

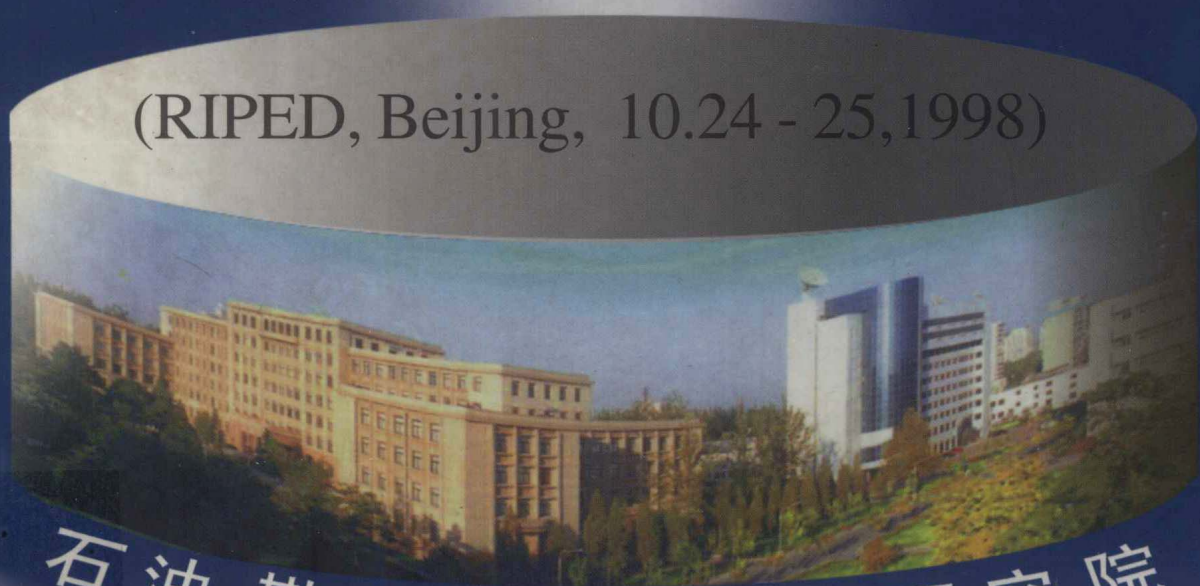
21 世纪石油勘探与开发——院长论坛

报告集

**Petroleum Exploration
and Development in
the 21st Century
—President Forum**

PROCEEDINGS

(RIPED, Beijing, 10.24 - 25, 1998)



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ADDRESS AT THE OPENING CEREMONY OF THE “PETROLEUM EXPLORATION AND DEVELOPMENT IN THE 21st CENTURY—PRESIDENT FORUM”



Shen Pingping, President
(*Research Institute of Petroleum Exploration and Development, CNPC*)

Good Morning!
Distinguished Guests, Friends,
Ladies and Gentlemen:

“The Petroleum Exploration and Development in the 21 st Century—President Forum” highlighting the celebration of the 40 th anniversary of RIPED, is solemnly opened here today. Personally and on behalf of all RIPED staff members, I would like to extend our warmest welcome to you all for joining us at the special occasion here today, and sincere thanks for the great support of CNPC leaders to the institute, for the big help of our new and old friends from foreign petroleum industry communities who traveled great distance and have overcome obstacles to join with us, and for the strong support of Chinese friends and fellow from Chinese petroleum industry circles for their enthusiastic involvement in the event.

The 21 st century will be a time full of challenges and opportunities. The Asia financial crisis still with repercussions and the sustained low oil prices worldwide impel us to well understand the challenges the petroleum sciences and technology facing with and be fully ready to meet these challenges. We need talented personnel, we need technical innovations and we need to create a harmonious environment to make our people happy with their innovation efforts. The President Forum will be a great opportunity for us to learn and have wide academic exchanges with our Chinese and foreign fellows. I sincerely hope that the Forum will help us to have better understanding each other, further develop our friendship and lay a solid foundation for our future cooperation.

The October is the golden month of the year here in Beijing. We will make every effort to provide every possible convenience and best service for the academic and business exchanges among our guests and make the President Forum truly a golden bridge of friendship, cooperation and development, leaving you everlasting memories.

Finally, sincerely wish each and everyone of you a happy time in Beijing and wish the President Forum a complete success!

(Translated by ChenYing)

SCIENTIFIC INNOVATION AND INTEGRATION ——THE WAY OF RIPED TO APPROACH THE NEW CENTURY



Shen Pingping, President; Bo Qiliang, Vice President
(*Research Institute of Petroleum Exploration and Development, CNPC*)



GENERAL DESCRIPTION OF RIPED

Research Institute of Petroleum Exploration and Development (RIPED) was founded in 1958. Along with the development of China's petroleum industry, RIPED has undergone her brilliant history of 40 years, becoming a comprehensive research institution directly underneath China National Petroleum Corporation (CNPC), and being mainly involved in upstream operations. Equipped with advanced science instruments, RIPED conducts research in all necessary disciplines, and boasts strong expertise. She has 3 branch institutes and 23 research departments with more than 1700 professionals, among them there are 6 academicians of Chinese Academy of Sciences or Chinese Academy of Engineering, more than 100 research professors, over 500 senior engineers, and more than 600 engineers. Totally there are more than 400 pieces (sets) of large scale equipment in various laboratories of this institute. According to the statistics conducted by the State Commission for Science and Technology in 1995, RIPED ranks third in terms of integrated research strength among over 4700 civil research institutes all over China. RIPED is authorized to award degrees of Master and Ph. D, and accept postdoctoral students.

The main tasks of RIPED are: ①to conduct studies on national petroleum safety strategy; ②to organize and coordinate integrated studies on macroscopic decisions of oil and gas exploration and development for the whole country; ③to launch campaigns of some key projects and try to apply the research achievements into field practices as soon as possible; ④to carry out basic and fundamental studies in advance for knowledge accumulation aimed at the major expected issues in long-term development; ⑤to perform studies and offer services concerning technical standards and specifications, information technology, and environmental protection for the sustaining development of Chinese petroleum industry, and ⑥to provide a strong technical support to CNPC's overseas operations.

The research domain of RIPED mainly involves oil and gas exploration, field development, production, EOR, drilling, machinery, oilfield chemistry and computer application etc. Through

researches made for many years, RIPED has arrived at significant achievements in 12 basic theoretical studies including organic geochemistry, and in 14 leading techniques such as oil and gas resource evaluation; and also developed 18 advanced integrated technologies, for instance, integrated petroleum geological study, frontier exploration, and integrated adjustment for EOR at the late development stage of water flooding fields. These theories and techniques are widely used with great success in the exploration and development operations in Songliao and Bohai Bay basins in eastern China and Tarim and Ordos basins in western China.

RIPED has been always devoting herself to solve the complex technical problems encountered in petroleum exploration and development, and advocating her motto of our institute—"Unity and Reality, Opening-up and Innovation". She is always industry oriented and persisting in serving the industry, and building an open research system and an open cooperation system. So far a sound academic exchange relationship has been established and an extensive cooperation has been carried out between RIPED and some domestic universities and research institutes and overseas oil companies and institutions from more than 30 major oil-producing countries.

RIPED is actively participating in CNPC's overseas exploration and development activities, providing technical support to the overseas projects. Recently she has been engaged in the evaluation of the gas resources in Siberia and some Middle-Asian countries, the pre-feasibility study of the proposed long-distance gas pipelines of these countries, the feasibility study of heavy crude development by emulsification in Venezuela and integrated oil and gas resource evaluation and FDP design for Blocks 1, 2 & 4 in Muglad Basin of Sudan. Entrusted by CNPC, RIPED sends her specialists to Venezuela and elsewhere, who are responsible for new technology adoption in the relevant oil fields. By doing so RIPED plays a significant role for CNPC to open up a new prospect in overseas exploration and development operations.

CHALLENGES RIPED IS FACED WITH

After being restructured CNPC still holds the absolute dominance in terms of oil and gas resources and production; its primary mission is still petroleum exploration and development. CNPC will continue to implement the policies of "Stabilizing the East, Developing the West, Giving Equal Emphasis on Both Oil and Gas and Running Operations Abroad". In order to maintain a sustaining and steady increase in oil and gas production, and to gain maximum economic benefits, CNPC has to regard economically recoverable reserves as its objective in exploration, and low operation cost, high economical production and high recovery factor as its objectives in field development. However, the geological conditions in the oil-bearing basins and fields which CNPC has been prospecting and developing are extremely complex. Furthermore, most of the strategic prospective areas are distributed in deserts, marine beaches and plateaus. At the turning of the century, CNPC, and even the entire petroleum industry of China, is faced with a series of challenges.

1. OIL AND GAS PRODUCTION CANNOT MEET THE NEEDS OF THE QUICK GROWTH OF THE NATIONAL ECONOMY

According to the outline for the development of Chinese national economy to 2010, the

annual rate of increase of oil and gas energy needed by the country is approximately 5%, but at present the annual rate of increase of crude production on an average is only 1.5%, showing a big gap between the needed and the current real increase. The amount of oil imported has already exceeded the exported, and China has become a net oil import country. In the last decade China's gas reserves have been growing rather quickly, which are mainly distributed in some western basins and in some basins along continental shelves. However the infrastructure for gas gathering, transportation and utilization in China is not strong enough, resulting in a small contribution (1.5%~2.0%) of gas to the energy structure of our country.

2. SURFACE ENVIRONMENT AND UNDERGROUND GEOLOGY ARE BECOMING INCREASINGLY COMPLEX

In mature exploration areas the primary targets are stratigraphic-lithologic reservoirs, deep reservoirs and marine beach reservoirs. In a number of large composite basins in western China, the pattern of oil-gas reservoir distribution is greatly complicated by the factors such as multiple tectonic movements, stacking of multiple petroleum systems, multiple pool-forming periods, and adjustment and evolution effects. A great portion of reservoirs are stratigraphic-lithologic ones and are deeply buried, which makes prospecting and drilling even more difficult. As for field development, 80% of the national total production is from Songliao and Bohai Bay basins, where the reservoirs are mostly sandstone, complex and highly heterogeneous, with water cut already above 80% on an average, making the stabilization of the production increasingly difficult. In most of the newly-discovered oil fields and those in the west, the reservoirs have mid- or low permeability, hence difficult to develop.

3. SITUATION OF COOPERATION AND COMPETITION IS EMERGING IN TALENTS, TECHNOLOGY AND MARKETING

The founding of the two giant upstream and downstream integrated corporations——CNPC and SINOPEC, the coexistence of CNOOC and China New Star Petroleum Company (CNSPC), as well as the introduction of foreign oil companies, accelerate the emerging of the situation of cooperation and competition in talents, technology and marketing.

4. SCIENCE IS STILL FALLING BEHIND THE NEEDS OF INDUSTRY

In the development of Chinese petroleum industry science and technology play an indispensable role. However, considering the increasingly complex exploration and development conditions, the petroleum science of our country, as a whole, cannot meet the needs of the industry, and is still falling, to some extent, behind the world level. The fluctuating world economy and the oil price hesitating at low levels are very demanding to Chinese petroleum science.

The various challenges Chinese petroleum industry is faced with, fundamentally speaking, are challenges from science and technology. Being the integrated research organization of CNPC, RIPED still has the unshirkable duty to play the role of a workhorse in upstream research for Chinese petroleum industry. Enhancing technical innovation and integration, and ensuring the support of science and technology to the development of Chinese petroleum industry, are the most direct and realistic challenges to RIPED.

Therefore, we must train and gather talented professionals, strengthen management, and

pay more attention to the integration of innovative projects and key projects of great significance. In addition, based on continuous innovation, we have to apply and spread scientific achievements into exploration and development practices, and maintain the vitality of RIPED and boost the sustaining development of the national petroleum industry.

THE SCIENTIFIC INNOVATION AND INTEGRATION STRATEGY OF RIPED

“Innovation is the spirit for a nation’s progress, and the inexhaustible motive power for the prosperity of a country.” Innovation is the core of all research work, the basis upon which all research organizations remain invincible, the magic weapon to win in competition and challenge, and the prerequisite to offer qualified services and technical support. Integration is not only the necessity in solving complicated problems encountered in petroleum exploration and development, but also an effective approach for tackling key technological problems.

1. TRAINING AND GATHERING TALENTED PROFESSIONALS ARE PREREQUISITES FOR SCIENTIFIC INNOVATION AND INTEGRATION

Qualified people are the paramount factor in scientific innovation. In order to realize innovation and integration we must have, first of all, an army of competent and qualified professionals, as well as some discipline leaders. In addition to the basic quality an ordinary research worker should possess, an innovative professional ought to have sharp and precise insight, pioneering spirit, rigorous and scientific thinking ability, rich and even odd imagination, strong innovation consciousness, and finally, foresight and sagaciousness. A comprehensive professional must possess an extensive, exquisite and reasonable knowledge structure, be able to make synthetic use of knowledge of various disciplines to solve complex problems, and be good at uniting with others and organizing teamwork to tackle key technological problems.

RIPED is trying her best to implement the “Talent Strategy”, regards training and attracting qualified professionals as the prerequisite of scientific innovation and integration. In the last decade or so RIPED has attracted and accepted more than 20 doctors who got their degree abroad. During the same period 65 and 117 ambitious youths have finished their course work and dissertation in RIPED with Ph. D degree and MS degree awarded respectively, and 25 Ph. D holders have completed their postdoctoral research program under the guidance of RIPED experts. Meanwhile we have been selecting some promising professionals from the backbone of our research army, emphatically training them, and letting them show themselves and become discipline leaders of the next century.

Relying on the key laboratories and key research group of CNPC (both in our institute), RIPED will try to keep attractive to excellent professionals at home and abroad, choose some young professionals, send them to various oil fields, and assign them to important posts. In this way they will go deep into the realities of oil fields, further broaden their knowledge scope, enrich their experiences, locate problems in practice, and constantly bring forth new ideas.

2. APPLIED FUNDAMENTAL STUDY IS THE INEXHAUSTIBLE SOURCE OF SCIENTIFIC INNOVATION AND INTEGRATION

Since her foundation RIPED has been laying stress on applied fundamental study, implementing the policy of “Emphasizing, Encouraging, Ensuring and Promoting”, and acting in the spirit of innovation in every aspect of research work. More than one third of all our projects are applied fundamental study; As for the institute – level projects, more than 70% of them are of basic or in – advance study. RIPED also actively takes on State Natural Science Foundation and “height – scaling” projects of China, and projects of CNPC Youth Innovation Foundation. In addition RIPED Youth Innovation Foundation has been set up to assist applied fundamental study and scientific innovation. A number of significant achievements have been arrived at through strengthening applied fundamental studies and cutting – edge techniques, for instance, hydrocarbon generation theory of continental basins, theory on the formation of composite continental oil – gas accumulation play, flow mechanisms of oil – gas – water in dual – porosity media, and column – beam drilling theory etc. These achievements enriched the relevant disciplines and greatly contributed to the development of Chinese petroleum industry.

Geared to the needs of the 21st century and backed by the State and CNPC, RIPED will pay more attention to applied fundamental study. Based on their abundant experiences accumulated her professionals will, in cooperation with experts at home and abroad, launch several key project studies, including theory of hydrocarbon accumulation in marine carbonate reservoirs in composite basins of China, scientific basic study for EOR in Chinese oil fields, and control theory of drilling engineering, laying a solid foundation for their scientific innovation.

3. ENHANCING THE CUTTING-EDGE RESEARCH IN AN EFFECTIVE APPROACH FOR SCIENTIFIC INNOVATION

Faced with the new challenges of petroleum exploration and development in the 21st century, RIPED is making full use of the new theories, new knowledge and new methods to launch a new round of the cutting – edge research. All these are aimed at solving the even more complex problems in exploration and development, and to fulfil the task RIPED use experiences both at home and abroad for reference. As examples, the following projects will be addressed: hydrocarbon evaluation for marine carbonate rocks; oil and gas prospecting in multi – cycle composite basins; high resolution 3D prestack depth migration; seismic data processing and interpretation with forward and inversion models; imaging logging, NMR logging and through – casing logging evaluation; residual oil prediction techniques (cross – well reservoir prediction at middle or late stage of water flooding fields, logging in water – flooded zones, detailed reservoir simulation and parallel computation using models with million nodes); EOR techniques (chemical combination flooding, gas miscible and immiscible flooding, microbial flooding and physical recovery etc.); drilling and production technologies of deep and ultra – deep wells, multilateral wells, extended reach wells and slim – holes. By concentrating the main force of the research army and enhancing a series of cutting – edge research, RIPED will be able to solve some key problems in exploration and development, and realize scientific innovation.

4. SYNTHETIC INTEGRATION IS A GOOD METHOD FOR TACKLING KEY TECHNICAL PROBLEMS

Oil – gas exploration and development is a highly complex system engineering, and needs the

integration and application of a number of disciplines. Only by relying on the teamwork of many disciplines can the key and complex problems encountered in exploration and development be solved.

For many years RIPED has been bringing her superiority of possessing all the necessary disciplines and rich experience of integration into full play, and paying close attention to the study and application of the composite multi – discipline projects. As for project organization the international practice is adopted, i. e. , the coexistence of fixed specialty research departments (divisions) and temporary research groups. In this way the advancement of various disciplines is promoted, and the fulfillment of particular research tasks is guaranteed. For example, in order to solve the problems in frontier exploration, a few explorationists with great theoretical attainments and rich exploration experiences were made responsible, who organized a research group consisting of structure geologists, petroleum geologists, geophysicists, drilling specialists and production specialists. The comprehensive research group did an excellent and fruitful teamwork. Cooperating with the professionals of the relevant exploration areas the group elaborately chose locations for two scientific exploration wells which were very successful. One is Well TC – 1 in Turpan – Hamy Basin which opened up a new field there and gave an impetus to exploration of Jurassic in the western basins. The other is Well SC – 1 in Ordos Basin which revealed a giant Ordovician gas field in the central part of the basin.

With the multi – discipline integration approach RIPED has designed FDPs for more than a dozen of complicated oil or gas fields onshore China. The FDP for TZ – 4 Block in Tarim Basin, which was designed and optimized by our specialists of reservoir geology, reservoir engineering, production, drilling, as well as economy, generated satisfactory technical and economic benefits after being implemented.

At the turn of the century RIPED is implementing a scheme of cross – century integrated cutting – edge research, while conducting single technique projects. The following topics are focused on: exploration for the deep oil and gas reservoirs of mature areas in the East; geological exploration in cratonic structures and foreland structures of multi – cycle composite basins in the West; oil and gas prospecting in Jurassic and Permo – Carboniferous coal measure strata in North China; the distribution pattern of China's large and medium gas fields and their prospecting; development technology of gas condensate and volatile oil reservoirs, as well as heavy or ultra – heavy crude reservoirs; technology for economically and efficiently developing low and ultra – low permeability reservoirs; and development technology for marine beach oil fields. In addition, along with the swift development of computer information technology, RIPED is developing a multi – purpose software platform which features customer – oriented databases and conforms to POSC Code. The platform will integrate information – processing system, oil and gas evaluation, geological modeling, reservoir simulation, and FDP evaluation into the same package. With this platform data will be shared by many disciplines, and flow – process and integrated study will be realized.

5. INTERNATIONAL EXCHANGE AND COOPERATION ARE ESSENTIAL CONDITIONS OF SCIENTIFIC INNOVATION AND INTEGRATION

International academic exchange and cooperation is becoming more and more extensive and

urgent since the world economy is heading in the direction of increasingly integrative mode. In recent years RIPED has been conducting academic exchange and cooperation actively with both domestic and overseas organizations, which greatly spur technology progress and discipline advancement.

In the coming years RIPED will continue to focus on the theoretical and technical issues of the State and CNPC concerning oil – gas exploration and development, and decide on several domestic and international cooperation projects, and some expertise – import projects (workshops and consulting etc.). Meanwhile we will send more professionals to work and study in domestic and overseas universities or colleges, research institutions and operating companies. On mutually beneficial basis RIPED will actively launch diversified forms of academic exchange to promote the advancement of petroleum science.

6. SOUND MANAGEMENT MECHANISM AND HARMONIOUS ATMOSPHERE ARE IMPORTANT GUARANTEES TO SCIENTIFIC INNOVATION AND INTEGRATION

Sound management mechanism and harmonious atmosphere are necessary for scientific innovation and integration. For many years RIPED has always been positively constructing a humanity environment which is favorable for scientific innovation and technical integration. From now on we will continue to carry forward scientific system reform, perfect management mechanism, strengthen corporate culture construction, and create a uniting, harmonious and mutually aiding research environment, in which our professionals will love RIPED better and be proud of being a member of her, and cheerfully devote themselves to scientific innovation and integration.

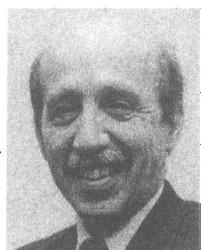
CONCLUSION REMARKS

“Wooden Bucket Theory” enlightens us: The volume of a bucket is mainly dependent on two factors. One is the length and quality of each wood bar; the other is the number of the bars and how they are integrated. The volume and quality of the bucket would be adversely affected as long as one of the bars has a flaw or they are imperfectly integrated. The goal of RIPED in pursuing the innovation and integration approach is striving to raise the theoretical and technical level of various disciplines, and organically combine these theories and single techniques, so that we can offer stronger technical support and satisfactory technical services to petroleum exploration and development of CNPC and the State.

Petroleum exploration and exploitation in China will grow into a new phase in the 21st century. RIPED will be energetically participating in tapping the potentialities and EOR activities in the mature eastern oil fields, exploration and development in the western composite basins, as well as exploitation of natural gas. Simultaneously this institute will be taking an active part in overseas operations as the brain trust of CNPC. RIPED is willingly looking forward to cooperation with her colleagues both at home and abroad in order to make new contributions to the development of Chinese petroleum industry and the advancement of world petroleum science.

(Translated by Du Delin)

POTENTIAL TECHNOLOGY BREAKTHROUGHS



Drs. albert van der Kallen, Vice President
(*Shell International Exploration & Production BV, Research
and Technical Services*)

Mr. President CNPC Ma Fu Cai, Mr. President RIPED Shen Ping Ping, Mr. Chairman Wang Fuyin, Ladies and Gentlemen, I am very pleased on behalf of Shell Research and Technical Services and Shell China Petroleum Development B. V. to be able to celebrate with you the 40th anniversary of the Research Institute of Petroleum Exploration and Development and honoured to present a keynote speech at your Petroleum Exploration and Development in the 21st century President Forum in Beijing.

WHAT IS A BREAKTHROUGH?

Today I would like to discuss with you Technology Breakthroughs, their specific characteristics, how one recognises them, some historical examples from my personal experience and to present examples which have the potential to be the breakthroughs of the 21st century.

For an innovation to qualify as a breakthrough I would suggest it has to satisfy three criteria.

- It has to mark a substantial discontinuity in the progress of technology.
- The potential business impact has to be worth hundreds of millions of dollars (if not billions).
- It will lead to a realignment of the work practices of the whole industry.

For example, the introduction of horizontal drilling and of three – dimensional seismic would fully qualify as E&P breakthroughs.

WHERE DO BREAKTHROUGHS COME FROM?

Logical questions to ask are: How do these breakthroughs occur in the first place? What drives the process?

I suggest that we, as human beings, have an instinct to try to understand the world around us, to search for the truth in order to create a better world for ourselves, our dependants and our society. This provides us with a deeper meaning to our lives. This sounds rather philosophical and so let me describe the process a bit more in detail.

During the process to come to a breakthrough one can visualise a funnel (Figure 1) continuously fed with observations and ideas, but it requires intuition and some reasoning to

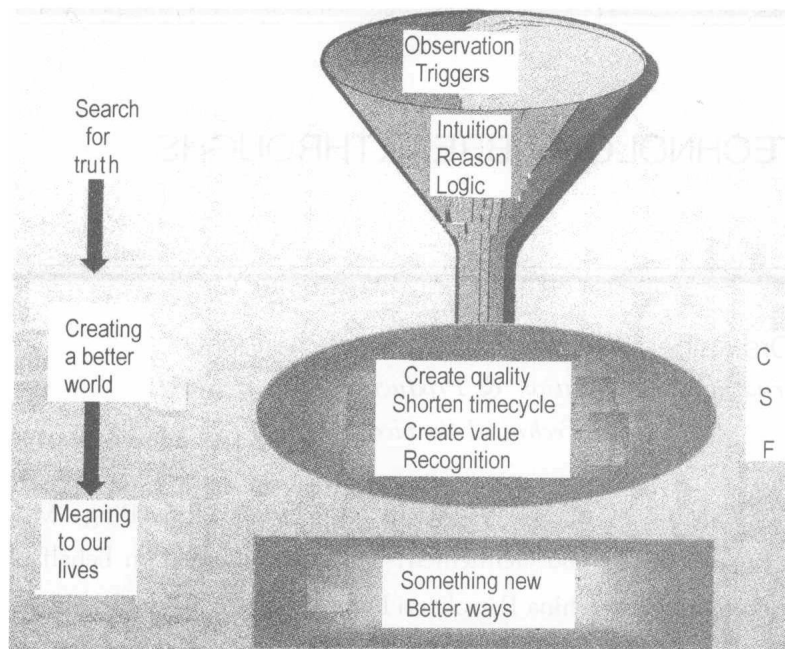


Figure 1 Creativity

who excel are able to sense what feels right and they have the passion and tenacity to drive their idea through the organisation. They cannot be stopped at this stage, as the thrill of being a change catalyst and of taking creative risk is what makes them tick.

Where are these ideas or triggers coming from? Somewhere in a university or a technical institute researchers are breeding ideas, mostly from an academic point of view. People with the right antennae pick up these ideas and are triggered into action. They have a good feel for the unresolved problems, while others do not even realise such problems exist.

They recognise the application

potential, go after a practical solution and initiate a successful pilot to demonstrate the potential to their customers and technical peers. This provides them with recognition – another critical factor which fuels the creative drive.

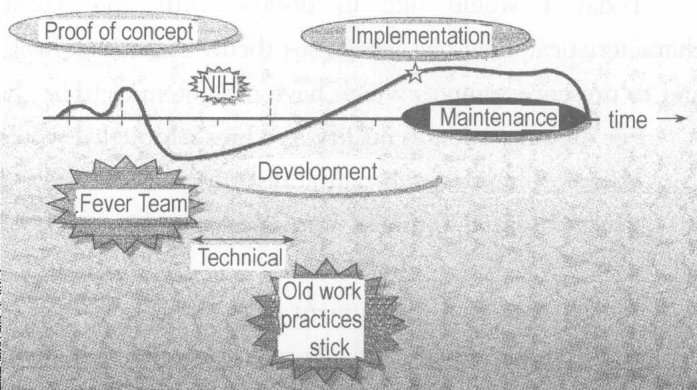


Figure 2 Single Breakthrough Characteristic

HOW ARE THEY ADOPTED IN THE BUSINESS?

One would expect the whole E&P community to grasp the opportunity and asset managers to jump at the breakthrough offered. However at this stage the tools are still immature with no track record. Consequently the NIH (not – invented – here syndrome) and all “antibodies” of the organisation come in to play. Typically it takes us as an industry ten years before a breakthrough

is fully recognised and our industry work practices are readjusted by all stakeholders such that the full bottom line impact is achieved. Of these ten years, only a few are really needed to mature the product. The rest are eaten up by the sluggishness of the organisation – frequently caused by lack of technical leadership and aversion to risk taking.

How can we recognise a potential breakthrough earlier? There has to be a culture to challenge current practices and look outside the E&P industry for ideas. We in Shell have set aside 10% of our R&D budget to foster breakthrough ideas in E&P supported by a lean process to allow filtering and quick decision making.

SOME EXAMPLES FROM THE PAST

Having described what it takes, it is now time to put some meat on the bone and share a few of my own triggers with you. I have selected three examples out of the E&P geophysics arena:

- hydrocarbon detection;
- 3D seismic and;
- pre-stack depth migration.

examples which by now will be familiar to most of you.

DIRECT HYDROCARBON INDICATIONS ON SEISMIC

It is hard to imagine today, but at the time I joined the industry in 1968, all geophysicists around the world knew that hydrocarbons could not be observed on seismic. The acoustic contrasts created by hydrocarbons would be too small to be detectable. However, the seismic being acquired showed carbonate reef structures where the top carbonate reflection of one structure was strong (Figure 3) while the same reflection of the next structure was very vague (Figure 4). The first structure was water-bearing whereas the second one was gas-bearing.

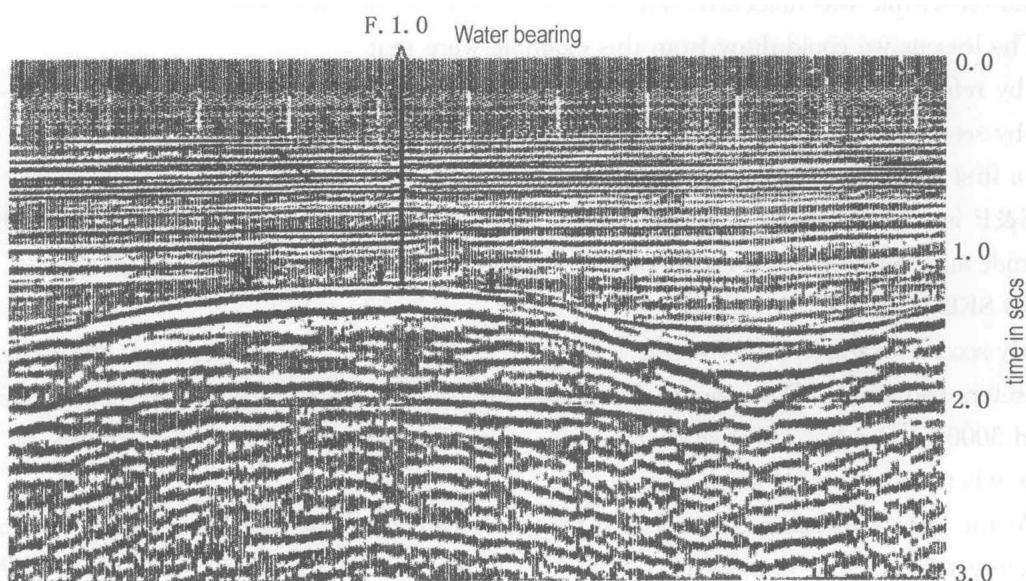


Figure 3 Water Bearing

In the bridge building industry, Gassmann had already in 1950 (20 years earlier) produced