Lecture#1 Reservoir Management Process

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Introduction

- The modern reservoir management process involves establishing a pur pose or strategy and developing a plan, implementing and monitoring the plan, and evaluating the results (Figure 1).
- Integration of all these are essential for successful reservoir management. It is dynamic and ongoing.
- While a comprehensive plan for reservoir management is highly desirable, every reservoir may not warrant such a detailed plan because of cost effectiveness.
- The key to success is to have a management plan (whether so comprehensive or not) and implement it from day one.

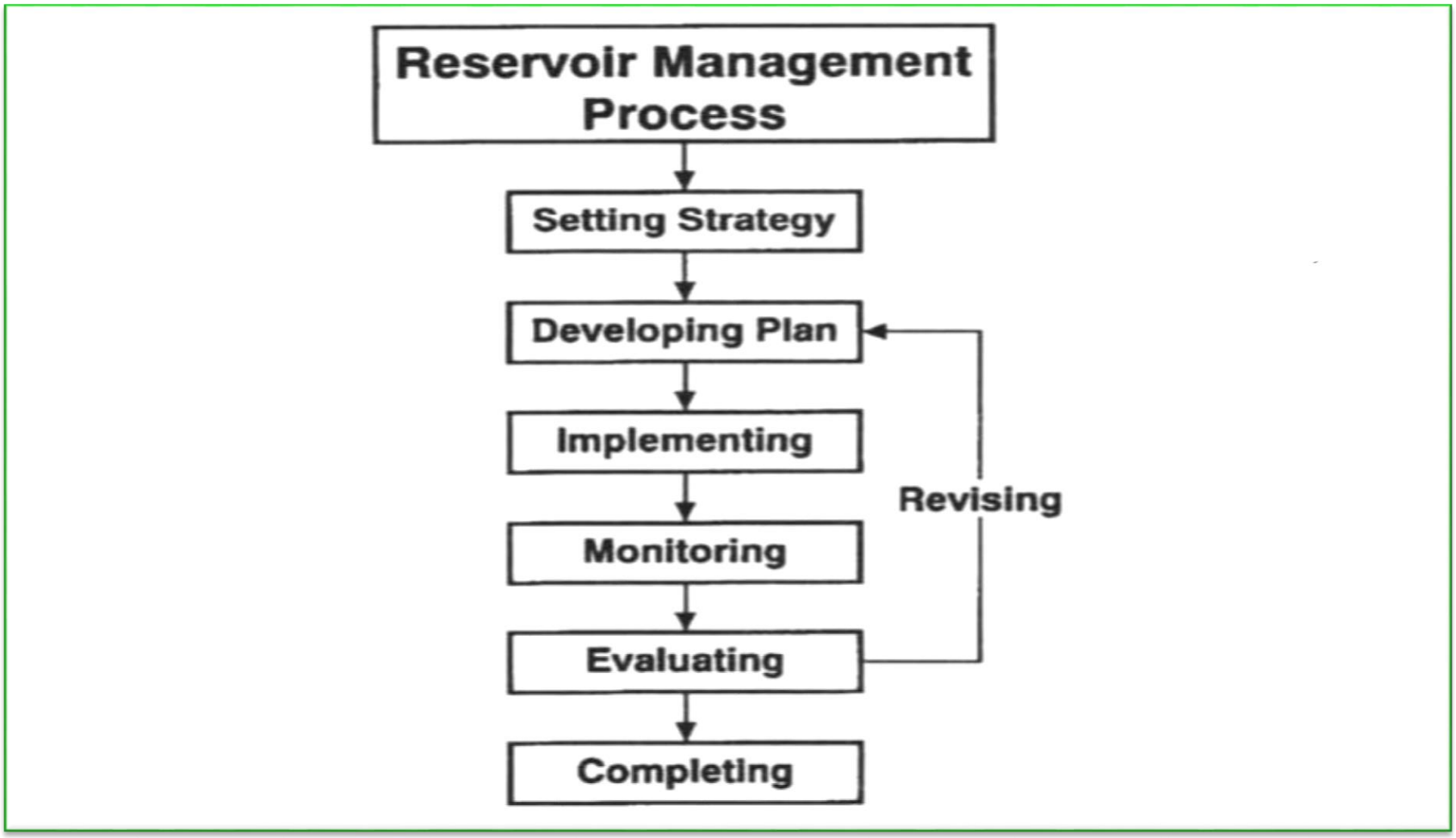

Figure (1): Reservoir Management Process ***(Copyright @ 1992, SPE, from paper 22350)***

Setting Goals

- Recognizing the specific need and setting a realistic and achievable purpose is the first step in reservoir management.
- The key elements for setting a reservoir management goal are:

➢ Reservoir characteristics.

➢ Total environment.

➢ Available technology.

- Understanding of each of these elements is the prerequisite to establishing short- and long-term strategies for managing reservoirs.

Reservoir Characteristics

- The nature of the reservoir being managed is vitally important in setting its management strategy.
- Understanding the nature of the reservoir requires a knowledge of the geology, rock and fluid properties, fluid flow and recovery mechanisms, drilling and well completions, and past production performance (Figure-2).

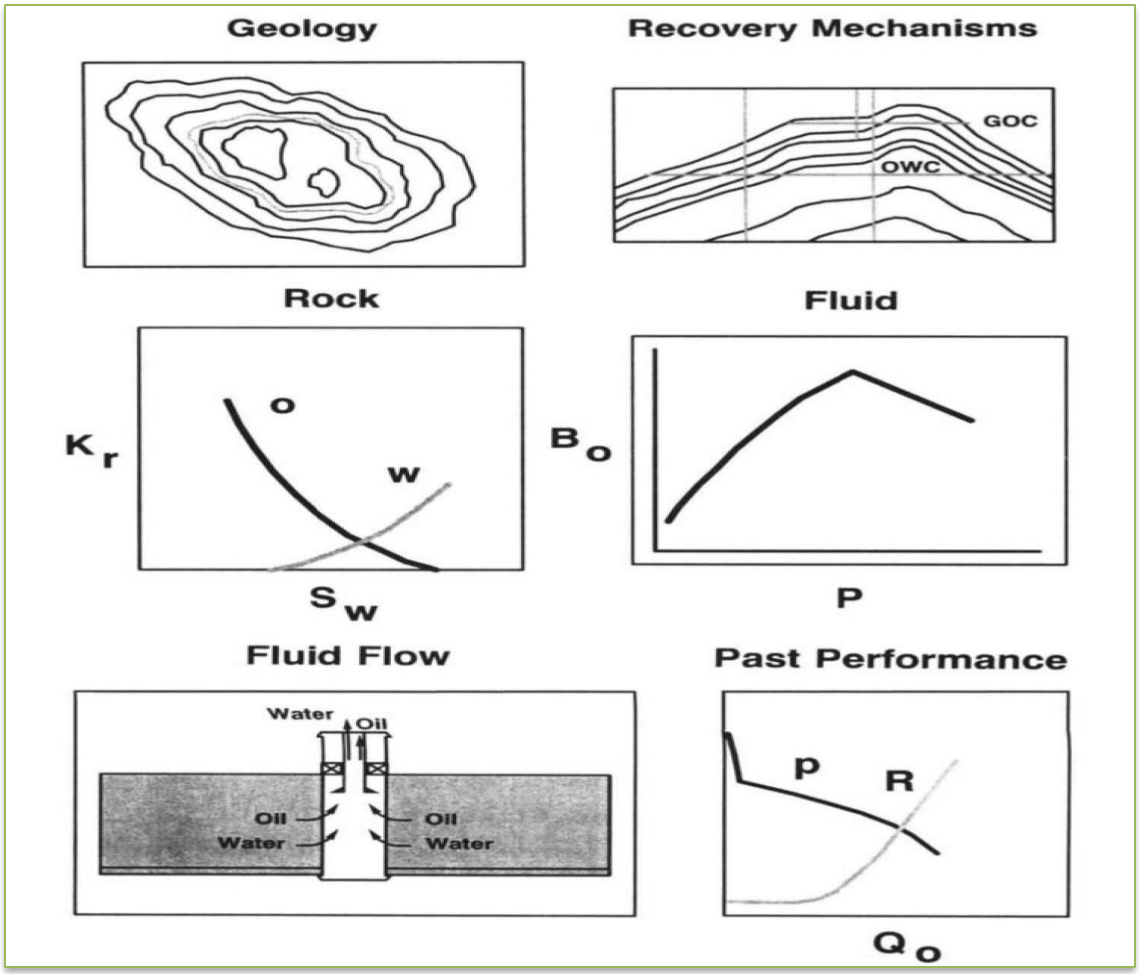

Figure (2): Reservoir Knowledge ***(Copyright @ 1992, SPE, from paper 22350)***

Total Environment

- Understanding of the following environments is essential in developing management strategy and effectiveness:

➢ Corporate-goal, financial strength, culture, and attitude.

➢ Economic-business climate, oil/gas price, inflation, capital, and personnel availability.

➢ Social-conservation, safety, and environmental regulations.

Technology and Technological Toolbox

- The success of reservoir management depends upon the reliability and proper utilization of the technology being applied concerning exploration, drilling and completions, recovery processes, and production (Table-1).
- They offer opportunities that may or may not be appropriate for every reservoir.

Geophysics	Geology	Production Engineering	Reservoir Engineering
2D Seismic	Core Description	Economics	Portfolio Management
3D Seismic	Thin Sections	Data Acquisition & Management	Log Analysis
Cross-Hole Tomography	Microscopes	Well Stimulation	Transient Well Tests
Vertical Seismic Profile	Image Analysis	Pipeflow Simulation	Conventional Core Analysis
Multicomponent Seismic	X-Ray	Wellbore Simulation	CT Scan, NMR
Shear Wave Logging	Stable Isotope Analysis	Nodal Analysis	Fluid Analysis
	Depositional Models		Decline Curve Analysis
	Diagenetic Models		Material Balance
	Maps, Cross-Sections		Waterflood
	Remote Sensing		Streamtube Models
			Reservoir Simulation
			Geostatistics
			EOR Screening
			EOR Technology
			Expert Systems
			Neural Networks

Table (1): Technology ***(Copyright @ 1992, SPE, from paper 22350)***

Developing Plan and Economics

- Formulating a comprehensive reservoir management plan is essential for the success of a project. It needs to be carefully worked out involving many time-consuming development steps (Figure 3) .

Development and Depletion Strategy

- The most important aspect of reservoir management deals with the strategies for depleting the reservoir to recover petroleum by primary and applicable secondary and enhanced oil recovery methods.

- Development and depletion strategies will depend upon the reservoir's life stage.
- In case of a new discovery, we need to address the question of how to best develop the field (i.e., well spacing, number of wells, recovery schemes, primary, and subsequently secondary and tertiary).
- If the reservoir has been depleted by primary means, secondary and even tertiary recovery schemes need to be investigated.

Figure (3): Developing Plan ***(Copyright @ 1992, SPE, from paper* 22350)**

Environmental Considerations

- In developing and subsequently operating a field, environmental and ecological considerations have to be included.
- Regulatory agency constraints will also have to be satisfied.

Data Acquisition & Analysis

- Reservoir management starting from developing a plan, implementing the plan, monitoring and evaluating the performance of the reservoir requires a knowledge of the reservoir that should be gained through an integrated data acquisition and analysis program (Figure 4).

- Data analyses require a great deal of effort, scrutiny, and innovation.
- The key steps are

➢ Plan, justify, time, and prioritize.

➢ Collect and analyze.

➢ Validate/store (data base) .

- An enormous amount of data are collected and analyzed during the life of a reservoir.
- An efficient data management program consisting of collecting, analyzing, storing and retrieving is needed for sound reservoir management.

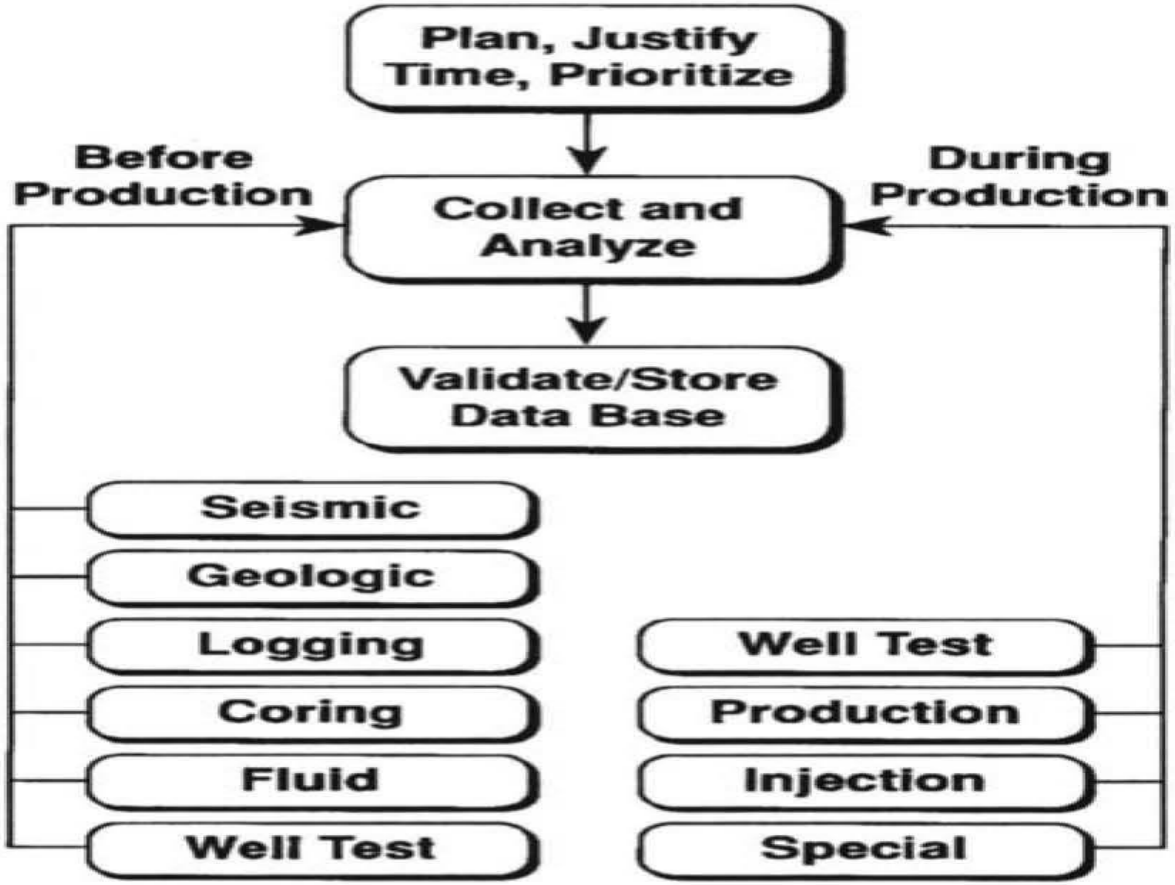

Figure (4): Data Acquisition & Analysis *(Copyright @ 1992, SPE, from paper 22350)*

Geological and Numerical Model Studies

- The geological model is derived by extending localized core and log measurements to the full reservoir using many technologies, such as geophysics, mineralogy, depositional environment and diagenesis.
- The geological model, particularly the definition of geological units and their continuity and compartmentalization, is an integral part of geostatistical and ultimately reservoir simulation models.

Production and Reserves Forecasts

- The economic viability of a petroleum recovery project is greatly influenced by the reservoir production performance under the current and future operating conditions.
- Therefore, the evaluation of the past and present reservoir performance and forecast of its future behavior is an essential aspect of the reservoir management process (Figure 5).
- Reservoir simulators play a very important role in formulating initial development plans, history matching and optimizing future production, and in planning and designing enhanced oil recovery projects.

Analyzing Reservoir Performance and Estimating Reserves Methods

- Classical volumetric.
- Material-balance.
- Decline-curve analysis methods.
- High-technology black oil.
- Compositional and enhanced oil recovery numerical simulators .

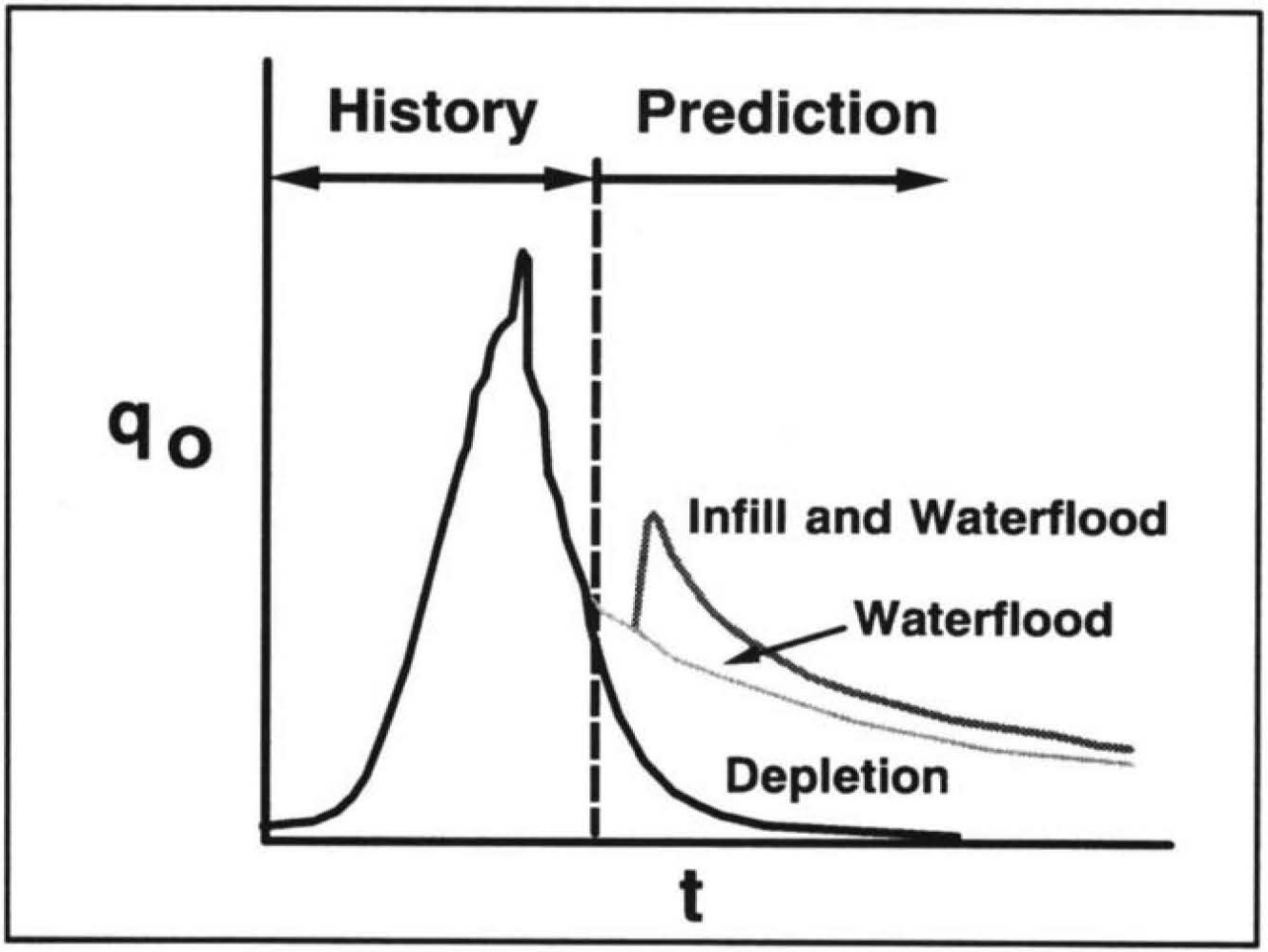

Figure (5): Production and Reserves Forecasts *(Copyright @ 1992, SPE, from paper 22350)*

Facilities Requirements

- Facilities are the physical link to the reservoir. Everything we do to the reservoir, we do through the facilities.
- These include drilling, completion, pumping, injecting, processing, and storing.
- Proper design and maintenance of facilities has a profound effect on profitability.
- The facilities must be capable of carrying out the reservoir management plan, but they cannot be wastefully designed.

Economic Optimization

- Economic optimization is the ultimate goal selected for reservoir management. Figure (6) presents the key steps involved in economic optimization.

Management Approval

- Management support and field personnel commitment are essential for the success of a project.

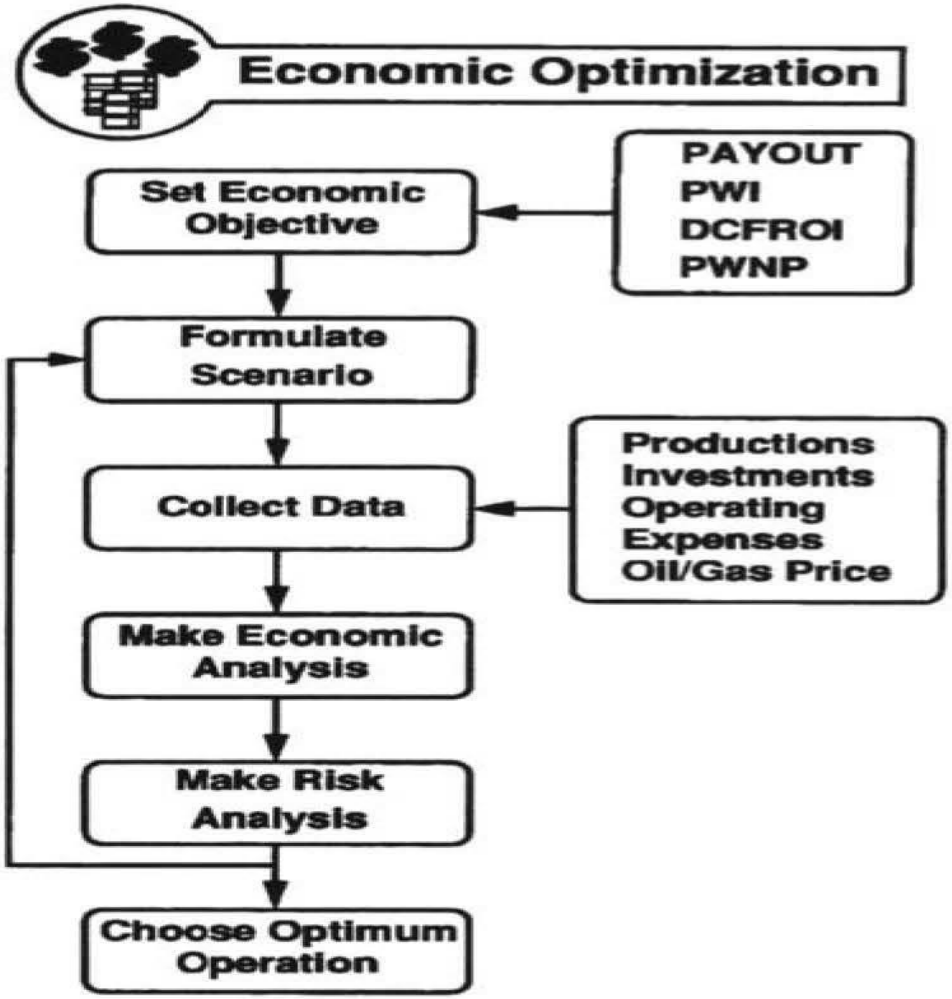

Figure (6): Economic Optimization *(Copyright @ 1992, SPE, from paper 22350)*

Implementation

- Once the goals and objectives have been set and an integrated reservoir management plan has been developed, the next step is to implement the plan.

- The first step involves starting with a plan of action, including all functions.
- Start with a plan of action, involving all functions.
- Flexible plan.
- Management support.
- Commitment of field personnel.
- The plan must be flexible.

- Periodic review meetings, involving all team members (inter disciplinary cooperation in teaching each other's functional objectives).
- The plan must have management support.
- No reservoir management plan can be implemented properly without the support of the field personnel.
- It is critical to have periodic review meetings, involving all team members.

- The important reasons for failure to successfully implement a plan are:
  (1)lack of overall knowledge of the project on the part of all team members.
  (2) failure to interact and coordinate the various functional groups.
  (3) delay in initiating the management process.

Surveillance and Monitoring

- Sound reservoir management requires constant monitoring and surveil lance of the reservoir performance.
- In case of enhanced oil recovery projects, the monitoring and surveillance program is particularly critical because of the inherent uncertainties.
- The major areas of monitoring and surveillance involving data acquisition and management include:

(1) Oil, water and gas production.

(2) Gas and water injection.

(3) Static and flowing bottom hole pressures.

(4) Production and injection tests.

(5) Injection and production profiles.

Evaluation

- The plan must be reviewed periodically to ensure that it is being followed, that it is working, and that it is still the best plan.
- The success of the plan needs to be evaluated by checking the actual reservoir performance against the anticipated behavior.
- The actual performance (e.g., reservoir pressure, gas-oil-ratio, water-oil ratio, and production) needs to be compared routinely with the expected (Figure-7).
- In the final analysis, the economic yardsticks will determine the success or failure of the project.

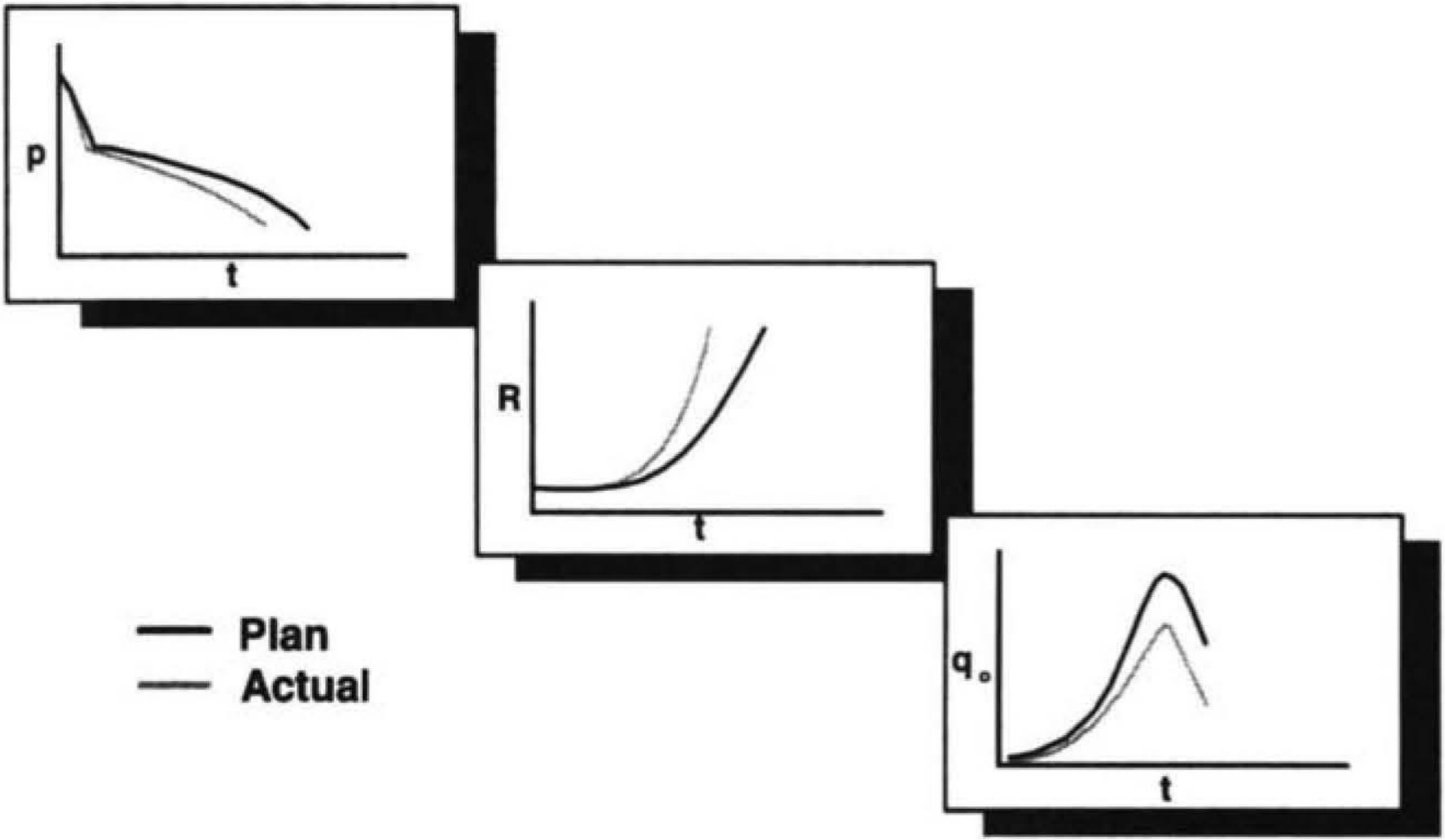

Figure (7): Evaluation *(Copyright @ 1992, SPE, from paper* 22350)

Revision of Plan and Strategies

- Revision of plans and strategies is needed when the reservoir performance does not conform to the management plan or when conditions change.

Reasons for Failure of Reservoir Management Programs

- There are numerous reasons why reservoir management programs have failed. Some of the reasons are:

➢ Unintegrated System.

➢ Starting Too Late.

➢ Lack of Maintenance

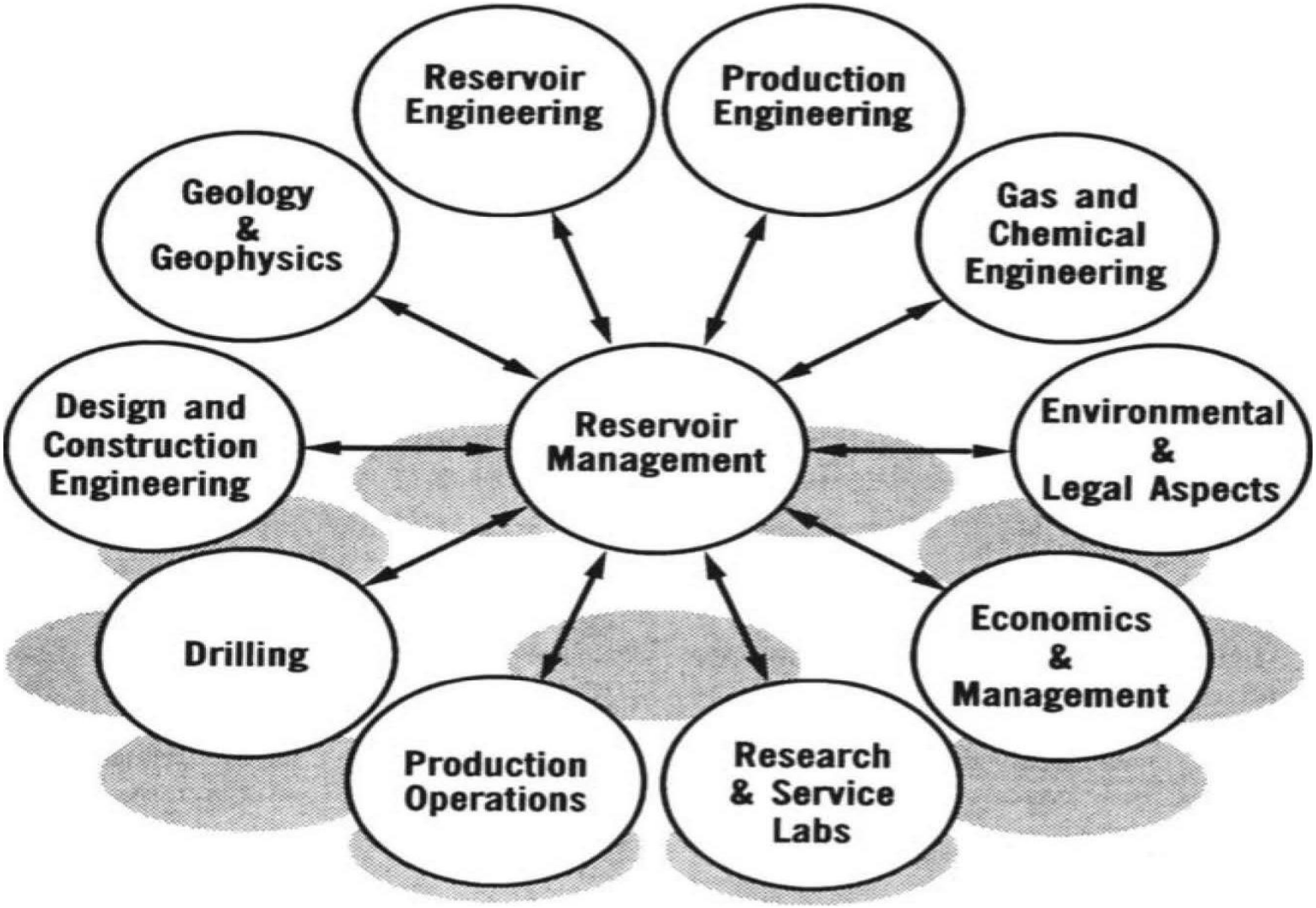

Figure (8): Reservoir Management Approach *(Copyright @ 1992, SPE, from paper 20748)*