Rejuvenation of 30-Year-Old McAllen Ranch Field—An Application of Cross-Functional Team Management

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Summary

This case history overview describes the application of cross-functional team management in redevelopment of a 30-year-old south Texas gas field. Multidisciplinary cooperation and synergism were emphasized, and efforts focused on a common team goal. The results have been extraordinary; all areas have shown significant improvement, including gas production, which is up by more than 250%.

Introduction

By the mid-1980's, McAllen Ranch field gas production had declined to a low of 24 MMcf/D owing to reservoir depletion and curtailment. The end of curtailment and subsequent development drilling activity increased the rate to 80 MMcf/D by early 1988. However, with reduced drilling and natural decline, the rate had fallen again to about 50 MMcf/D by early 1989.

At this time, a cross-functional team was established to evaluate additional investment opportunity and to develop a plan to increase production from the noncontributing reserves that were behind pipe. This team looked at all aspects of the field's production and developed a consensus plan that included acquisition, processing, and interpretation of a fine-grid 3D seismic survey; development drilling focused in the northern portion of the field (B-area); procedures to obtain regulatory approval to commingle noncontributing reserves in existing wellbores; and enhanced drilling and completion techniques.

This paper describes the interaction and synergism among the various specialties and functions involved in the producing operations at McAllen Ranch and how the concept of cross-functional team management has led to the rejuvenation of this 30-year-old field. It focuses on the process of cross-functional team management rather than just the results achieved.

Background

The McAllen Ranch field, located in Hidalgo County in south Texas, is operated by Shell Western E&P Inc. (SWEPI) on behalf of itself and its working-interest partners, Fina Oil and Chemical Co. and Conoco Inc.

Regional Geologic Setting. The field is located in the expanded Oligocene Vicksburg productive trend, which covers 4,200 sq miles, extending 140 miles northeast from south of the Mexico/Texas border to just west of Corpus Christi Bay. The trend averages 30 miles in width.

Structurally, many of the Vicksburg fields in this area are associated with rollover anticlines that resulted from the lateral translation of the expanded Vicksburg along a decollement surface on top of the Eocene Jackson shale. These sediments have moved as much as 20 miles from their point of deposition at the head of the main Vicksburg flexure. Stratigraphically, the primary productive intervals, deposited at a sealevel-high stand, are made up of alternating coarsening-upward deltaic sands and shallow marine shales. Overall, these sand and shale packages are wedge-shaped with the thickest and most sand-rich portion at the detachment surface. Typically, these wedges then thin and shale out in a basinward direction.

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Developmental History. The McAllen Ranch field, discovered in 1960, comprises stacked, deep (14,000-ft), geopressured, tight (<0.1 md), condensate-rich, gas reservoirs with porosities ranging from 12% to 20%. The field covers a productive area of about 14,000 acres, and more than 150 wells have been drilled to the various reservoirs at about an 80-acre spacing. Because of the relatively tight nature of the pay sands, massive hydraulic fracturing is required to sustain commercial production. Gas production in this field peaked in the late 1960's at almost 150 MMcf/D but by 1984 had declined to 24 MMcf/D as a result of reservoir depletion and curtailment. A field study conducted in 1985 identified new well locations (without seismic) and recompletion opportunities.

In 1987, a program was initiated to develop these opportunities. As implementation of this program began, recently acquired 2D seismic data were incorporated into the existing interpretation. This work, combined with revised log correlations, indicated an area of significant potential in the northern part of the field (B area). Subsequently, the McAllen Ranch Well B-16 was drilled in 1988 and confirmed this new interpretation. At this point, further development in this structurally complex area was deferred to acquire the first fine-grid Vicksburg 3D seismic data set across this area. With the drilling deferment, it became evident that, without additional development and/or contribution from behind-pipe reserves, the field production would show a steep decline.

Concept of Cross-Functional Team Management and Development of McAllen Ranch Asset Management Team

At the initiation of the McAllen Ranch field cross-functional team effort in early 1989, the engineering group of SWEPI's Production Department was organized along specialty lines, as in many other major oil and gas upstream organizations. The specialties within this group were drilling, facilities, geological, petrophysical, production, and reservoir engineering.

A group of engineers of similar discipline (e.g., drilling engineers) formed a section and reported to a division engineer. The various division engineers did not always report to the same manager, and each had his or her own specific goals and targets. For example, the targets for reservoir engineering might have been reserve additions; production engineering might have concentrated on production increase through recompletion and reconditioning (R&R); and drilling engineering may have focused on reduced trouble cost. Given the silo nature of the various specialties and the sometimes incompatible goals, the prioritization required to focus on a specific target was difficult to achieve and the results were poor. The general organization structure before the development of cross-functional teams is shown in the upper part of **Fig. 1**.

Efforts had been made in the past to establish multidisciplinary teams by assembling a team of various engineering disciplines under one supervisor (division engineer). This concept, although focusing a group on compatible targets, did not provide the overall technical depth required in complex projects because the supervisor may not have had in-depth exposure to all the specialties in the group. For example, the division engineer may have had only a reservoir engineering background and was supervising a geological engineer in a field with complex stratigraphic and structural features. Furthermore, these multidisciplinary teams were generally limited to engineering specialties and did not include staff

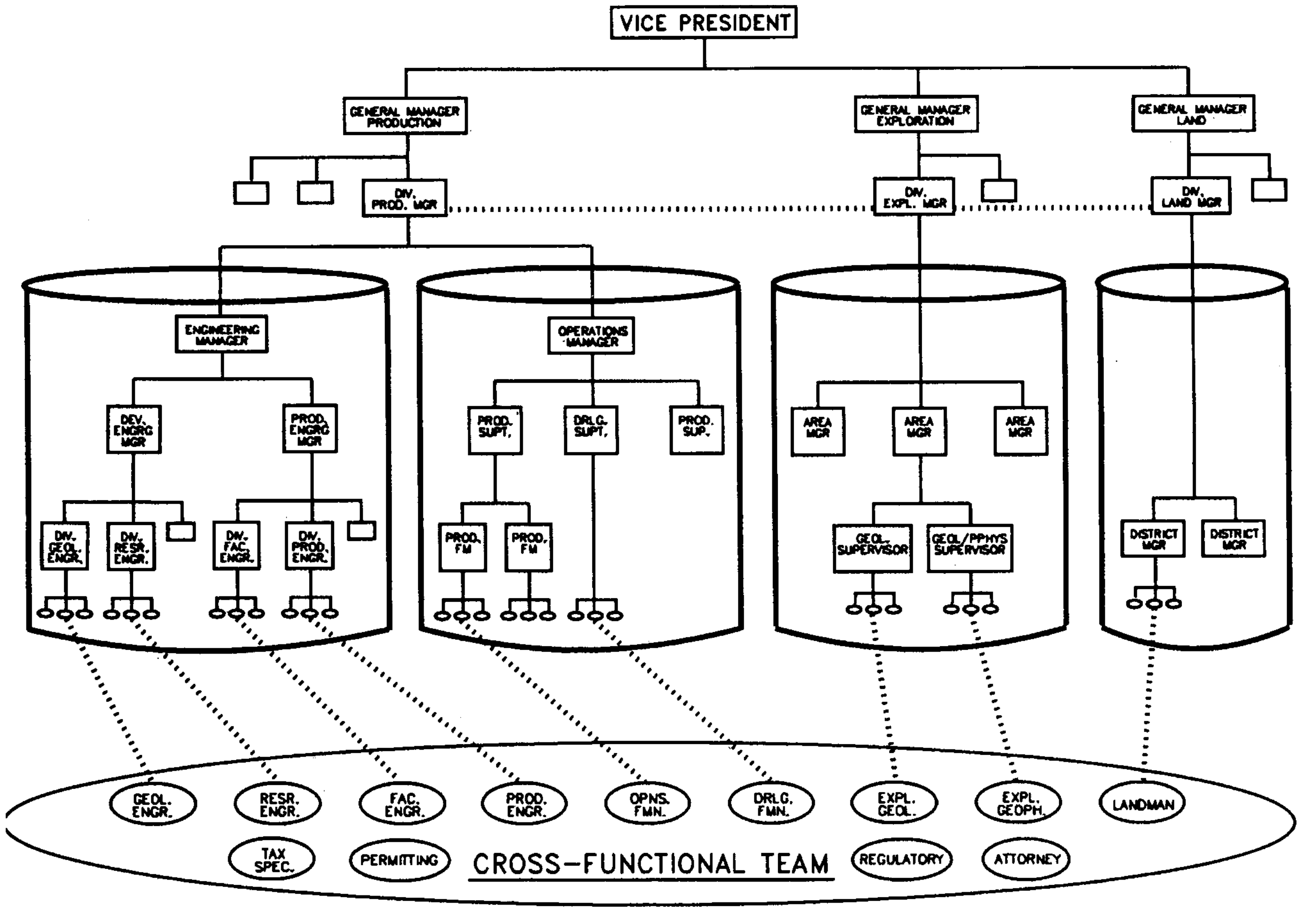

Fig. 1—Organizational structure with cross-functional teams.

from nonengineering functions. Many of these nonengineering functions (exploration, operations, etc.) are an integral part of the field's ongoing performance. While most of the functions were well integrated vertically, horizontal communication between functions was limited.

This lack of cohesion led to the realization that the application of cross-functional team management was critical to the rejuvenation of McAllen Ranch field.

Asset Management Teams. In this cross-functional team management, the staff assigned to a specific field team would be from all functions involved in operation of the field (i.e., all appropriate specialties of engineering, exploration, operations, business and regulatory affairs, land, permitting, tax, legal, etc.) and would have compatible and consistent targets. Furthermore, team members would remain in their own specialties and thus would have technical backup and review available from peers and supervisors but would not be directed toward "provincial" goals and targets.

Such cross-functional teams were formed for several major south Texas fields and called asset management teams (originally surveillance teams). The specialties and functions represented on the asset management team were determined from the primary activities of a specific field. Not all specialties or functions were required on all teams; furthermore, the team membership expanded and contracted based on the priority and activity on which the members were focused. The lower part of Fig. 1 shows how the cross-functional teams were linked to the existing organizational structure.

A management steering committee, set up to overview the progress of these teams, was made up of the engineering manager(s), division engineers, and operations management (production superintendent). Before the kick-off of a team, a field management strategy session (FMSS) was held to outline the team's targets and goals, including short-term and long-term plans for the field. "Buy in" by the team and management steering committee members was essential so that there was consensus on the plans for the field and efforts were focused on common goals. An FMSS is held annually to review the team's efforts and to calibrate the goals/targets with actual results. A field data book containing salient facts, targets/goals, and work plans was developed for each field and made available to each team member, regardless of specialty or function.

The various specialties (individuals on the team) were empowered to make collective consensus decisions for the team regarding the asset (field). Supervisors were encouraged to minimize individual technical reviews in favor of joint review with other specialty supervisors. In this way, individuals could discuss their technical findings and evaluations with their team members without waiting to get their supervisor's approval of their technical conclusions. In the cross-functional team concept, the supervisors of the individual team members were less of a "boss" and more of an "adviser/nurturer."

Each team had a leader who was selected on a rotational basis from among the team members. The team leader's role was to coordinate and facilitate team meetings and to promote effective communication within the team. The leader was "an equal among equals" and had no supervisory responsibilites—each member's performance was evaluated by his or her specialty supervisor.

To facilitate the efforts of the various asset management teams, an asset management coordinator was selected to advise the teams on the general framework of cross-functional management and to schedule periodic reviews. These reviews were an integral part of cross-functional management and ensured that all team members were involved in decision-making and were contributing to the overall goals. Depending on the nature of the team's activity, there were three or four full team reviews, including at least one team review at the field office with participation of key field staff, including lease operators. The team members were encouraged to hold informal update sessions as frequently as needed. Additionally, a computer coordinator was identified to assist the team members in computer utilization and technology transfer between asset teams.

Management Involvement. Significant management involvement and support in many areas were critical if the desired results were to be achieved in a timely manner. The following areas were some of the most important: ensuring appropriate dedication of resources, developing clear goals, focusing staff efforts on goal attainment, striving for multidisciplinary and cross-functional cooperation, maintaining effective communication at all levels, encouraging innovative thinking, and supporting appropriate risk taking.

McAllen Ranch Asset Management Team. The first application of cross-functional team management was at McAllen Ranch field. **Fig. 2** shows the geographical location of the field. In developing the membership framework of the McAllen Ranch asset management team, we evaluated the major focus of the field activities. These included 3D seismic survey acquisition and interpretation, development drilling, commingling (including regulatory approval), field producing operations, and remedial well work.

To incorporate seismic information from the 3D survey in overall field activities, a geophysicist was added to the team. Because of the high level of anticipated drilling activity, a drilling engineer, a drilling rig foreman, a geological engineer, a petrophysical engineer, a permitting staff member, and a landman were also included. The commingling effort and level of anticipated remedial well work required the addition of a reservoir engineer and a production engineer. An operations foreman and a facilities engineer were also included to ensure that the development and commingling activities would be integrated smoothly into existing field operations. Approval of the Texas Railroad Commission was required to commingle the various productive intervals, so a regulatory staff member was added. A team leader was chosen from these members.

McAllen Team Goals. With the challenge of a declining production rate and low wellbore utilization (40% of the developed reserves were behind pipe), four goals were identified for the McAllen Ranch team: (1) develop a technique to allow accelerated production of existing reserves, (2) add reserves profitably, (3) incorporate 3D seismic into the planned drilling program, and (4) identify potential for commingling similar pay sands and obtain regulatory approval to commingle them.

These became the team's goals. Team members were encouraged to concentrate on these overall goals rather than on those segments that were specifically applicable to their specialties or functions.

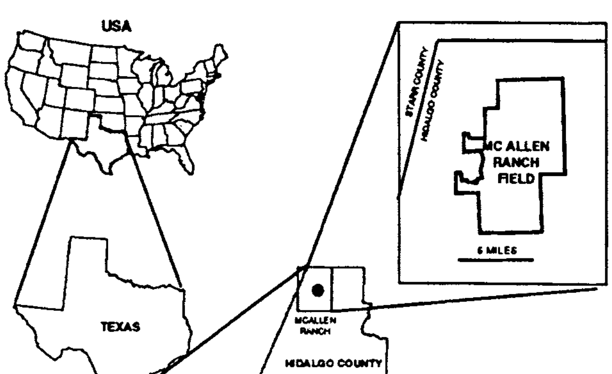

Fig. 2—Location map.

McAllen Team Targets. Given the broad but field-specific goals, the team members came up with the following specific targets to be accomplished within 2 years (1990–1991): (1) to increase total field gas production rate to >100 MMcf/D, (2) to reduce noncontributing behind-pipe reserves by 50%, (3) to complete 3D seismic interpretation and mapping and identify at least 10 new drilling locations, (4) to reduce drilling costs by at least 10%, and (5) to commingle production from all S, T, and U sands in the B area.

3D Seismic Survey—Planning and Application

Objectives of 3D Survey. The geological, reservoir, and petrophysical engineers consulted with the exploration geophysicist to develop the objectives of acquiring a 3D survey over the B area. Two objectives of the 3D acquisition program were identified. Our first objective was to improve the success rate by "sharp shooting" well locations in this structurally complex area using higher-resolution data than existing 2D seismic could provide. Early in the program, we had determined that accurate identification and location of faults, including those with <100 ft of throw, were critical to a successful drilling program. The second objective was to expand our knowledge of the structural evolution and trapping mechanisms associated with these very complex Vicksburg reservoirs.

Acquisition Parameters. Acquired in 1988 over the northern half of McAllen Ranch field where well control was sparse and the potential considered largest, the survey was designed to image a 22-sq-mile area with 45-fold multiplicity. Therefore, source and receiver lines were run perpendicular to each other on 1,200-ft spacing, resulting in acquisition of data points every 75 ft. During the acquisition of the survey and the subsequent processing phase, there was close coordination among the seismic crew, the geophysicist, and the geological engineer.

Interpretation and Application. The quality of the 3D migrated data exceeded expectations and showed a dramatic improvement over even the modern 100-fold 2D seismic data.[1] Additionally, the 3D survey confirmed that the area contained numerous small faults not previously identified. Because the pay sands are not massive but are comprised of multiple stacked pays generally <100 ft thick (**Fig. 3**), even relatively small faults (displacements <100 ft) could potentially cut out key productive intervals. Consequently, every well location selected to date in the B area since the 3D survey was acquired has been the result of a rigorous evaluation by a team made up of a geophysicist, a geological engineer, a petrophysical engineer, and a reservoir engineer. The 93% (14 of 15) success rate for wells drilled in association with this survey confirmed the data quality and the validity of the team approach. The one dry hole drilled to date was considered a high-risk delineation well.

Drilling Operations

Daily communication among geological, petrophysical, reservoir, and production engineers and the construction group was maintained during the entire drilling program. This communication was essential for maintaining a continuous drilling program while these complex wells were being planned and drilled.

The geological engineer was asked to provide not only anticipated formation tops and thicknesses for the objective formations but also tops and thicknesses for formations (usually shale) needed to plan intermediate casing points. Petrophysical and reservoir engineers provided a significant aspect of new well planning in predicting pore pressure and fracture gradients so that mud weight and casing programs could be optimized. Proper placement of the protective casing for a sufficient fracture gradient is critical for minimizing drilling trouble costs and eliminating protective liners. A production engineer's involvement was required for each well design. Timely communication of the decision on making a completion was necessary to eliminate rig downtime.

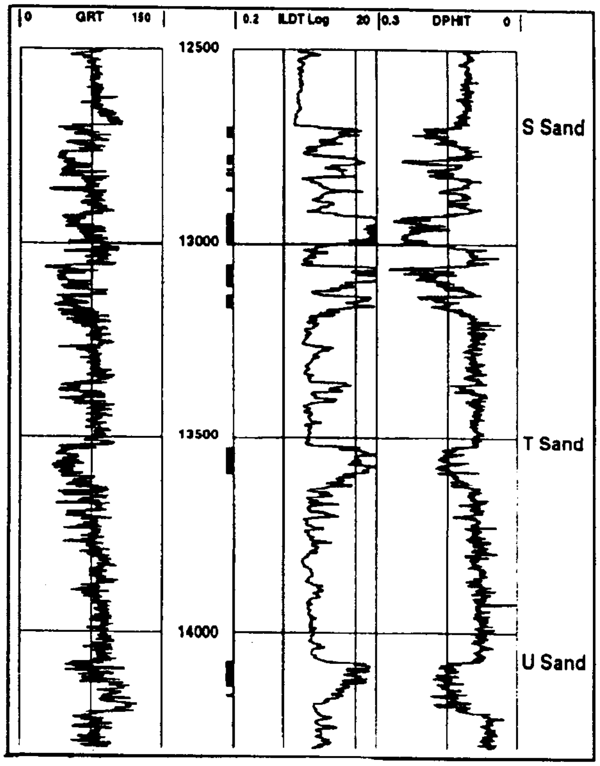

Fig. 3—Typical well log for S, T, and U sands.

Close communication between the drilling engineers and the drilling foreman helped spawn a redesign of the 8.5-in. polycrystalline-diamond-compact (PDC) bits used during the program. The need for a new bit design was passed to the bit manufacturer's engineering staff, who in turn produced a matrix body bit design to meet our requirement. This new bit design not only met our requirement of drilling the entire interval with a single bit but also doubled the penetration rate of the steel-body PDC bit. Additionally, the first bit ever run (designated as experimental) drilled the entire 8.5-in. interval in the next three wells. This bit design set a then-world record of 19,066 ft for the most footage drilled by a single 8.5-in. bit.

The initial 14 wells drilled in the B area required an average of 66 days to drill. The 15 redevelopment wells were drilled in an average of only 32 days (>50% improvement). **Fig. 4** shows the time required to drill and case each well. One of the wells drilled during this redevelopment program reached a depth of 14,304 ft in less than 16 days. (This is believed to be the fastest that an onshore geopressured well was ever drilled to this depth.[2]) The enhancement in drilling performance has resulted in savings exceeding $7 million in total drilling costs.

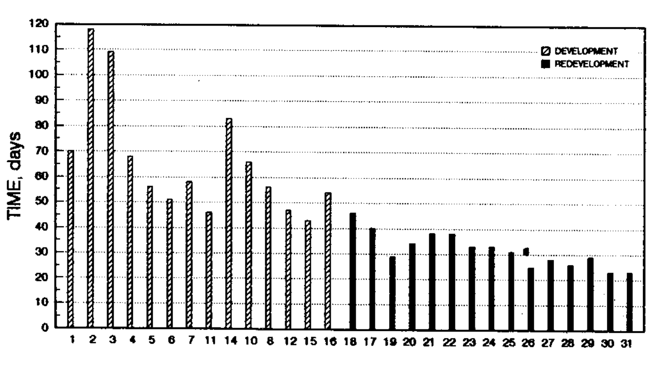

Fig. 4—Time (in days) from spud to rig release.

Subsurface Engineering Studies

As part of the team effort, subsurface engineers (geological, reservoir, and petrophysical) have contributed to the rejuvenation of McAllen Ranch field by completing a number of geologic/reservoir studies to define reserve potential, to optimize well placement, and to assess recompletion potential. A significant component of these studies was the process of integrating log evaluations for all wells in a reservoir with production information, the geologic setting, and the state of reservoir depletion. This iterative process required substantial input from the geological, production, and petrophysical engineers. Vital to the process was obtaining accurate production data for each zone in a reservoir, knowledge of the prior completion and stimulation techniques used in a given zone, and knowledge of the reservoir drive mechanism and pressure at the time of completion. The process of reconciling log evaluation results with production data, given knowledge of the completion techniques used and their effectiveness, often revealed opportunities for recompletions in existing wells or for drilling new infill wells. Log data quality problems that were previously overlooked and that affect the reservoir model were also identified and corrected.

Log Evaluation Uncertainty. A key goal since early 1988 has been reducing uncertainty in log evaluation results to improve reservoir characterization and to optimize well completions. Uncertainties in wireline log evaluations in the McAllen Ranch field primarily result from highly variable and relatively low formation water salinity (typically <20,000 ppm NaCl); difficulties in obtaining representative formation-water samples and determining formation-water resistivity through log techniques; low-permeability reservoirs that result in pay zones having high irreducible water saturations and relatively low resistivity contrasts; different vintage wireline logs and difficult logging conditions that resulted in an inconsistent log data set with common log quality problems; and poorly defined rock properties for a diagentically complex rock.

Uncertainties in log evaluation results have been minimized by improving databases of formation water and key rock property information and by reducing systematic errors in wireline measurements that resulted from the severe logging environment and inadequacies of earlier logs run. With the help of field operations personnel, a water sampling program was undertaken throughout the field to improve the database of produced-water properties. Care was taken to sample only the wells that produce in sufficient quantities that contamination from condensation water would be minimal. A research program was also initiated to study the geochemistry of the produced water. With the help of drilling operations, a coring program was undertaken to improve the understanding of key log evaluation parameters and rock properties. Core was obtained in a number of wells having representative reservoir intervals. Systematic errors in log data were often identified through detailed comparisons with other wells in a reservoir and by reconciling log evaluation results with production information.

Concept of Commingling and Regulatory Approval

In 1989, faced with gas prices that were continually declining, engineers and management began reviewing ways to improve the overall profitability of the McAllen Ranch drilling program. Besides reviewing drilling and completion operating practices to minimize costs, the team reviewed ways to accelerate production by getting contributions from behind-pipe reserves and to improve ultimate recovery. In the B area, past practice had been to complete each of the three sands—S, T, and U—sequentially beginning from the bottom sand (U) and working upward in the wellbore after each individual sand was depleted. The historical mindset was that, by completing each sand individually, future operational risks and costs were minimized.

After considerable review by the McAllen team, several drawbacks to this philosophy were identified. Referring to the log in Fig. 3, the S sand typically has the highest pay count, usually three to four times as great as the T or U. Unfortunately, the S sand is also

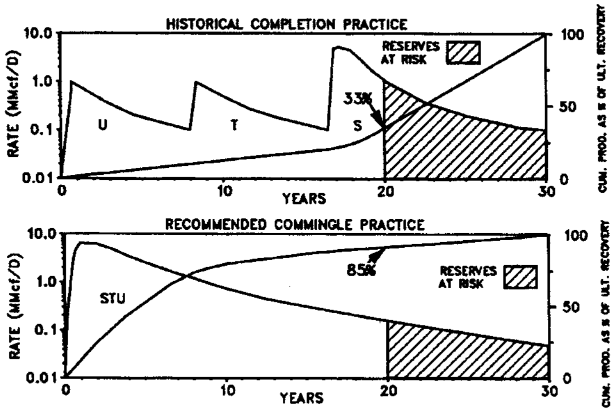

Fig. 5—Completion practices—wellbore life risk assessment.

the shallowest interval and thus in a sequential completion would be the last to be opened up for production, as long as 20 years after the well was drilled (see the top part of **Fig. 5**). The production function and ultimate recovery as a function of time in the upper part of Fig. 5 are based on actual well performance. The first drawback of this philosophy is that, even though the S sand has substantial reserves, the present value associated with its reserves becomes virtually insignificant because it is produced last in the sequence. Second, the wellbores in McAllen Ranch have been found to have a finite life of 20 to 30 years. Major wellbore integrity problems, such as casing damage, occur frequently after 20 years of production, with a resultant loss of reserves. Fig. 5 illustrates the "reserves at risk" associated with producing the sands sequentially vs. simultaneously. Historically, only about 33% of the reserves would be recovered after 20 years with sequential completions, leaving the majority of the reserves remaining behind pipe and at risk after the 20 years.

It was at this point (at the first McAllen Ranch FMSS) that the idea of commingling (vs. sequential) completions of the S, T, and U sands was considered. The pros and cons of this philosophy were carefully reviewed. The major drawbacks identified included the operational and mechanical aspects of multiple fracture treatments in a single wellbore, the integrity of the fracture treatments over time, and the decreased capability to monitor depletion/fracture integrity in individual sands through pressure-transient analysis. The first problem was an operational problem and is addressed elsewhere in this paper. Fracture design at McAllen Ranch has advanced considerably over the past 10 years, including the increased use of higher-strength proppants (instead of sand) to preserve fracture integrity over a wider range of stresses. We concluded that, with the use of higher-strength proppants, the risk of having to refracture treat was minimized and thus diagnosis of individual treatments would no longer be as frequent.

As the evaluation progressed, it soon became obvious that the benefits of commingled completions would far outweigh any drawbacks. The first benefit identified was increased ultimate recovery per well. With commingled completions, ultimate recovery is increased or maximized in three ways. First, given a constant per-well rate as an economic limit, commingled completions provide an improvement through lower abandonment pressures in each individual sand. This improvement is estimated to average 175 MMcf and 17,500 bbl condensate per well in the B area. Second, with declining gas prices, we were faced with completing new wells only in the better S sand to meet our return-on-investment requirements and thus foregoing the recovery of any reserves in the marginal T and U sands. The volumes in these lower sands would not be sufficient to justify attempting downhole recompletion work in the future. Finally, ultimate recovery is maximized by commingling because risk of losing the wellbore after 20 years is minimized considerably. Although it is difficult to quantify when a wellbore will be lost, obviously there are ultimate recovery benefits to getting the maximum amount of production before the 20-year mark. This is illustrated in the lower part of

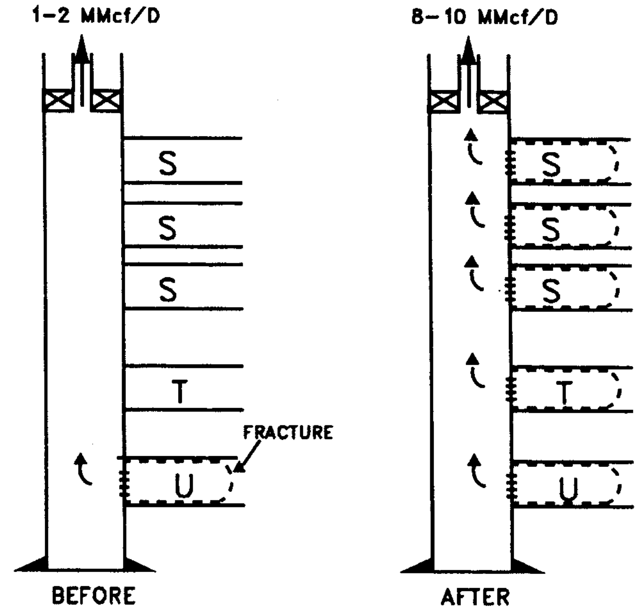

Fig. 6—Vicksburg S, T, U sand commingling.

Fig. 5, where 85% of reserves is estimated to be recovered by commingling compared with 33% in the sequential case. The production function and ultimate recovery as a function of time under the commingling case are based on initial production rates and predictions from simulation studies of McAllen Ranch wells. **Fig. 6** schematically shows the sequential vs. commingled completion techniques.

Besides ultimate recovery benefits, commingling zones has a substantial effect on the overall return on investment for the wells. These wells went from being marginally profitable or unprofitable with sequential completions to providing an acceptable rate of return with commingled completions. Several McAllen Ranch wells would not have been drilled had we not considered commingling.

Before implementing the commingled completion practice, we had to present evidence before the Texas Railroad Commission to obtain permission to commingle the three intervals. During the hearing before the commission on Feb. 23, 1990, we introduced most of the arguments presented above as justification for consolidating the fields. We also presented evidence that crossflow between zones would be minimal owing to similar reservoir characteristics and fluid properties. The commission approved the S, T, U sands field consolidation on March 20, 1990.

Completion and Remedial Well Work

When regulatory approval for commingling was obtained, the team immediately began the work required to identify opportunities in both additional commingling of existing wells and conventional remedial work.

The most significant opportunities were in hydraulic fracturing, where new technical tools supplied by our research organization (geometry models, design software, fluids testing, etc.) resulted in a significant reduction in treatment complexity and associated cost (15% to 20%). Changes were also made in other areas, including perforating, production equipment selection, and inspection (wellheads, tubulars, packers, etc.) and our philosophy on the use of surplus and used equipment.

In addition to the teamwork within the cross-functional team, efforts were made to ensure effective relationships with research staff, service company representatives and equipment suppliers who were not officially represented on the team. Coordinator roles were developed to enhance these relationships. These individuals served as a clearinghouse for new information, helped resolve problems, and assisted purchasing in preparing bids and negotiating contracts for the McAllen Ranch effort and other south Texas activity.

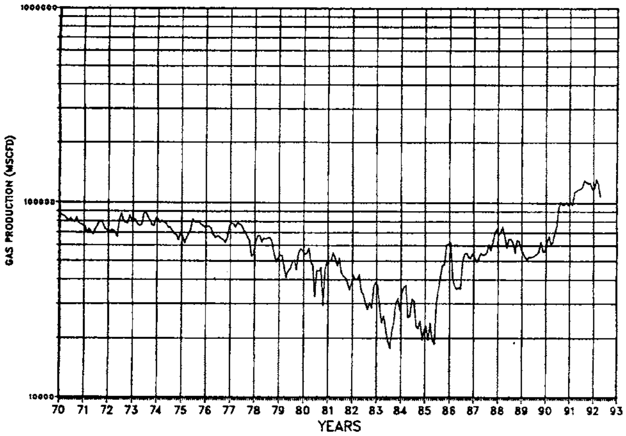

Fig. 7—McAllen Ranch field gas production.

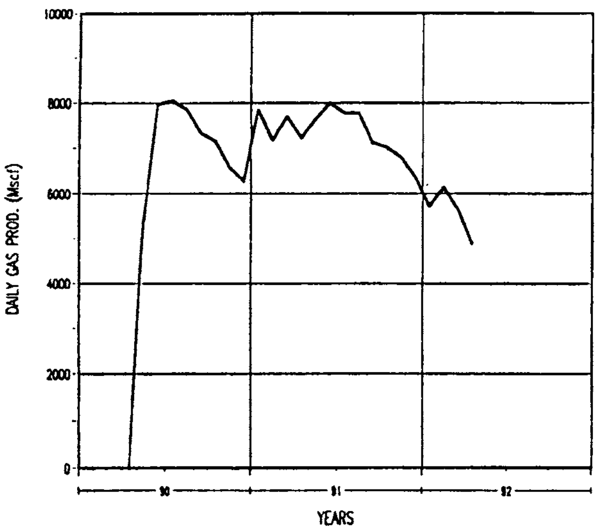

Fig. 8—McAllen B-20 gas production from commingled completion.

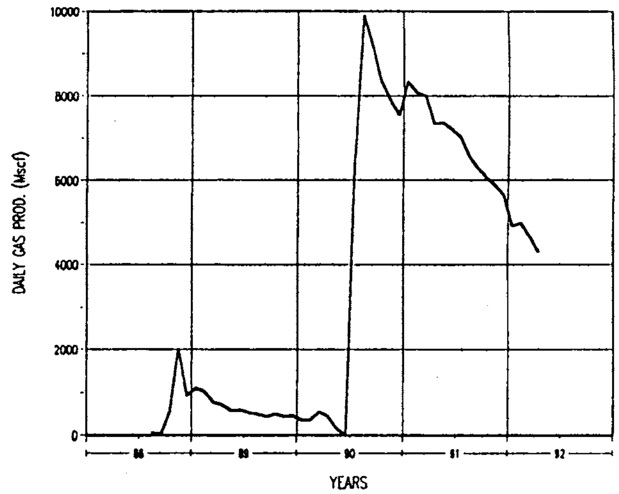

Fig. 9—McAllen B-16 gas production increase from commingling.

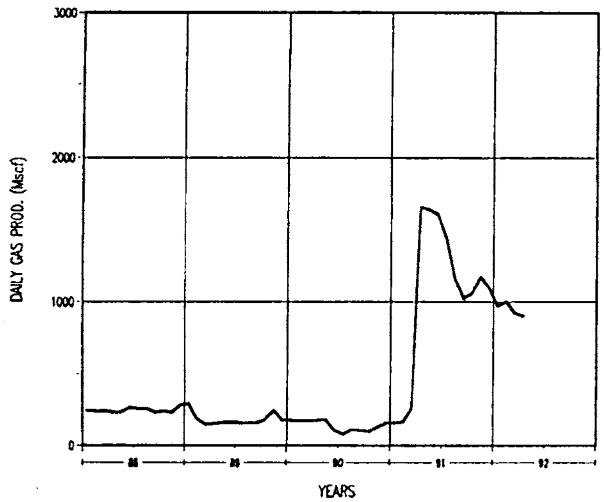

Fig. 10—Woods Christian 20 gas production increase from refracture treatment.

Results of the completions and remedial well work at McAllen Ranch were impressive. During 1990–91, production increased by more than 250%, from ≈50 to >130 MMcf/D (**Fig. 7**). This increase included gas from 13 new wells that produced at initial rates averaging 7 MMcf/D, compared with the 1 to 3 MMcf/D historically realized. Remedial well work also contributed a substantial portion of the increase. The level of this work was increased by one-third from the previous 3-year period, from about $4.5 million/yr during 1987–89 to almost $6 million/yr during 1990–91, with improved results. In all, 75 individual fracture/refracture treatments were performed in conjunction with these activities.

Completions. Completions at McAllen Ranch require costly equipment and massive hydraulic fracture treatments to achieve economical production. Typically, multiple "stacked" pay intervals are encountered (Fig. 3); they require multiple (two to five) treatments to stimulate the reservoirs adequately. Wells range in depth from 12,000 to 14,500 ft, with bottomhole pressures and temperatures exceeding 12,000 psi and 350°F in the deeper intervals. In addition, sufficient H_2S is present to make the gas metallurgically sour.

McAllen B-20 was the first commingled well completion. Four treatment sequences were required to treat pay intervals in the S, T, and U sands. This well produced at an initial rate of >8 MMcf/D (**Fig. 8**) in contrast to the 1 to 2 MMcf/D that would have been realized had it been completed in only the lowermost interval.

Remedial Well Work. Remedial well work consisted of recompletions (including additional commingling opportunities), refracture treatments, and wellbore cleanouts.

Results of remedial activity on McAllen B-16 best illustrates the impact of commingling. This well was originally completed in the U sand during late 1988. An initial rate of 1 MMcf/D was achieved; however, production had declined to ≈500 Mcf/D by early 1990. The well was worked over at that time, and production from the S, T, and U sands commingled. When production was re-established, a rate of 10 MMcf/D was achieved (**Fig. 9**).

Although commingling offered the most dramatic results, other remedial work was also very successful. **Fig. 10** shows production from Woods Christian 20, a well that was refracture treated during early 1991. This well was originally treated with sand at low loadings (<5 lbm/gal); however, the high closure stresses encountered at McAllen Ranch resulted in a loss of fracture conductivity owing to sand crushing. The refracture treatment incorporated intermediate-strength proppant at higher loadings (8 lbm/gal) for improved long-term productivity.

Wellbore cleanouts were also profitable. **Fig. 11** shows the results of such a job on McAllen Well 57. Snubbing units were used initially; however, coiled tubing is now routinely used when surface pressures allow. Effective teamwork between engineering and operations resulted in proper risk assessment, which allowed

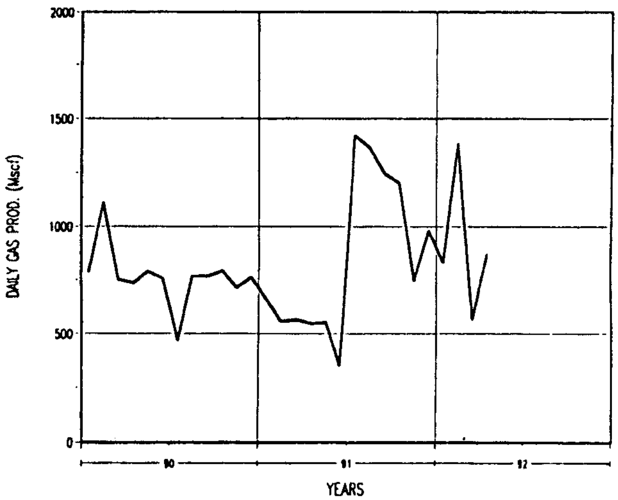

Fig. 11—McAllen 57 gas production increase from coiled-tubing cleanout.

its use at these conditions (depths, temperatures, etc.) to be "sold" to management.

Interaction With Field Operations

Another key ingredient in the overall success of the McAllen Ranch redevelopment program was the strong working team relationship between engineering and field operations personnel. Drilling, production, and facilities engineers developed this relationship by visiting the field frequently and, when in the office, communicating with appropriate operations personnel daily to ensure that lines of communication remained open and that the "field" was getting necessary support from the "office." All major changes to historical practices were discussed with operations and any differences worked out through both education and compromise before implementation. This teamwork allowed new ideas and innovative approaches from both groups to be brought to fruition in a timely and effective manner.

To enhance this teamwork, operations personnel were also included in the field's formal asset management team where they had an opportunity to interact with the subsurface engineering specialties (geological, petrophysical, and reservoir engineering). Individuals from these specialties were also encouraged to visit the field, particularly for such events as formal well reviews. Overall, the interaction between the groups resulted in a better understanding of the problems encountered by other team members and allowed the team to develop a very close and effective working relationship.

Results Summary

The McAllen Ranch asset management team was able to meet or beat all its targets.

- Field gas production rate has increased more than 250% from 50 to >130 MMcf/D in less than 2 years. This production was the highest rate in the field in more than 20 years.
- Application of fine-grid 3D seismic and synergistic subsurface engineering has resulted in a success rate exceeding 93% for drilling of 15 new wells with >100 Bcf of new gas reserves added.
- The time needed to drill new wells has been cut in half, with a world record established for cumulative footage drilled with an 8.5-in. bit, and overall drilling costs have been reduced by 25% (over $7 million).
- Average new well initial production rates are 7 MMcf/D, compared with previous rates of 1 to 3 MMcf/D
- The previously untested concept of commingling several massive hydraulically fractured intervals in the same wellbore, separated by hundreds of feet, was successfully applied after obtaining approval from the regulatory authorities.
- Through commingling, behind-pipe noncontributing reserves have been reduced to less than 20% of the proved developed reserves. This compares to more than 40% of developed reserves behind pipe before 1990.

Conclusions

On the basis of the extraordinary production results and the excellent teamwork exhibited by the McAllen Ranch team, we can conclude that effective cross-functional team management of a multidisciplinary team is indeed possible and necessary in complex oil- and gas-producing operations. The management and organizational actions listed below were instrumental in the success of this team effort.

- Eliminating organizational barriers and silos, along with supporting prudent "risk taking," can lead to innovative technical and business results.
- Empowering the staff to reach collective decisions without management intervention and reducing routine supervision can lead to a sense of accomplishment among the team members and can actually speed up all aspects of the approval and implementation process.
- Focusing the team members on a common goal can eliminate "provincial" and specialty-specific targets.
- The cross-functional team management concept can be applied to other fields as evidenced by the results achieved at the McAllen Ranch and other south Texas fields.

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References

1. Hill, D.P., Lennon, R.B., and Wright, C.L.: "Making an Old Gem Sparkle: The Rejuvenation of McAllen Ranch Field, Texas," *CGAGS Trans.* (1991) **41,** 325.
2. Simon, J.M.: "New Standard Set for South Texas Drilling Performance," paper SPE 24602 presented at 1992 SPE Annual Technical Conference and Exhibition, Washington, DC, Oct. 4–7.

SI Metric Conversion Factors

acre	× 4.046 873	E − 01 = ha
bbl	× 1.589 873	E − 01 = m^3
ft	× 3.048*	E − 01 = m
ft^3	× 2.831 685	E − 02 = m^3
°F	(°F − 32)/1.8	= °C
in.	× 2.54*	E + 00 = cm
gal	× 3.785 412	E − 03 = m^3
lbm	× 4.535 924	E − 01 = kg
mile	× 1.609 344*	E + 00 = km
psi	× 6.894 757	E + 00 = kPa
sq mile	× 2.589 988	E + 00 = km^2

*Conversion factor is exact.

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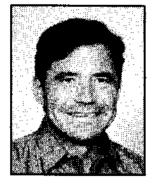
Durrani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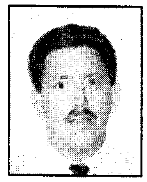
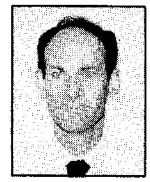
Ordemann


Bickley


Tepper


Simon