ECONOMICS OF LOG EVALUATION FOR LARGE PROJECTS

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ABSTRACT

Log evaluation of multi-zone, multi-well projects is done for three basic purposes:

1. Identification of potential reserves to be drilled during exploratory projects
2. Evaluation of probable reserves, for development now or in the future
3. Evaluation of proven reserves for use in cash flow analyses, for secondary recovery studies, and for reporting to regulatory agencies

Such evaluations usually require a large expenditure in professional staff and possibly computer time, as well as a large organizational effort by supervisory staff to keep the project on-track and on-time. This paper describes the job performance of a self-contained, portable, micro-computer based log evaluation system, which minimizes the direct cost and organizational overhead needed for effective and timely results. The average performance for a typical system provides analyses for about 500 zones averaging 200 feet in length in 378 working days (18 months), for an average cost of C$0.86 per foot of well-bore. A permanent data base is established during the initial evaluation, which can be reviewed or revised as prospect knowledge or economic conditions change.

INTRODUCTION

The exponential increases in petroleum demand, well-head price, and net-back to the producer have done more than dent pocket books and cause gas station line-ups in California. It has revolutionized the role of the professional log analyst and petrophysicist in the oil industry. Market forces have pushed the log analyst, sometimes unwillingly, into the forefront of the "reserves" game. When you see full page career ads for log analysts in national trade magazines (for the first time in history), you know that this demand, usually reserved for professional geophysicists or management, is real and urgent.

The dilemma posed by this situation is two-fold:

1. The applicants for such positions are relatively inexperienced, or the people who replace the experienced analyst,when he moves on, are inexperienced.

2. The urgent need for answers reduces the time the analyst has to spend on each project, thus reducing analysis quality, thoroughness and consistency.

The usual solution is to provide the analyst access to a computer with log analysis software, or to a logging service company or computer service bureau who have log analysis programs. The rational is that the professional can get more done, more consistently, than by hand or hand-calculator methods.

Unfortunately the expected improvement in performance or in results is seldom met, as many of us have found from first hand experience. To evaluate the success of a computer augmented log evaluation system, we must ask the following questions:

1. Does the system (analyst plus computer plus program) get more, better, and faster answers than some other method?

2. Even if it does the above, is the system support cost reasonable (computer, systems analysts, programmers, computer operators, technical assistants, data preparation)?

3. Is the organizational cost low enough (supervisor, clerical, filing, finding, computer access)?

4. Do you get answers when you need them (current wells now, reserves reports or large projects by fixed deadline)?

5. Is the professional analyst in a reasonably attractive work environment and career path (it not he'll leave or do poor work)?

If you can honestly answer YES to all the above for your existing system don't read any further. However, if the system you are using fails any part of this test, the following should be of help in re-designing or improving your existing system.

The five criteria mentioned above are expecially pertinent to large projects. This is true because large projects usually serve, or contribute to, some important corporate goals, or are part of some submission to a regulatory agency. If the log analysis results are inadequate, or cannot be developed in time to meet decision making or filing deadlines, then severe competitive or financial penalties may be incurred.

TYPES OF LARGE PROJECTS

There are a number of general areas in which large log analysis projects may occur. These may be catagorized by reference to the "Resource Triangle" shown in Figure 1, in which the known, proven reserves are contained within a small area at the top of the triangle. This classification of resource is usually the domain

The interconnecting links in the system are its most important feature. Good communication must exist, along with mutual trust and understanding, between the "user" and the "doer". The analyst in turn must be able to communicate with his computer hardware/software package effectively, as well as with his own staff.

This is where most log analysis systems fail, so we put a great deal of effort into designing a "push-button plus prompting" approach. Such a method provides ease of use with constant "memory-jogging", which prevents short cuts or missed parameters, yet reduces the work load on the professional. All data and file management chores are handled by LOG/MATE and not the analyst. It is interesting to note that less than 15% of the LOG/MATE program code performs any log analysis - the balance handles or displays data.

The "push-button" portion of the system makes use of the programmable function keys available on some micro-computers. Each button initiates some specific function, such as ENTER DATA, PLOT RESULTS, ENTER PARAMETERS, and so on. In all, 24 function keys are used in the present system. Since keys can be re-allocated under program control, there is no limit to the functions which can be defined.

The "prompting" portion of the system involves the use of interactive questions requesting parameters or logical choices in computational method. The choices usually relate to the kinds of available data, the quality of the data and the algebraic method desired by the analyst. A preset, or default, answer is provided for every question - no typing is required of the analyst if the preset answer is satisfactory. He merely presses a key marked "continue" to continue on to the next question. When all questions are exhausted, the program automatically proceeds to perform its function. If an error is made, a "RE-RUN" key allows the operator to re-initiate the question sequence.

A single line LED display presents the questions and accepts the answers from the keyboard. As well, during processing the display continuously documents the program activities - in English. For example, the display may show "Loading Data" and the well name, or "Computing Shaly Sand" and the depth currently being processed.

A further aid to communication is a printed Audit Trail, itemizing the functions performed and some basic parameters pertaining to the function. The analyst can review the Audit Trail for errors, or illogical operations and can pick up where he left off by referring to the last few audit entries.

JOB ORGANIZATION

We have built our system around a team concept; the team consisting of the lead or senior log analyst with a junior or trainee analyst and up to two technicians, and possibly a clerk.

The senior analyst is responsible for project definition, parameter and method selection, difficult editing, work scheduling and organization, review of intermediate and final results, presentation and discussion of final results

of the production, exploitation, or utilization department of the oil or gas company.

Development of this resource generates most of the positive cash flow for the company, from which exploration activity can be funded. As a result this is the resource which needs the best documentation, usually reserves and productivity estimates, such as those required by banks, regulatory agencies, and corporate management. Well log analysis for this purpose could encompass a review of every completed zone in which the company has an interest.

The alternative method of determining reserves, often used because it is faster, is decline curve analysis. This approach is not too satisfactory in the context of rapidly rising petroleum demand, since it merely reflects historical production trends or techniques, and does not address the problem of recovering additional production from the existing and known resource base. Log analysis, while it doesn't necessarily tell you how to recover more, at least tells you that there is more to recover.

A second class of large log analysis project involves exploration oriented decisions. Such projects usually include data from all (or most) of the wells in a specific block or tract of acreage. The object is to identify the second tier of the resource triangle - the unproven but promising leads found during previous drilling operations.

Because so much oil, and expecially gas, was by-passed when prices were low, there is a relatively large reserve in the "probable" category, just waiting for the exploration department, and the log analyst, to define.

The third class of large log analysis projects is similar in many respects to the second type described above, but involves more work defining reservoir quality and prospects rather than proving up previous hydrocarbon shows. The log analyst will spend more time defining water bearing reservoirs, in order to provide the geophysicist and geologist with data on potential reservoir conditions. We term these projects "reconnaisance" or "review" projects.

A SYSTEM TO DO THE JOB

After many years of using batch processing (in-house or service bureau) computers, service company log analysis, time-share computers, and hand-calculator methods, we came to the conclusion that something was missing in each of the methods. Usually they were too slow, too expensive, too complicated, or too boring. For these reasons, we reviewed every concrete need, and every real or imagined fault in other approaches, and designed a system which contained most of what we wanted and least of what we didn't want.

The resulting "system" is a hardware/software plus people combination we call "LOG/MATE"[1] Figure 2 illustrates the interaction between the components which justifies the term "system" - a word usually mis-used when describing computer software alone.

with the user, and training and work allocation of subordinates. He must have a thorough knowledge of log analysis methods, as well as be aware of all the available features on the LOG/MATE system. He can run the system effectively after only a few days exposure to it and can modify programs to suit special cases. The more junior members of the team run the system, under the direction of the analyst, and perform the many clerical tasks involved in organizing and filing large volumes of data.

Log analyses are performed on a definable zone - not on the entire well. As many zones as needed are run to cover all potential pay sections. A run control sheet is used to describe the zone to be analysed, the data available, the computation method and parameters required, as well as a brief well history which will aid the analyst. This portion of the well history is also annotated on the final results to aid discussion and comprehension of the log analysis by others.

On large projects, a group of 5 to 10 related zones will be picked, digitized and computed as a "batch". These are reviewed, parameters adjusted as needed, recomputed, reviewed again and eventually finalized. In the earlier stages of a large project the batches consist of those zones with the most core and DST data available. These zones are used to calibrate the log analysis parameters before the uncored zones are analysed. The organization of this procedure is illustrated in the block diagram shown in Figure 3.

These stages may seem simple, even trivial, but we feel that a clear definition such as this benefits the end-user and the analytical team. Large projects bog down if the job stream is unorganized or chaotic.

The two feedback loops shown in Figure 3 indicate that successive re-runs to optimize methods or parameters are easy and rapid. This is the key to satisfying both the technician and the professional analyst, because individual zones are usually finished completely in just a few elapsed hours - instead of days or weeks. As well, a reasonable number of zones (5 to 20) may be interleaved, so that different functions are being performed on different zones. This is a natural outcome of the variable number of times the zone has to be re-computed, and is not a contrived method to provide job variety to the technician or the analyst.

SYSTEM PERFORMANCE

With the organizational effort well defined, it is reasonably simple to keep jobs on-track and on-time. The performance figures shown in Table I illustrate several different large projects undertaken by us in the last 18 months. The time and costs relate to our consulting environment, but are similar to in-house costs if proper attention is paid to allocation of overhead, employee benefits, supervision, and computer costs.

Data for long zones and for short zones for unrelated wells are also shown for comparison. Several facts are apparent. Short zones from unrelated wells cost about twice as much per foot as short zones from related wells. This is mainly a function of the professional "learning time" at the beginning of each job.

Long zones cost the same or less than the comparable footage of project zones, due to the fact that the parameter selection applies to considerably longer intervals on such long zones.

It is also evident that we have improved our organizational ability over the last 18 months. The last two projects listed in Table I were considerably cheaper than the first three. However, the LOG/MATE system was not materially changed during this period, so the improvement was obviously in our use of the system.

Table II presents similar data for a hand-calculator project, and for two projects run at a service company computer center and supervised by us. The cost is considerably too high and the elapsed time for project completion is completely unacceptable in today's context.

CONCLUSIONS

With a combination of good management of jobs and a highly personalized, interactive, stand-alone computer system, we have tackled both large and small projects effectively. The average cost is in the order of C$0.86 per foot for all types of jobs. We believe this to be a significant step toward more widespread use of log analysis for definition of potential and probable reserves, as well for documenting proven reserves of hydrocarbons.

REFERENCES

1. Crain, E. R. and Curwen, D. W., 1979, The Log/Mate Evaluation System, CWLS Transactions, paper AA.

ABOUT THE AUTHOR

E. R. (Ross) Crain is a graduate engineer (McGill, 1962). He has held a number of positions in well logging and geophysical service companies and reservoir engineering, as well as geological and geophysical data processing centers. For the past seven years Mr. Crain has been senior consultant for his own consulting practice in well log analysis.

TABLE I

LOG/MATE SYSTEM PERFORMANCE

Job Name	Area	Number of Wells	Number of Zones	Elapsed Working Cays	Analyst Days	Tech Hrs.	Computer Hrs.	Cost C $	Feet	Match to Core	Unit Cost C$/ft
Projects											
W	Alberta Regional	150	185	60	45	392	274	32000	37000	No	0.86
H1	N. Central Alberta	145	145	48	32	257	301	23800	22100	Yes	1.08
D	Alberta Deep Basin	38	175	75	30	503	491	32800	31000	Yes	1.05
B	Alberta Deep Basin	41	320	86	38	560	580	39000	65000	Yes	0.60
H2	N. Central Alberta	85	476	112	69	954	912	72800	83800	Yes	0.86
Long Zones - Unrelated Wells											
A	Indonesia	1	5	5	4½	39	35	3200	6500	No	0.49
D	East Coast	1	1	2	2	10	15	1300	4250	No	0.31
K	Indonesia	2	2	7	6½	30	46	4025	2500	Yes	1.15
P1	Arctic	1	5	3	2½	3	17	1400	2100	No	0.67
B	Gulf Coast	1	1	2	2	6	10	1075	2250	No	0.48
P2	Arctic	1	4	4	4	20	30	3550	10000	No	0.36
Short Zones - Unrelated Wells											
-	Typical	144	144	-	56	318	400	35900	24000	Half	1.50
		610	1463	-	291.5	3092	3111	C$250050	292100	-	-

Average cost per zone = C$171.00

Average cost per foot = C$ 0.86

Average zones per working day = 4.50

TABLE II

PERFORMANCE USING OTHER METHODS

Job Name	Area	Number of Wells	Number of Zones	Elapsed Working Days	Analyst Days	Computer Service Bureau Cost	Total Cost	Feet	Unit Cost C$/ft
Hand-Calculator									
A1	MacKenzie Delta	50	63	100	70	NIL	21000	95000	0.22
Service Bureau									
A2	High Arctic	41	41	400	78	88000	115000	28000	4.11
A3	High Arctic	7	7	265	7	15400	18400	9300	1.98

FIGURE 1

THE RESOURCE TRIANGLE AND LOG ANALYSIS

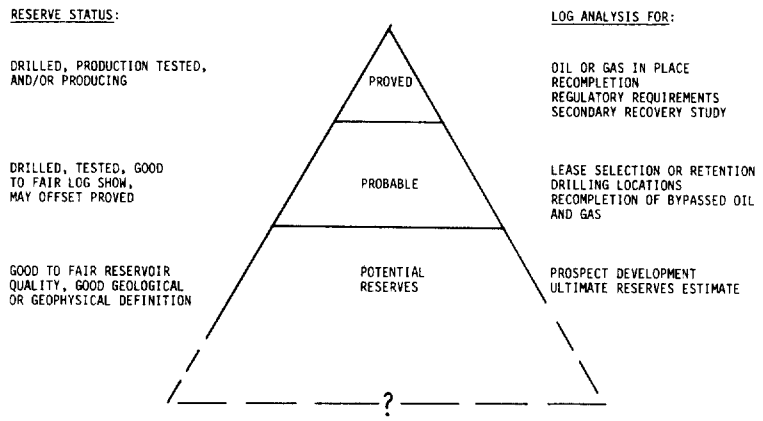


FIGURE 2

THE LOG/MATE SYSTEM

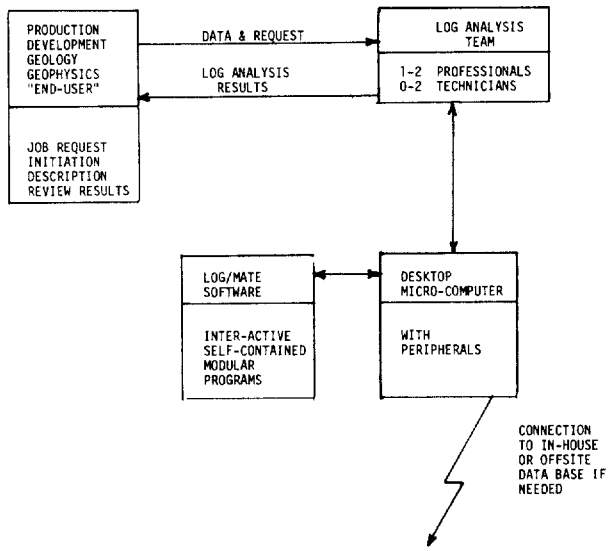
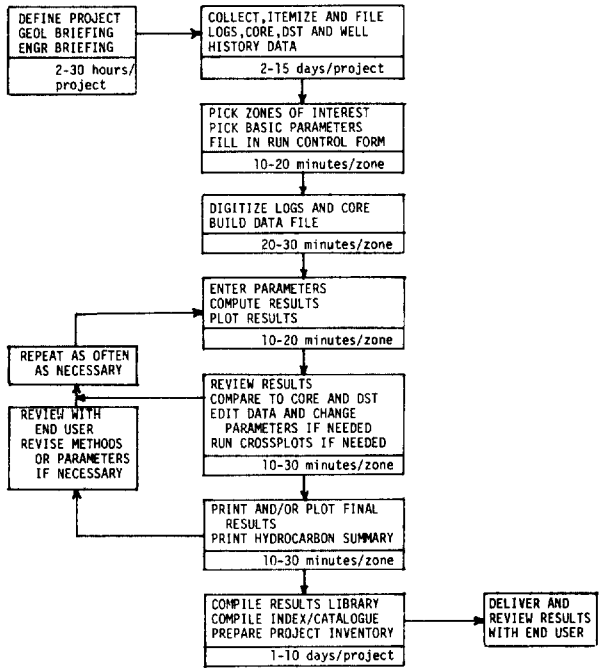


FIGURE 3

LOG/MATE JOB ORGANIZATION