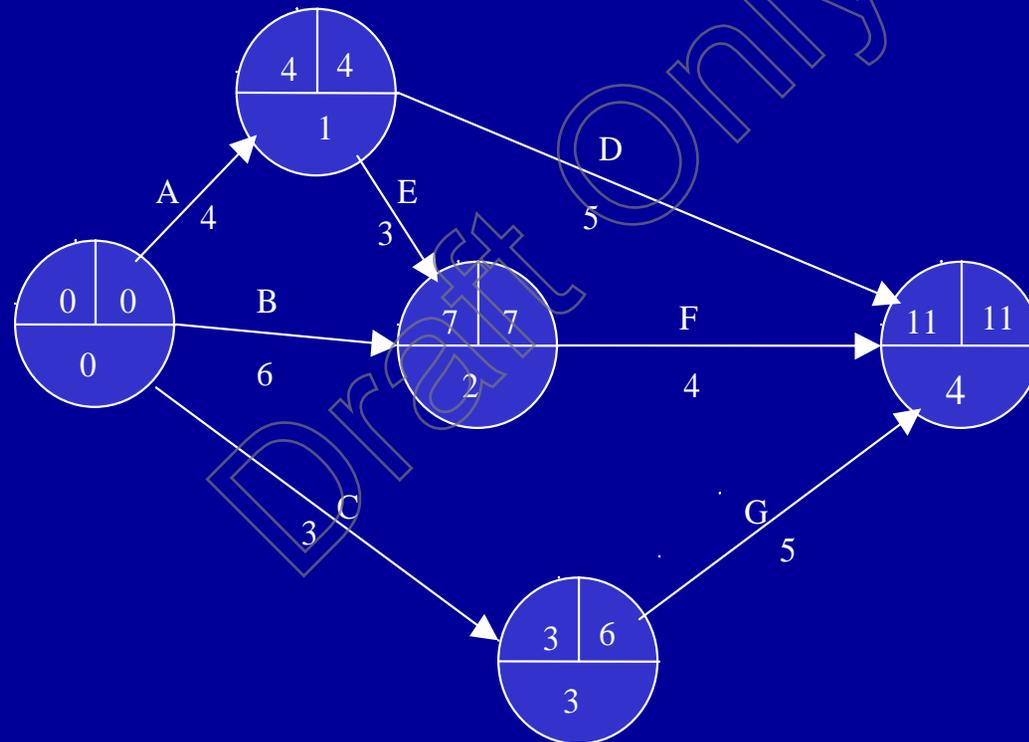
- Forecast is not believable.
- Switching company into new technology will need different marketing approach, organization, sales forces, outlets, production facilities, equipment, quality control, inventory management techniques, and management experience.
- Require large capital investment.

Analyze this case and answer three questions: (1) Determine why each of the participants are taking the positions indicated before the Board of Directors? (2) As Chairman of the Board, what action would you take? (3) Is Jordon taking the right approach?

Question # 2.10

- In planning for a project, the Critical Path Method (CPM) is being used widely in industry. Explain the basic concepts and techniques involved, illustrate it using an example, and discuss its advantages and disadvantages.

Answer # 2.10 (CPM Chart)



Answer # 2.10 (PERT Chart)

