

## “Oil Analysis, Phase IV” Innovation & Regeneration

Society of Tribologists and Lubrication Engineers  
Cincinnati, Ohio

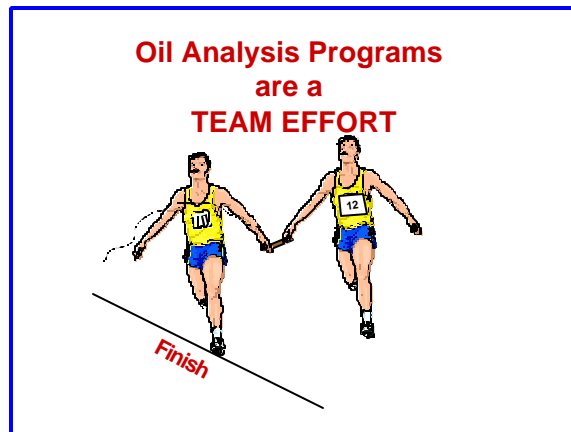
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### Introduction

Lubricant analysis has justifiably risen to a new level of respect and acceptance in industry. This heightened level of use is due to the *realization that it works!* But, it is also due to increased sophistication of laboratory analysis, on-site instrumentation, computers and the ability to integrate the oil analysis results with other technologies. In the opinion of the authors it is no longer acceptable for a testing laboratory or user to simply view oil sample reports and data without regard for the overall development of a cost effective, progressive, lubricant analysis program.

Each stage that one goes through in the process of developing and using a condition monitoring program has definable characteristics. This paper is an attempt to share with you the different levels of development in an oil analysis program and encourage the user to go beyond the advanced (Phase III) and move into Phase IV. **Why? So YOUR TEAM can win the race!** Phase IV companies lead their industry in knowledge transfer and innovation by using “Industrial Communications” and, “The Community of Users” philosophies. It is no longer acceptable in industry to finish first in your leg, while your team finishes last in the relay.



### Background

When the authors first began to work together in about 1991 neither had any idea that they were in the process of forging a map for others to follow. Diablo Canyon was in the beginning phase of developing an oil analysis program while Herguth Laboratories was in the intermediate stages of developing programs that were specific to the issues that nuclear power was facing, such as, extended drain cycles in reactor coolant pump applications, new product dedication and used oil analysis programs for safety related applications.

Looking back we both feel that if we were to have formed a more formal joint action and development plan we would have been able to reduce the time it took to move through the various phases of program development. This is not to say that the program at Diablo Canyon or Herguth Laboratories was especially hindered by the lack of formality. What the authors did do (and still do) is maintain a transitional relationship. This relationship has always instilled the vision of partnership, teamwork and cooperation to find better solutions.

A key example of this can be found in the development of the Westinghouse Owners Group (WOG), "Reactor Coolant Pump Motor Bearing Oil Analysis Project", study and subsequent Final Report # 6665. This project and its successful conclusion was due in a large part to the efforts by Westinghouse, WOG (the community of users) prompted by discussion between Diablo Canyon, other power plants, Herguth Laboratories and Westinghouse, asking the question, "how can we be certain that the oil in these machines will perform satisfactorily until the next outage?" The results of the partnership efforts are now, consistently utilized throughout industry.

### **What are The Three Standard Phases**

The three phases any program progresses through are the *Beginning, Intermediate and Advanced* phases. Oil analysis programs are no different. Table I summarizes characteristics associated with the different phases of development. To move from Beginner to the Advanced stages, it may *take months, years, or a lifetime* depending on the individuals support network (community of users) or lack thereof.

#### **Phase I**

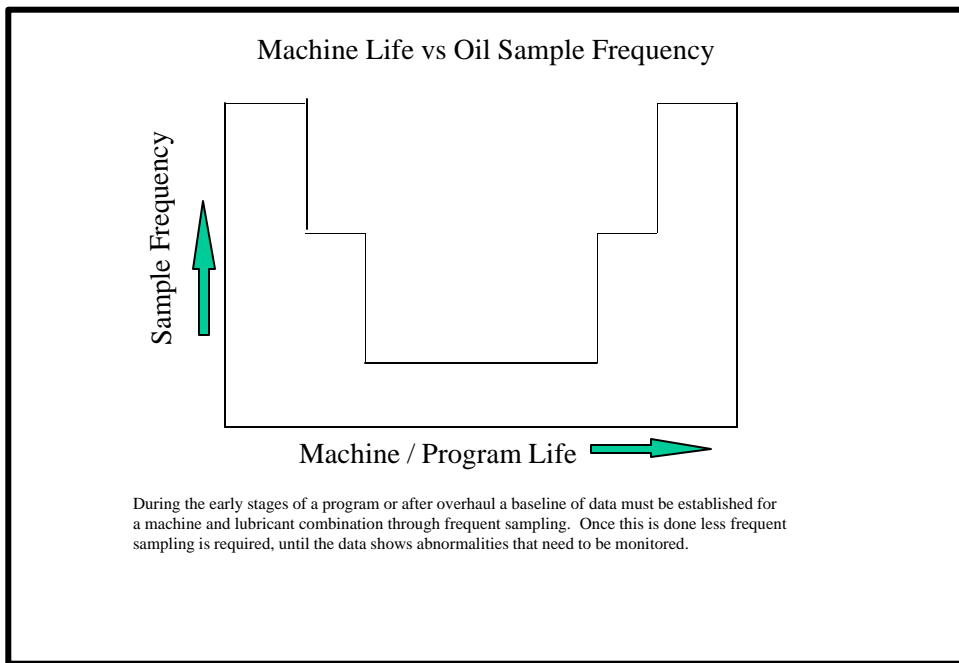
In a Beginning program, the user owner is usually swamped with issues that need attention. Logistics involving contracting outside services, administration and budgeting details required to get the program started can seem overwhelming. Personnel Issues (PI) involve the lack of knowledge, internal capabilities, credibility, and of course, the time to react to the many issues that surround change. The needs are program setup and ownership (internal & external). If these issues are not addressed properly in the beginning, problems will be encountered as the user moves through the program into the next phase.

The basic tenet here to is make sure you select services and systems that meet your goals and that can grow through Phase III and beyond. Price should be the last consideration in the beginning stages. Purchasing cheap services or software without the ability to expand will cost you more in the long run than you saved in the beginning due to quality and data rollover issues. Due to the level of knowledge of the user and time constraints, many mistakes can be avoided simply by having a qualified laboratory, such as Herguth, provide basic setup services.

#### **Phase II**

In the Intermediate phase, the program owner is usually grasping the technology and re-adjusting the focus of oil sampling and analysis. Logistics involve software & hardware control, level of on-site/off-site analysis, and sample results. PI involve continuous learning and understanding the limitations of the oil analysis techniques, verification of sample integrity and accurate interpretation of the results. The needs are still program setup (in a review format), ownership, and software/hardware modifications. The level of samples sent to the laboratory for routine analysis is slowly decreasing as confidence in the machine(s) and system conditions increase.



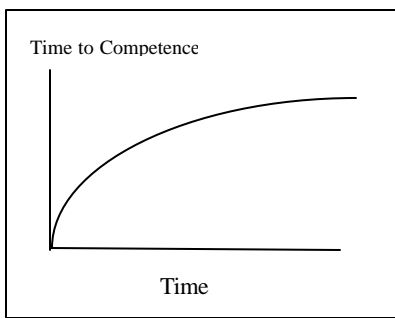


**Figure 1**

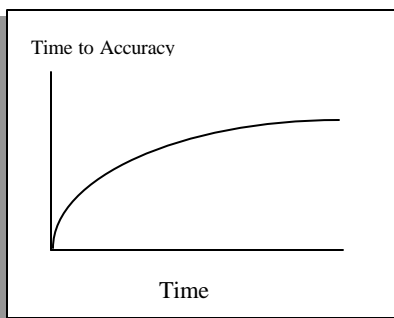
PI issues include decisions on including more equipment for on-site or off-site laboratory testing, obtaining more advanced laboratory services, and minimizing all problems associated with lubrication within the facility. The needs are conversions to paperless data tracking including automatic data input or downloading, sample tracking from job start to finish, and human proofing labeling errors.

**How much Time**

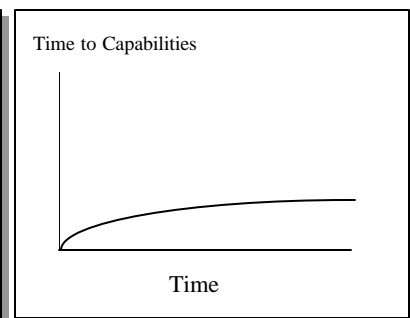
The time and effort it takes to move through the three standard phases is dependent on the commitment of the individuals within the plant that are responsible for the program, the support they receive from their management and the laboratory to which they look to for not only test results but, interpretation, advise, guidance, joint action and development activities. Figures 2-4 represent the typical relationship of time to program level with a very limited amount of community interface.



**Figure 2**



**Figure 3**



**Figure 4**

In the case of the Pacific Gas and Electric Diablo Canyon Nuclear Power Plant, which is well into the advanced phase, this process has developed over about a 5 year period. Nuclear power plants have unique requirements; many of which are based on regulatory requirements that are not found in general industry, slowing the process. However, an oil analysis program for machine condition monitoring is not one of those requirements and must therefore be operated profitably. The nuclear issues simply added some additional time to a program that could have moved faster.

This being the case, the time to move from Phase I to Phase IV and beyond is thought to be atypical of other types of plants having the same commitment and resources. The basics stay the same however and this paper is presented to give users chance to compare where they are in the process to what will lay ahead.

**Phase IV**

So, what is Phase IV? Phase IV takes the expertise and resources of both the beginner and the advanced individuals in industry or your company and combines them with a common goal. That goal is bigger than their individual contributions could ever achieve. It’s a “community of users” who’s goals are to help each other as much as possible including sharing of resources equipment, knowledge, data, personnel, etc. The goal of this community is to support the group by applying your resources to prevent *The Team* from failing.

**Making The Journey Easy And Efficient**

In an industrial community everyone should benefit from everyone else’s experiences. That’s why your reading this paper. In politics the “Sphere of Influence” may be a method of advancement but, in industry this is the wrong way to tackle a problem as shown is figures 5 and 6.

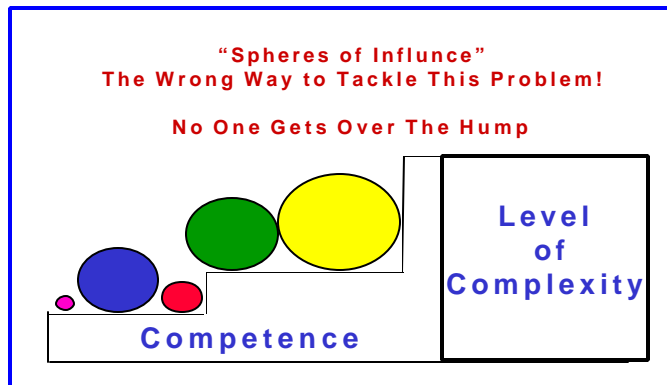


Figure 5

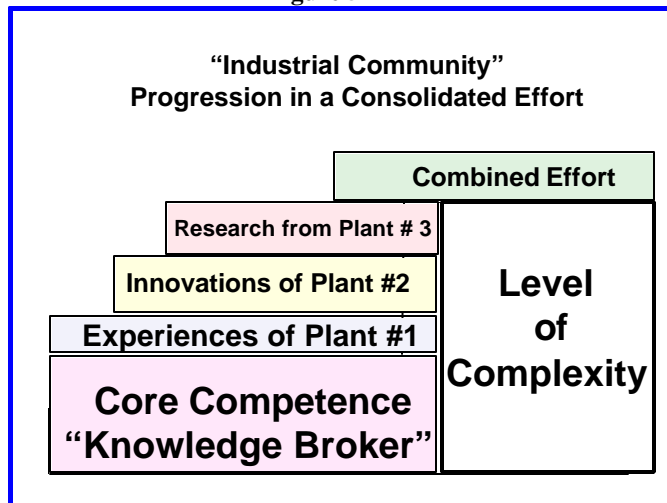
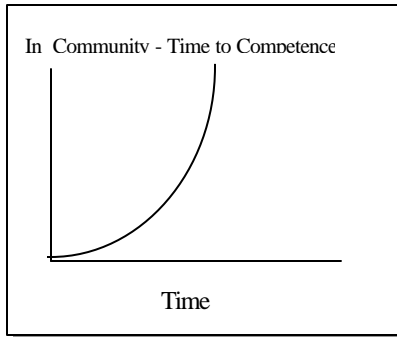


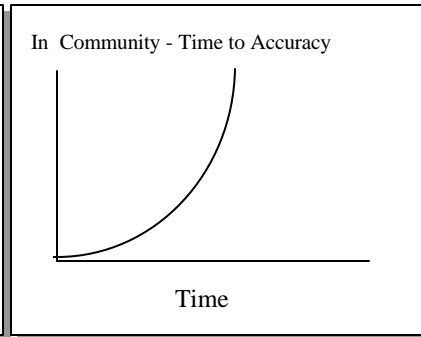
Figure 6

### How much Time

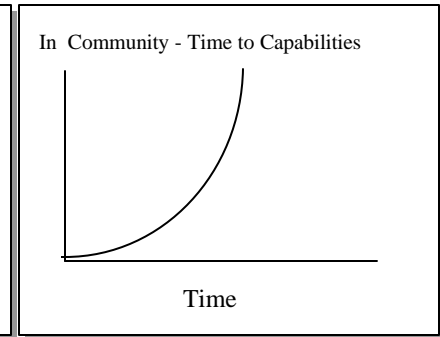
Once the program is into Phase IV significant enhancements can be made utilizing the “community of users” philosophies. Technology moves forward and organizations always find better ways to do things. It is imperative that the personnel involved continue to communicate with industry in an effort to increase knowledge and reduce costs. Ultimately the person who originated the program will move on and hand it over to a less experienced individual. As this process takes place the need for the communications with other users will be more important to facilitate the rapid efficient progression of the new owner of the program. Communicating with the industrial community increase the learning curve dramatically and thus the competency, accuracy and capabilities of the user as graphed below in figures 7-9.



**Figure 7**



**Figure 8**



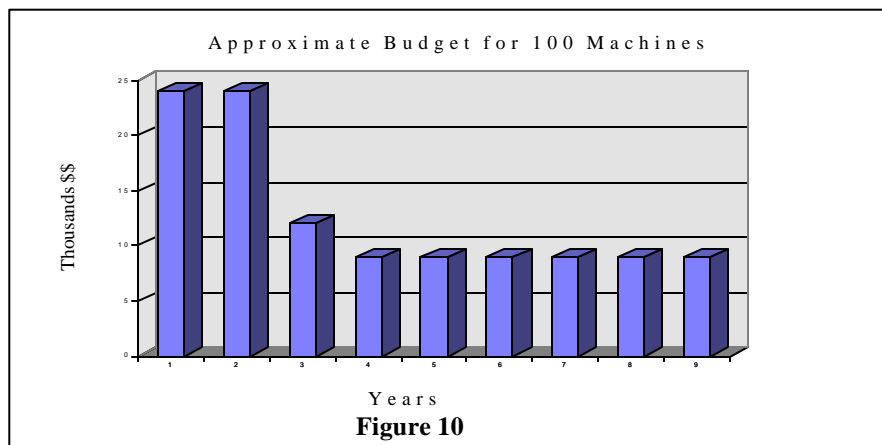
**Figure 9**

### Budgeting

The budgeting process for an oil analysis program is based on a variety of parameters, too numerous to address in this paper. It should be noted however that there will be three distinct phases as show in Table I. A fourth budget phase will be associated with the oil analysis program but for more advanced studies, integration with other technologies and contract services, these are not addressed in this paper.

During the beginning phase extra money will be required for frequent samples to establish baseline data, software, training and implementation expenses.

During the intermediate phase less money will be required since hard assets and training were acquired in the beginning. Sample frequencies and scope of analysis reviews late in the intermediate phase will often justify less frequent sample thereby reducing the necessary budget as shown in Table 2 and graphic figure 7. A key decision must be made as the program move through the intermediate phase into the advanced phase about how much screening or analysis will the user perform on-site, this will directly impact the budget for one or both of these phase.



1 <sup>st</sup> Year	2 <sup>nd</sup> Year	3 <sup>rd</sup> year	Subsequent Years
Setup = \$4,000	Setup = \$1,000	Setup = \$1,000	Setup = \$500
Training = \$4,000	Training = \$1,000	Training = \$1,000	Training = \$500
Software = \$4,000	On-site = \$15,000	Analysis = \$5,000	Analysis = \$5,000
Analysis = \$12,000	Analysis = \$8,400	Special = \$5,000	Consume = \$2500
TOTAL = \$24,000	TOTAL = \$24,000	TOTAL = \$12,000	TOTAL = \$9,000

**Table 2**

NOTE: The above table and graphic figure are rough estimates for an oil analysis program for 100 machines. Assumptions are that the sample fee is \$21.00 and that there are 800 samples analyzed the first year, 400 the second 238 the third and subsequent years. Setup, training and software are initially high but level off to maintenance levels. In the second year some on-site analysis equipment was purchased. In year three there is a category "special" this category represent extra laboratory analysis to identify root cause issues and consumables that may be required for the on-site instrumentation. In subsequent years the consumables level off depending on the level of on-site analysis being performed. Wages for on-site personnel for analysis are not included. No consideration is given to nuclear power plants which may require 10CFR-50 Appendix "B" Part 21 Quality requirements or radioactive samples.

**Conclusion**

Knowing what to expect and the approximate costs involved give the user a clearer picture of the road ahead. Three distinct phases are characteristic of an oil analysis program as it matures from the beginning phase to the advanced phase. Different skills and resources are required for each phase as it is developed. Initially, selecting a lubricant analysis laboratory that can provide the full range of services that will be required beyond the advanced phase will save time and trouble for you and your company.

Advanced program management techniques minimize costs while increasing the overall effectiveness of the program. Documentation and communicating with the community of industrial users will assist in the smooth growth of your program and for those that come after you. Taking advantage of all of these concepts will help you realize the tremendous saving in maintenance costs that an oil analysis program can provide.

<b>Phase I Beginning</b>	<b>Phase IV Community</b>
<u><b>Program Logistic Issues</b></u> Analytical Services Administrative Services Computer Software / Hardware	Automatic trending and alarms Expertise contracts & Services
<u><b>Personnel Issues</b></u> Low Level of Knowledge Low Internal Capabilities Too Busy to React Many Problem Machines/ Lubes	High Level of Knowledge Sharing of Info and resources Training Protégé
<u><b>Needs</b></u> Program Setup Services Ownership (internal/external) Training Success Measurement Tools Management Support Baseline Data	Wide Area Network Local Area Network www. Routine Meetings / Review
<u><b>Budgeting</b></u> Large Due to Initial Program	Budget Planning for Enhancements

**Table 3**