

System Dynamics of Petroleum Development Training for Long-Term Cooperation Across Cultural Divides

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Abstract

This paper addresses the dynamics of energy development projects. Nationalization has repeatedly squandered the economic, physical and mental resources of large joint-ventures between multinational oil companies and developing countries. A deteriorating relationship between multinational oil company (MNO) management and regional hosts consistently leads to nationalization. This cultural gulf between corporation and regional host, while existent in many regions, is most significant in high conflict areas, which is why petroleum managers, with most of their experience in low conflict areas, have mostly ignored the cultural gulf. To form strong relationships that bridge the cultural gulf requires cultural sensitivity. Neighbor conflict studies show this problem to be most prevalent in developing countries, but also existent in emerging areas such as offshore California, Florida and Alaska.

The proposed microworld trains first world petroleum managers, through cause-effect analysis, that while cultural-sensitivity to the developing country's needs increases marginal costs, it lowers the probability of nationalization, generating positive project economics and raising expected payouts from extended project life.

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INTRODUCTION:

Failing multinational petroleum projects provoked by poor relationships between the MNOC and the developing country have squandered great economic, mental and physical resources. IPREMARA, an Integrated Petroleum REservoir MAnagement Risk Analysis system dynamics model, illustrates the cultural dynamics of development projects to petroleum managers and host region leaders. IPREMARA integrates the primary factors driving the international petroleum management environment to determine what interrelations exist.

This paper presents a set of hypotheses and their historical basis, then introduces a system dynamics model designed to test these hypotheses. Next, the paper details each field in the model and shows how the model integrates the fields. A brief description of system behavior follows, setting the stage for conclusions and plans for further research.

PRELIMINARY HYPOTHESIS:

- 1) IPREMARA, by systematizing international petroleum project economic analysis for culturally-sensitive investments, raises expected value.
- 2) IPREMARA, by raising the probability of complete economic reserve recovery, offsets the higher initial investment and costs required to promote cultural stability.
- 3) IPREMARA, by stabilizing the investment environment, promotes technology modernization making Latin American energy exploitation projects more efficient.
- 4) IPREMARA, by improving control over cultural stability and the investment environment, improves access to increasingly inaccessible and therefore increasingly valuable natural resources.

HISTORICAL BASIS

In developing countries, the multinational firm typically implements its standardized work culture (i.e., work ethic, modern western management styles, language, work hours, customs). Often this is substantially different from that of the host nation, which creates tension with the national workers. As host workers feel more competent in managing the project, they pressure government officials to nationalize the project and return to the national work culture. Coupling this with political instability multiplies the nationalization risk. The higher expropriation risk reduces the expected value of project cash flows by shortening the economic project life. Under these conditions, project IRR falls below the cost of capital. The MNOC regrets its project investment and the host country loses access to the advanced technology flow-stream needed to maintain and improve the large project.

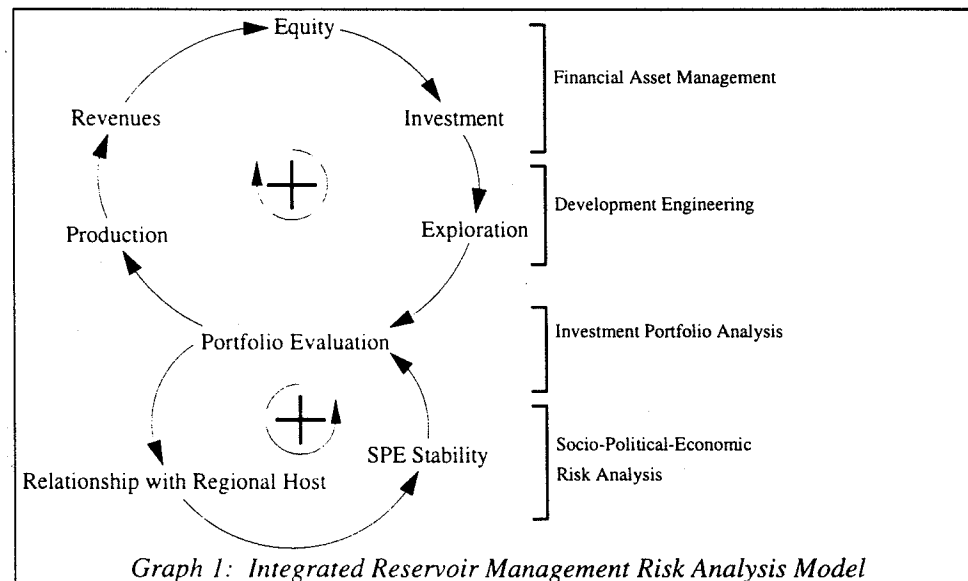
Concern over this reoccurring problem prompted this initial research into the variables that promote disintegrating relationships between the host country and the multinational company and frequent nationalization and expropriation.

INITIAL MODEL CONCEPT

IPREMARA integrates four interdependent fields usually considered independent: financial asset management, development engineering, investment portfolio analysis and socio-political-economic (SPE) risk analysis. The following brief definitions demonstrate the interdependency among these fields. Traditionally the separate disciplines indicated below took complete responsibility for each field, leading to independent analysis.

- Financial Asset Management:** Maximize project Return on Investment (ROI) by scheduling sales that determine production volumes.
⇒ by financial analysts
- Development Engineering:** Maximize recovered reserves over time by scheduling production volumes that determine sales.
⇒ by petroleum engineers and geoscientists
- Investment Portfolio Management:** Maximize firm's Return on Equity (ROE) by selecting portfolio of projects.
⇒ by middle to upper management
- SPE Risk Analysis:** Assess SPE environments for investment suitability.
⇒ by country risk specialists

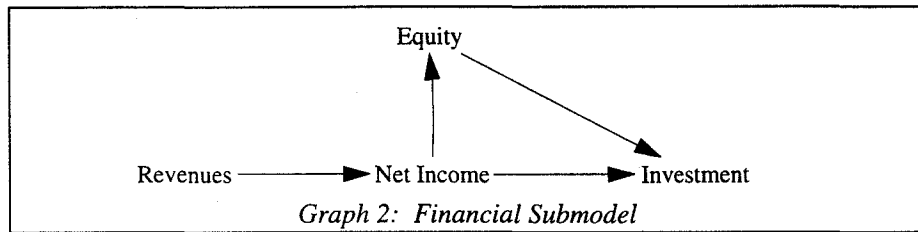
These definitions show obvious interdependencies among the fields - value maximization. However, separating the responsible disciplines filters relevant relationships from the global analysis. Losing relevant relationship information before the investment decision frustrates the shareholder wealth maximization goal. The IPREMARA model (Graph 1) integrates all four areas concurrently, ensuring that all relevant relationships enter the investment decision.



Story Line: In the petroleum business, production constantly depletes the MNOC's equity in its reserves. To maintain equity, MNOCs continually acquire reserves through purchase or exploration. This continuing experience in financial asset management, development engineering (including exploration technology), investment portfolio analysis and political risk analysis, allows MNOCs to better manage opportunities. As each opportunity becomes more valuable, the relationship with the opportunity's host becomes more valuable. [Historical evidence shows, though, that MNOCs lose opportunities by undervaluing the commercial and cultural relationships with the host, and underinvesting in relationship maintenance.] Improving the relationship raises SPE stability and project strength in the portfolio evaluation. As project strength triggers investment, production generates cash flows that increase the MNOC's equity.

To illustrate the model, the following sections describe the role of each field in the model. The final section presents the fully developed model.

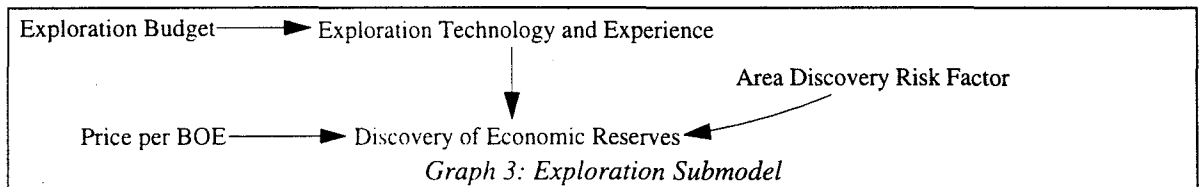
Financial Asset Management



Story Line: As production increases income, equity increases at the portfolio required rate of return. Production depletion thus requires reinvestment in exploration to maintain or increase the ROE.

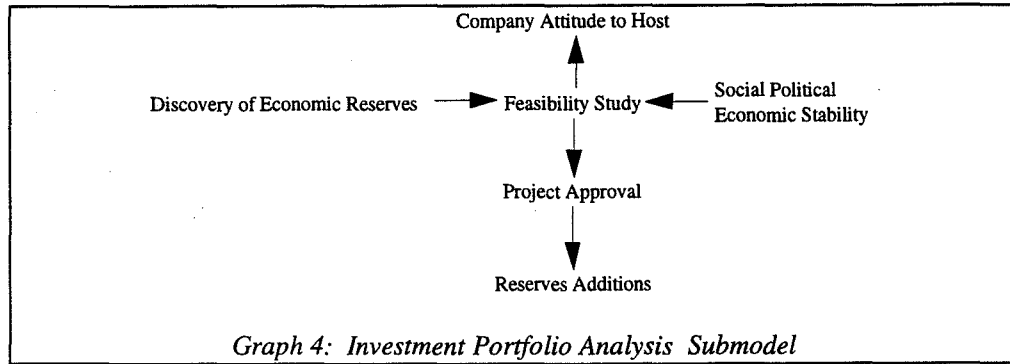
Situation: Since the early 1980s, flattened revenues and increased investment costs lowered net income per barrel of oil equivalent (BOE), forcing management to improve portfolio selection methods to meet required rates of return.

Exploration (Part of Development Engineering)



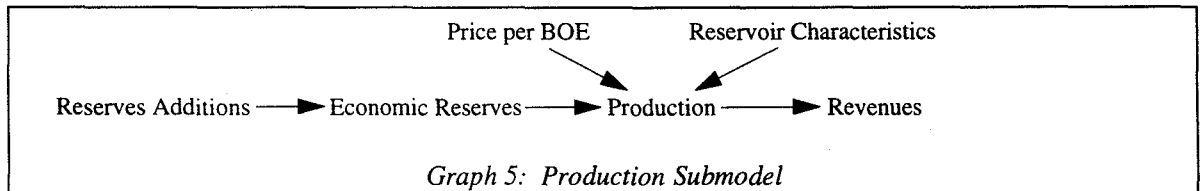
Story Line: Increased investment in exploration improves available corporate exploration experience and technology. Since technology and training relate directly to the probability of discovering reserves, the more experienced exploration group finds more reserves and better determines the risk of reaching and recovering these reserves. If the price per BOE less investment meets ROE requirements, reserves are economically recoverable.

Situation: Typically, a management team of geologists, geophysicists, petroleum engineers, and financial analysts use industrial statistical information and intuitive knowledge to determine exploration project risk.

Investment Portfolio Analysis

Story Line: The discovery of economically recoverable reserves and a stable SPE environment positively influence project feasibility. As project feasibility increases, the MNOC's attitude toward the host and the project approval improve, which directly affects reserve addition.

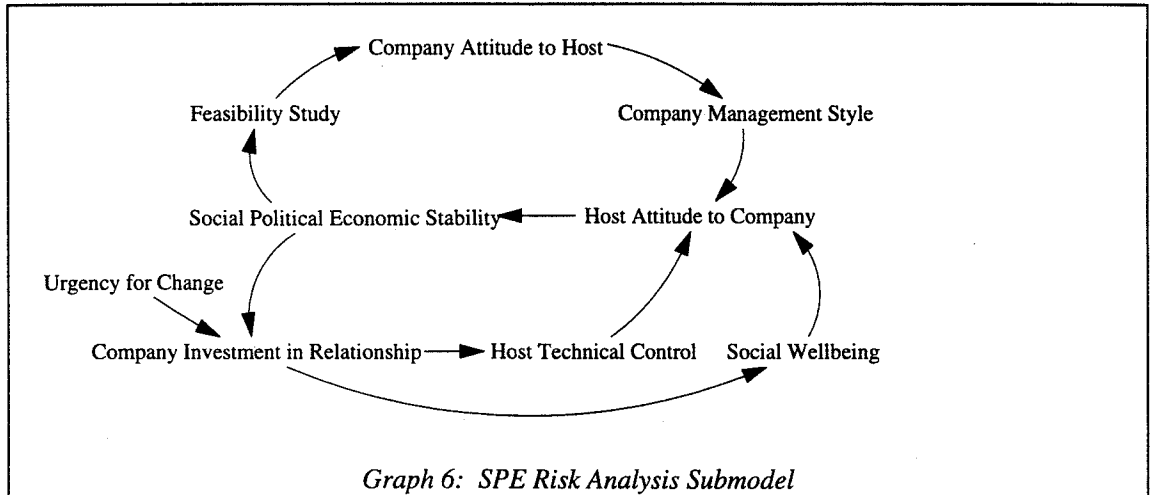
Situation: Typically, four separate groups analyze and recommend project alternatives. This information synthesis from four independent sources filters out many significant variable relationships too complex to see without proper modeling. This weakens critical investment decision processes.

Production (Part of Development Engineering)

Story Line: Added economic reserves increase the petroleum reserves asset base. Reservoir characteristics and price per BOE directly determine production rates and corresponding revenues.

Situation: Ever decreasing net income causes management to demand more efficient production methods, yet financial demands often adversely affect optimal production rates. External factors, such as topography and pipeline routes through politically-sensitive areas, directly determine production rates, increasingly complicating production rate determination.

Socio-Political-Economic Risk Analysis



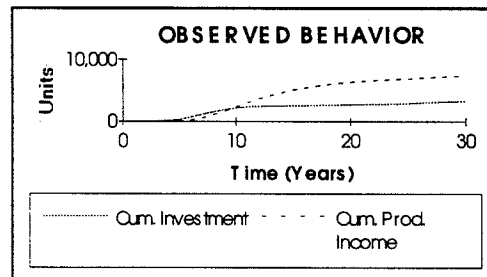
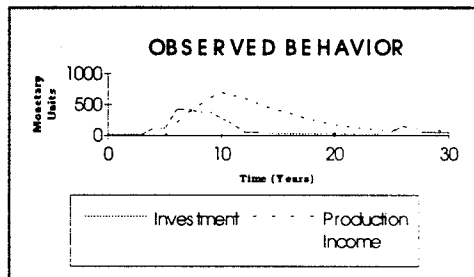
Graph 6: SPE Risk Analysis Submodel

Story Line: Increased project feasibility improves the MNOC's attitude and subsequent management style towards the host, positively affecting the host's attitude to the company. This increases regional SPE stability. In a deteriorating relationship, lowered future revenue expectations directly augment the urgency for change to a better relationship. To improve the host's attitude toward the relationship, the MNOC invests in the host's technical skills and social well-being, increasing SPE stability and project life.

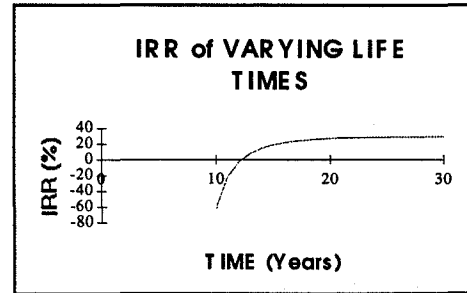
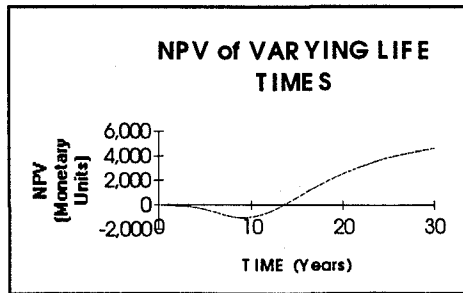
Situation: Historically strong cultural differences between MNOCs and developing nations in need of advanced energy development technology caused many of the high-risk investment failures. Neither party benefits from this cultural gap.

SYSTEM BEHAVIOR

Case studies in Ecuador, Colombia and Indonesia show a "typical" behavior for large-investment petroleum projects. Production lags behind investment in exploration and exploitation (drilling and production system installation). The following graphs demonstrate this systemic behavior.



The lag time between initial investment and income is five to ten years, for large-scale projects. Cumulative production income does not surpass the cumulative investment until the tenth year of the project and the fifth year of production.



The project's NPV becomes positive after the 13th year¹. The project IRR becomes positive in the 13th year and quickly reaches its maximum of 30% at year 20. This "typical" scenario indicates that management must ensure a minimal project life of 12-15 years to recuperate the investment and 20 years to generate the required ROE. Since nationalization or non-renewed concessions prematurely terminate many long-term projects after 10-15 years, corrective system behavior generation is crucial.

PROPOSED INTEGRATED MODEL

Appendix 1 shows the complete IPREMARA model. Appendix 2 displays an executive flight simulator that controls the main variables determining system behavior. As Kleindorfer states, "the general conclusion is that the reliability of intuitive judgments, even for experts, is usually low. People can often be outperformed by their own models..." This realization provides the impetus for further model development and utilization.

CONCLUSIONS

Petroleum projects that fail due to poor relationships between the corporation and the regional host waste great economic, mental and physical resources. System dynamics modeling provides an integrated view of the complex, international petroleum management environment and determines what interrelations exist between decision variables and how to generate a stronger, value-creating system behavior.

SUGGESTED FURTHER WORK

Further case study will validate the relationship of those variables that most directly affect "nationalization" and project life variables. The researcher proposes in-depth interviews, before and after simulation training, with petroleum executives and developing country petroleum agency and government officials to determine insights gained through this executive flight simulator approach to project stability maximization.

¹ From the researcher's experience at two large oil companies, a 12% capital rate is considered typical in project economic analysis for large oil companies. Though it is significantly higher than current 1994 lending rates, it is considered to reflect long-term rates in the U.S.A. for this type of investment project.

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Paper Preparation

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