

# ANALYTICAL CHEMISTRY 256

## ROLE - PLAYING LAB

1998-1999 Academic Year

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Northfield, MN 55057

### Introduction to Role-Playing and Laboratory Computing

Defining the Kinds of Role-Playing Responsibilities  
 Round-Robin Certification of Laboratory Glassware  
 Production Quality Control Lead Analysis  
 Statistical/Chemical Evaluation of Lead Data  
 Semi-Automated Weak Acid Titration  
 Graphical Analysis of Weak Acid Titration  
 Designing a Mock Robot Experiment  
 Executing the Mock Robot Experiment  
 The Incredible Edible Easter Egg Grass Advertising Dilemma  
     The Downsizing Dilemma  
 The Broken Pill Coating Machine Assembly Line Shutdown Dilemma  
     The Instrument Purchase Payment Release Dilemma  
     Closure

#### ROLES:

**Manager:** Read About Role-Playing, Grading, and Lab Management

**Chemist:** Locate The **MSDS** forms on  $K_2Cr_2O_7$

**Software:** Do the **Excel** and **LabVIEW** tutorials.

**Hardware:** Operate the Mac laboratory computers.

#### OBJECTIVES:

The primary purpose of the lab is to gather together to discuss the uses of computers in the role-playing lab. To do this requires that **Manager knows** what good lab management means, that folks are oriented to using the various course computers in the lab for information management, and that the people who will be playing roles take the time to understand what role-playing is.

Previous experience has shown that having a full period to explore Microsoft Office, in particular, **MS Word** and **MS Excel** spreadsheets via tutorials, helps offset “computer anxiety”. Also, printing an **MSDS** form using Word sets up the following lab period when **Manager** and **Software** must work with **Chemist** to instruct in laboratory safety. **Hardware** also explores the lab computer operation, the Spectral CCD multichannel spectrophotometers, the analytical and top loading balances, and the pH meters with regard to interfacing them (next period!) to the Mac computer. The LabVIEW language is used by **Hardware** to operate a top-loading balance via its serial port.

#### MANAGEMENT INTERVIEW:

While there is no formal management interview for this lab, since it is largely for orientation, **Upper Management** and the **Staff** will tutor in the lab and make sure that good communication is started. It is especially important that **Manager** learn how to locate and read information on the **Analytical Chemistry Server**, using **Microsoft Word**, and how to print selections from it for his/her staff on the **Analytical Chemistry Department Laser Printer**. **Software** and **Manager** have to know how to drag and drop files from the server to allow interchange of information between companies. Furthermore **Manager** has to know how to exchange information with **Staff** and **Upper Management** via e-mail. Exercises to this end will be given to **Manager** in lieu of an interview. The lab often meets in Rolvaag 250 to have access to multiple computers simultaneously.

## The Role-Playing Laboratory

The chances are good to excellent that you have heard of “role-playing”, but probably not in the context of a chemistry laboratory. What is role-playing?

First, role-playing is a new way to work in the lab. It stresses **interdependence**, as the core part of mature independence, and **division of responsibilities**, rather than division of labor, between those in the lab.

You have done “division of labor” when you did “partners”. When you did this, you divided up the work, and were both or neither actually held responsible for what happened. Role-Playing is not “partners”, since **responsibilities** are divided, and each person in the group is clearly responsible for the execution and outcome of certain responsibilities. It may be that different role-players do labor that is not in their list of responsibilities. We do, after all, help each other out in all manners of ways. But, no matter who actually does the work, or parts of the work, **only one person will be responsible for the results**. This is the difference between “Division of Responsibilities” and “Division of Labor”.

Actually, role-playing is a “bridging” educational model for the sciences. It bridges the full scale, **interdependence** (individuals in a group retain their individuality, but agree to become mutually dependent in achieving a goal) that accompanies industrial work and “independent” research, and the “partners” approach that characterizes, of necessity, some of the beginning labs in the sciences.

As a bridge, it allows you to explore management roles, specialist roles, and small group communication dynamics, including how to reach a consensus without alienation. Role-playing allows exploration of research or development work situations, but without placing you in the high risk position that accompany these roles in the actual professional world. You cannot be laid off from the analytical lab!

Role-playing is an approach that **Upper Management** introduced in the analytical labs at St. Olaf. It is based on 17 years of professional experiences as a Ph.D. research director at the University of Wisconsin, Madison, 15 years teaching at St. Olaf, and four years working in the Stephen Ministry at St. John's Lutheran Church in Northfield.

The actual experiments done in the lab here either represent adaptations of research work, or method's development work done in the Instrumental Analysis course, or have been adapted from the interdependent management style that was developed for research in optical emission spectroscopy, and on experiences in teaching undergraduate analytical chemistry, between 1965 and 1982 at the University of Wisconsin, Madison. Additionally, many components were learned from watching successful industrial research and development efforts in the companies for which **Upper Management** consulted over the past 30 years. The techniques of role-playing are adaptations of approaches used in the Stephen Ministry training taken, taught, and used here in Northfield.

### What is Role-Playing?

What is role-playing? It is not a “gimmick”. Formal role-playing is a legitimate group activity. It has been used for training counselors, therapists, ministers, physicians, sociologists, and teachers. It has been used in AA, chemical abuse rehabilitation, management training, and for training professionals in small group dynamics.

Basically, role-playing is the activity of acting out, or *mimicking*. The “role” that is mimicked is a perspective or a personality that is defined to demonstrate some behavior pattern. The role is acted out, usually in a small group of less than 6 people, by adopting an exaggerated stereotypical aspect of the behavior pattern. The stereotyping and the exaggeration accent key functions of the role for teaching purposes. In a word then, role-playing is acting out of a deliberately exaggerated personality or cultural stereotype for the teaching of others and for experiential learning.

## How is Role-Playing Learned in the Analytical Lab?

In the analytical lab role-playing is first learned, and then done, in steps. At the start of the semester, it is introduced, individually. In the first set of four experiments it is explored in “Companies” of four students. In the last four experiments, it is practiced in these same Companies of four students. The key small group unit needed to learn role-playing is the “bench”, or “Company”. To follow this, you need to look at the lab schedule of experiments and understand the four roles that are defined here. These four roles are as follows:

### What Are the Roles to be Played?

#### 1. MANAGER

**Manager** is the only person who is responsible for the organization and planning of the experiment, and for the complete outcome of the experiment, whatever it is. **Manager** is the person who receives all rewards or penalties, whatever they are.

**Manager gets the “grade”; everyone else gets the same grade as Manager, no matter what they have actually done.**

#### 2. CHEMIST

**Chemist** is the only person who is responsible for the preparation and delivery, at the right time and place, of those reagents, chemicals, standards, and solutions that are needed to make **Manager's** plan of execution for the experiment work, at the expected level of quality.

#### 3. HARDWARE

**Hardware** is the only person who is responsible for the operation of any instrumentation, simple or complex, needed to make **Manager's** plan of execution of the experiment combine with **Chemist's** preparations in a way to make the outcome of the experiment occur at the expected level of quality.

#### 4. SOFTWARE

**Software** is the only person who is responsible for the operation of any computers, and any programs contained in computers, need to make **Hardware's** instrument operation combine with **Chemist's** preparations in such a way that **Manager** can determine what has happened in the experiment, and report same at the expected level of quality. **Software** may also occasionally program!

### Why Are We Doing Role-Playing in an Analytical Chemistry Lab?

These are the four roles. What are the benefits of playing these roles? The benefit of role-playing is obvious once it has been done, but subtly deceptive beforehand.

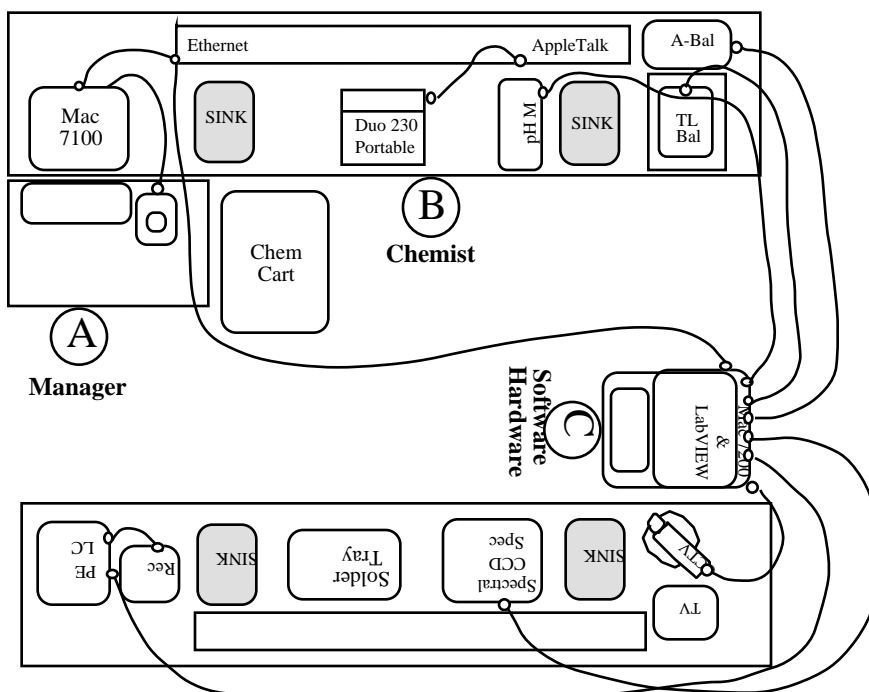
The role-playing activity allows you to explore the more dramatic aspects of living the role without the penalties of accountable responsibility of continued involvement in it. While it is a formal game, with formal play, it carries enough of the actual role by experience that it is almost impossible not to learn from the activity, even when done superficially.

If you role-play seriously, the experience can be quite intense. It is a great way to learn, and have some fun in the process. It helps you get ready for group interactions in future industrial and academic research situations. And, it allows a lot more work to be done on problems that are a lot more interesting than can be done when other approaches have been used in the past.

## How Does Role-Playing Work in the Lab?

How do these roles actually operate in the day to day laboratory environment? First, understand that all of your experiments and all of the physical arrangements in our analytical lab have been deliberately designed with role-playing, or its equivalent, in mind as a central theme.

For example, each open area between the laboratory benches is designated as a “Company” or a Company Bay Area, and accommodates a maximum of four people, one for each role. Where there are too few or too many in the lab “section” (the “Division”), rotations are formed into smaller Companies. We have to work this out in the first “staff meetings” for the semester



Each Company is equipped with its own instrumentation, placed on adjacent benches to the open space, and the instrumentation is deliberately quadruplicated in the four Companies. This allows each Company, as well as the people in it, to operate interdependently.

Each Company is equipped with one Mac Mac 7100 computer. This is for **Manager** to

use in preparing reports and diagnosing results. Each Company also has one interfaced, stand-alone Mac 7200 microcomputer for **Hardware** and **Software** to use. The Macintosh Mac 7200 allows physical linking between the lab and lecture room, using the Analytical Chemistry server and the ethernet network, which is present in both the lab and class rooms.

Each Company has its own hood and set of reagents, sinks, deionized water, and glassware for **Chemist** to use, along with its own small parts collection. Specialized reagents, glassware, digital pipettes, and plastic containers are available on the “Chem Cart” so Chemist can move between lab locations, such as the hoods, the sink, and some remote instruments.

The instrumentation for each Company consists of one electronic analytical balance, one serially interfaced pH meter, one electronic top loading balance, one serially interfaced multichannel spectrophotometer, one portable pH meter, and one isochratic liquid chromatograph. The diagram above shows a typical layout of these resources, with rough locations for the Company micro-computer and other instrumentation. **Hardware**, in consultation with **Manager**, will determine the daily location of needed devices.

The open area between the benches is the Company Bay Area, and there are located the four role-players. **Manager** has a station at the end of the area where the Mac 7200 computer is plugged into a Duo mini-dock with full keyboard and video display. **Chemist** works along the bottom half of the top bench. **Software** works at or near the other full Duo/DuoDock computer, which

services instrumentation on the top half of the bottom bench. **Hardware** works mainly along the top half of the bottom bench. These are not restricted locations, but represent where most people naturally gravitate during an experiment. On those occasions when there are three people in a Company, **Hardware** and **Software** are kept as distinct roles, with separate responsibilities, but done by one person. In this case, **Manager** often does more of the work in one or another role as the tasks become more or less demanding. Experience has indicated either four or three people can play out the four roles effectively.

The bottom half of the bottom bench in the diagram becomes the work area for the **Chemist** in the next Company, and so forth until the end of the lab room is reached at the East wall, which contains only half of a bench.

### Where is “The Professor” in All of This?

Where does “the Prof.” figure in this? As your teaching professor, she or he is “**Upper Management**”. As with your **Manager's** role, **Upper Management** is the only person responsible for the quality of your educational experience.

If, for example, you fail to learn the chemistry, instrumentation, and programs that constitute the lab because of the role-playing mode of operation, then such is the responsibility of **Upper Management**. Should you, however, learn an immense amount of and about these aspects of the lab, because of the role-playing mode of operation, then such too is **Upper Management's** responsibility. As Harry Trumann allegedly so aptly put it, for any **Manager**, “The buck stops here!”.

The role that **Upper Management** plays during the lab periods is that of **Consultant**. **Upper Management** will consult for you, but not for free. If you need technical information, then **Upper Management** will help you get it, and that is free. But, if you want **Upper Management** to make a decision for you, then s/he works by “bid and job contract”, and the fee is (really!) one apple per request. You have access to apples; **Upper Management** has decision making experience. It is a good bargain.

What will **Upper Management** do during the lab? First, the roles are not self-teaching. While **Upper Management** has not had to actually coach anyone in the past, there still are techniques to be learned. **Upper Management** does instruct, and does trouble-shoot, and not as a paid consultant!

The decision making responsibilities lie with each Company's **Manager**. I set up the Companies, work with the stockroom, lecture at the start of the lab periods to explain the organization, and write and rewrite the experiments. But, the most important thing I do is evaluate (a sort of grading) the Company through its **Manager**.

And, when requested to make decisions, **Upper Management** will consult, for an apple.

### What Are Some Responsibilities for the Role-Players?

What are specific examples of some responsibilities of these roles? Each experiment will have in its write-up some description of the **objectives** of the experiment. This will help establish the specific responsibilities for the experiment. In general, however, there are responsibilities for all of the experiments that fall to the various roles more or less as follows:

#### Manager

**Manager** has to handle the organization of the experiment. S/He explains and specifically **interprets** the written objectives of the experiment. S/He also handles and resolves any conflicts between personnel.

S/He decides when parts of the experiment should be done, and how to handle potentially competitive demands on the Company resources from becoming impediments to experiment execution. S/He makes sure the work is done on time, makes sure his/her staff has read the experiment and knows how to implement their roles, understands the roles, and assures that each role is implemented at the level of quality required.

**Manager** is the person who establishes safe laboratory practices, in consultation with **Upper Management**.

**Manager** also electronically writes the lab summary results, reviews the data and submits what is needed to explain the experiment results during the Management Interview. **Manager** reports directly either to **Staff** or to **Upper Management**, and assures **Upper Management** that each person in the Company is fully aware of what is going on in each other's role-playing.

In other words, **Manager** makes sure that each person in his/her Company knows what each other person is doing, why they are doing it, and how things are going, as they are going. **Manager** may do this in any way desired, ranging from pre-experiment staff meetings to post-experiment debriefing.

But, if **Software** doesn't know the kind of chemistry that **Chemist** is doing, while **Chemist** is doing it, then that is a management problem, leading to a lower grade for the entire Company. And the responsibility for this lies with the Company **Manager**!

### Chemist

**Chemist** has the specific responsibility of making, dispensing, and using the solutions and preparations for the specific experiment. **Upper Management** usually will provide the stock. But, the preparation of sub-standards, aliquots, dilutions, and final solutions for measurement all falls to **Chemist**. Along with this comes the responsibility for the correct preparation.

If, for example, results come in too high because there was an error in the standardization of a base solution due to a weighing error in preparing the primary standard acid, then **Chemist** must assume local Company accountability for that, and **Manager** must assume responsibility for allowing it to reverberate through the experiment to the final result.

The responsibilities of these two roles are thus close, and in fact are interrelated. The two roles are interdependent. Communication is all important!

### Hardware

**Hardware** has those very specific responsibilities associated with making the Company instruments run properly. For example, it would be **Hardware** who would read the instruction manual for the instrument and learn from that manual how to operate it, in the context of the experiment! **Hardware** thus also has to know and understand the complete context of the experiment.

For example, in setting up the scan rate for a spectrophotometer, **Hardware** would have to know if any of the chemicals being measured were unstable with time, perhaps due to air oxidation. Such would influence his/her selection of how to run the instrument for this one experiment, but the same instrument might best be run differently in another experiment.

**Hardware** also will connect parts of instruments together, solder cables and connectors, and arrange physical components on the bench when appropriate. Hardware would assemble the circuits needed for the local pH meter, would test connections, would locate spare parts and, with help from **Staff** or **Upper Management**, do limited repairs. Thus, **Hardware** needs to know what **Chemist** has made, just as **Chemist** needs to know what the instrument behavior will be as **Hardware** will use it. These roles are also interdependent, and it is up to **Manager** to make sure

that **Chemist** and **Hardware** are on speaking terms, and in fact are speaking to each other in time to influence the decisions that each will be making during the lab period. **Upper Management** will be circulating around the lab looking for this kind of “speaking collegially”.

## Software

**Software** emerges last, but with responsibilities that operate first. For example, **Software** holds the means for communication and it is communication between people in the Company that makes the whole thing work.

While it is **Manager** who has to electronically write the experiment results, it is **Software** who makes such writing possible by being “on top” of the Company word processor, and helping **Manager** use it! **Software** needs to know what **Chemist** is doing because it is **Software** who helps **Hardware** run all of the instruments that are computer based. And, today, that means just about every instrument there is!

**Software** also handles the spreadsheets on the Company computers, and the spreadsheets are the repository for the data that **Chemist** solicits from **Hardware**, and that **Manager** has to assume are correctly calculated, and so forth. If there are any keys to the kingdom here, it is **Software** who uses them to unlock the communication puzzle. And, it most certainly is communication that makes the experiment actually work. (**Software** does spend a lot of time reading manuals!).

## How is All This Organized?

To get all of this going, look at the lab schedule, and especially the column marked “**Roles**” (see diagram below). These responsibilities are clearly marked in the first set of four experiments. In fact, this is the place for you to practice role-playing in the technical context. These experiments will be the ones you use to learn the roles. Then, in the last set of four experiments (called “dilemmas”) you put all of your experience to work and do a fully accountable job of role-playing.

<i>Week of</i>	<i>Experiment Objectives And Responsibilities</i>	<i>Roles</i>	<i>Rotation</i>
2/09/98	<b>Introduction to Role-Playing and Laboratory Computing</b> (Meet in Rolvaag 250 on your scheduled lab day)	All	None
<i>Defining the Kinds of Role-Playing Responsibilities</i>			
2/16/98	Teaches all about <b>Laboratory Safety</b> and <b>Lab Statistics</b>	<b>Manager</b>	Person <b>A</b>
	Teaches all about <b>MSDS</b> forms and <b>solution preparation</b>	Chemist	Person <b>B</b>
	Teaches all about serial data acquisition and <b>file transfers</b>	Software	Person <b>C</b>
	Teaches all how to <b>solder a serial cable</b> for the balances	Hardware	
<i>Round Robin Certification of Laboratory Glassware</i>			
2/23/98	Monitors certification procedures and <b>organizes the statistics</b>	<b>Manager</b>	Person <b>A</b>
	Cleans, handles, and <b>measures</b> all volumetric glassware	Chemist	Person <b>B</b>
	<b>Designs spreadsheets</b> and does inter-company data transfers	Software	Person <b>C</b>
	<b>Interfaces balance</b> to computer and assists <b>Chemist</b>	Hardware	
<i>Production Quality Control Lead Analysis</i>			
3/02/98	Designs <b>round robin statistics</b> and schedules experiment	<b>Manager</b>	Person <b>B</b>
	Forms and <b>digests</b> the lead chromate <b>precipitates</b>	Chemist	Person <b>C</b>
	<b>Designs spreadsheets</b> for inter-company round robin transfer	Software	Person <b>A</b>
	<b>Interfaces balance</b> to computer and assists <b>Chemist</b> w/Ppts	Hardware	
<i>Statistical / Chemical Evaluation of Lead Data</i>			
3/09/98	<b>Designs lead ISE procedures</b> for standard addition detns	<b>Manager</b>	Person <b>B</b>
	<b>Prepares standard lead solutions</b> for ISE determinations	Chemist	Person <b>C</b>
	<b>Designs spreadsheet</b> to compare ISE and Ppt methods.	Software	Person <b>A</b>
	Assists <b>Chemist</b> with Filtration, and <b>makes ISE msmts</b>	Hardware	

Notice also that roles are rotated! No one person is **Manager** all of the time! In fact, each person in the Company assumes one role, once, for each of four roles during the final four experiments. In this way, each person gets a chance to play each role, and to understand how that role becomes interdependent with the others when the lab is over for the semester.

## What About Grading?

The role-playing laboratory is graded. Since the department has stipulated that all laboratories will carry 0.25 course credit, and then be graded P/N, that is how the role-playing laboratory will be formally graded. **Upper Management**, and **Manager**, will meet in the **Management Interview** to assign letter grades to the experiments. At the end of the semester, **Upper Management** will translate the letter grades into P/N equivalents. Unless performance is noticeably poor, it will take a grade of C or better to pass an experiment, and at least 5 out of the 8 experiments must be passed in order to pass the lab.

The “grades” that are assigned in the first set of four experiments are developmental grades, and your **Management Interviews** are directed a lot more toward improvement and getting ready than they are toward evaluation. These first four graded interview sessions are designed to signal how well along the way the Company is toward doing the final role-playing in the last set of four experiments. It is in those “dilemmas” that the tough grades are assigned, and that all of the above responsibilities become real.

In the role-playing model, it is **Manager** who gets all of the tangibles associated with the experiment. These tangibles are the **Management Interview**, the evaluations, the suggestions for improvements, the requests for permission to use the results in future classes, and, last, the letter grade for the work done.

**Manager** then conveys these tangibles to others in the Company in the debriefing session. With respect to the letter grade, all of the people in the Company get the same grade that their **Manager** gets. Thus, the zero-sum game fails; if **Manager** is not doing well, none other in the Company can be doing better.

## The Management Interview

During the time that you are working in the lab, **Upper Management** will pass around a calendar and sign-up sheet and ask **Manager** to make an appointment for a **Management Interview**. The **management interviews** are those sessions where the grade for the work is assigned to **Manager**.

The **Management Interview** is not an oral examination. It is not a time when you have to defend what you have done against **Upper Management's** criticisms. Instead, it is an interview, not too different from the performance evaluation interviews you will have in the professional world.

The Management Interview gives you a way of reporting back to others in your Company what objectives and tasks were effective, and what were ineffective, in meeting the overall lab objective as given on the cover page of the experiment. As the grade is set, information comes from three sources:

- (1.) During the interview, **Manager** communicates verbally what s/he accomplished during the lab.
- (2.) Lab data, and interpretations of the data, must be available, either on paper, or, preferably, on the Analytical Chemistry Server.
- (3.) Spreadsheets, programs, and electronic files of raw lab data should be available on the Analytical Chemistry Server.

A common concern is what weight is given to “getting the right answer”. There is no one single right answer in our course. When an analytical determination is done, getting statistically significant results for that work is, of course, important. But, the determination itself is only one part of the session, and getting good returns in the other areas also counts.

During the interview, the above three sources of information will be reviewed and used to aid the verbal part of the discussion. In addition, **Upper Management** has **good lab management goals** that he will expect **Manager** to comment on. There are no intended subtleties here. These **good lab management goals** are as follows. It would be a good idea for **Manager** to have filled in some answers to these questions before coming to the interview, in conjunction with other role-players in the Company.

**Manager** should come to the interview with all of these “boxes filled in”, in the sense that she or he should have information available to discuss in any or all of the areas considered to be good laboratory management.

It is up to **Manager** to be sure that all people in his or her Company know about the need for discussing the information in the boxes as they are doing the work. No one should be left out, and no one should consider that only Manager needs to know what is happening.

### *Good Lab Management Goals for Assigning Grades in the Management Interview*

1. How did you assure that your people had good communication with each other while the experiment was going on? What specifically did you, **Manager**, do to keep up good communication?

2. How did you assure that the person playing one role know what the **reverberations** of his/her actions were (or were likely to be) on others in the group playing other roles?

3. What did you, **Manager**, do to define and interpret the objectives of the experiment to your people before they had to act on them in the lab? As the lab progressed, and problems came up, how did you adjust and reinterpret these perceptions?

4. What techniques did you use to resolve “squabbles” and any other personnel problems that came up during the lab? What management skills were most useful to you for this, based on our reading list for **Managers**.

5. How well were the specific objectives of the experiment actually met?  
What were the results?

Where are the lab data and records? Are they all time and date stamped?

What did you do to assure that your graphs, tables, and spreadsheets were professionally prepared?

What statistical tests did you do to determine acceptable results?

6. How did you manage laboratory safety during the time the experiment was underway? Consider labels, MSDS forms, hoods, and chemical handling.

7. What did you do about hazardous waste disposal?

8. What management flaws occurred during your tenure as **Manager**? How did you compensate for them as you became aware of them? What would you do differently if you had to manage this experiment again?

9. What kind of debriefing session are you planning to explain to your people the grade you got for them?

10. Past years have produced the following problems, most of which caused a potential “A” grade to be lowered. Are any of these flaws problems that you encountered?

**Manager** doing the work of the other role-players after the fact to make it look more professional, or to be more technically acceptable.

Blunders.

Failure to take critical data.

Indications that one or another of **Manager's** people were playing the “zero-sum” game, i.e., improving their perceived position by causing another role-player to do less well.

Late work.

Loss of lab data not written down during the work.

Loss or corruption of electronic data.

Mathematical mistakes.

Poor or incorrect spreadsheet design.

Poor record keeping.

Poor understanding by one person of what was happening as the work of other players progressed leading to poor contributions to the whole effort.

Spreadsheet graphs, or other graphical presentations, with non-integral divisions along the axes, poor labeling, bad regression display, or in other ways awkward to read during the interview.

Statistically bad results at the 95% confidence level, based on class histograms, round robin testing, or the class data base from previous semesters.

Undated work.

Unsafe work.

Good results do produce good grades. But, the prevailing principle in use in our lab is that good results stem first from good management.

*Good Grades Come from Good Results;  
Good Results Come from Good Management*

What then does **Upper Management** value as good management? Here are some suggestions for **Manager**.

(1.) Enablement

The style of management that is valued most highly is one of **enablement**. This means, in its simplest form, doing things that make it possible for others in the Company to do their work effectively, *as opposed to doing it for them*.

The central teaching objective, by which the entire lab is structured, has two parts. One is **interdependence between distinct, unique individuals**. The other is **division of responsibility (and thus accountability) between interdependent individuals**. It is **Manager** who keeps the interdependence active by enabling all workers to do their own work. It is **Manager** who assures that only one person retains responsibility, and accountability, for one role and its outcomes, no matter how labor is locally divided.

This style of management is well described in three of the Company reference books that **Manager** may want to read. These books may either be bought or time-shared between the **Managers**. They are, in order of relevance:

- (a.) Empowering Leadership: A Brief Introduction, Bruce B. Roberts and Howard I. Thorsheim, Lutheran Brotherhood Foundation, 1987.
- (b.) Managing on the Edge, Richard Tanner Pascale, Simon and Schuster, NY, 1990.
- (c.) The One-Minute Manager, Kenneth Blanchard and Spencer Johnson, Berkeley Books, NY, 1986.

Empowering Leadership does a fine job of explaining the management philosophy of enabling a person to do work, good or better, by him or herself, in opposition to doing the work for him or her. Roberts and Thorsheim use the word empowerment instead of enablement, but the intent is what **Upper Management** values. The authors show very clearly that it is often counterproductive to do work for someone else. In some ways it can lead to alienation so strong that it becomes bad management.

In his book Managing on the Edge, Pascale shows by case study and example the disastrous results when managers in big industries attempted the kind of control that is the opposite of enablement. He is quite clear about how to handle the apparent disorder that results when enablement operates. He also deals with apparent paradoxes, and does a fine job of showing how successful enablement operates in, among other places, Japanese management. He makes very explicit the ways in which others have been able to divide responsibility, to celebrate uniqueness and diversity, while at the same time enabling workers to link together in a non-competitive manner. He calls this the “fit/split” style of managing, but it still is just what **Manager** can do here.

The One-Minute Manager can help **Manager** understand both how to enable someone to do their own work, while at the same time being able to assertively criticize and evaluate their efforts. This is not paradoxical; the book will help with its punchy, anecdotal style show how this can be approached.

All of these goals will require **Manager** to do quality work in setting up communication between the other roles while the work is going on. This is not simple, and in fact becomes the second of **Manager's** main strategies.

## (2.) Communication

How can management style be graded? It seems unfair! One answer lies in the ability of people being managed to communicate to each other what they are doing, and what is happening because of it. Simply put, if people are enabled, they will likely feel willing, even anxious, to talk to each other about what they are doing, and why they are doing it. Thus, enablement, which **Upper Management** values, enhances openness and good communication.

For example, consider that **Upper Management** approached your **Chemist** in the lab and asked him/her why **Software** was reading the sports page instead of working on a good graphing routine for results that were expected as soon as he/she finished the present set of dilutions. If **Chemist** answered, "Don't ask me, I'm **Chemist**, not **Software**." then **Upper Management** easily could conclude that **Manager** had instituted a style that led to privatization, as opposed to enablement and open communication.

Since **Upper Management** does not value that style, it could be tolerated, but not likely appreciated. If bad results occurred, **Upper Management** probably would look critically at the style **Manager** used, as well as the more specific details of the lab steps. In that sense, style could contribute to, if not actually set, the resulting grade.

What tools are available to help **Manager** establish this communication? One great tool is the ensemble of computers at the bench. As spreadsheets are designed, as reports are written and modified, as graphs are prepared, and as data are taken from the lab instruments, **Manager** can bring the other role-players to the computer, by beck and call, and they can all caucus under the lead of **Software** on the local event. It is very powerful!

## (3.) Overspecialization

We all have identifiable specialization's. Some styles of management reward high degrees of specialization. The problem with specialization is that it can produce isolation, and introversion, instead of just a high skill, when it is over applied, or even applied for too long a time.

But, if specialties are developed with the idea of solving a problem that only exists for a limited time, and if **Manager** rewards innovation and creativity (even in its primitive forms) with as much fervor as s/he rewards detailed skills, then specialization can be acquired with the idea that it will be shared with others in the group.

Management that avoids overspecialization is one that sets up ways, and rewards, for a lot of "coming together" to exchange viewpoints and ideas on how each person's role is doing in the problem solving plan. It also is one that studiously avoids diminishing the uniqueness of each role-player, and what they bring in their role to the problem solving effort.

This kind of management is at the heart of the discussion in M. Scott Peck's book, The Different Drum (Simon and Schuster, 1987). Peck points out that the specialization that will accompany each role in our lab is best combined on a very regular basis with other specializations so that each person can have the opportunity to modify their approach according to their impact on the others and the net effectiveness they are presently having on progress to a solution. This is a practical way of defining the broader terms of community and interdependence.

## (4.) Record Keeping

It always has been, and always probably will be, a problem for **Manager** to know how to instruct the others in the Company in what records to keep while the work is being done. There is the question of how, and how much, to record, and in what device.

**Software** can be a real help to **Manager** by setting up a spreadsheet whose function is to hold both narrative remarks about the work going on, and columns of data, labels, and calculations. Excel, or its other workalikes, do very well here, since narrative may be entered in its "word

processor” mode, and columns of data and formulas are what it is made for. For the equivalent of legal protection, dated printouts of the spreadsheet can be dumped during the lab.

Professional **Managers** use a device like the “day timer” to keep track of their events. Professional **Chemists** use bound, dated, signed, and witnessed lab books. Still, **Upper Management** here feels that the spreadsheet/computer combination, with periodic dumps to the printer for protection, is the best.

#### (5.) Safety

It should come as no surprise to **Manager** that the final responsibility for laboratory safety lies with him or her. This is a complex task that cannot be learned from a book. It involves tours of the lab, stringent enforcement of safety glasses rules, and a host of discussion points about situations and items in the lab that others can get into trouble with if they are unaware of potential hazards. In the next period, **Manager** will take a very active role in teaching lab safety.

By far the most important professional aspect of safety that **Manager** must accomplish is the education of his or her Company members in the “right to know” aspects of the chemicals that they will be handling during the day. If materials are hazardous on skin contact, **Chemist** must know this. If they have a low flash point, or a high volatility, everyone must know this, before the chemical is opened. If they are carcinogenic, everyone must know this. It is up to **Manager** to make sure this happens.

In this introductory session, **Manager**, **Software**, and **Chemist** will get together and practice reading an **MSDS** (**M**aterial **S**afety **D**ata **S**heet) from the Malinckrodt Chemical Company data base, and editing it with Microsoft Word into a form where it can be included in the course compendium. This is what **Manager** will use as the primary way of teaching others in the Company what they the “right to know” about the chemicals that they will be handling.

#### (6.) Attendance

The Company groups are small. The work may not be excessive, but the fact that responsibility is divided means that if one role-player is absent, his or her role will suffer, and the Company will suffer accordingly. When responsibility is divided, everyone is a key player. This is not true when labor is divided, and responsibility is diffuse.

Past practice has indicated a good way to handle absences, which must be limited to **circumstances beyond the person's control**, is for **Manager** to double up the role, and assume the responsibilities of the absentee role-player, in addition to his or her own. Thus, if **Chemist** is absent, **Manager** must both manage, and handle all of the responsibilities of having the right solutions in the right place at the right time.

If a role-player drops the course (it happens), then **Upper Management** will work with the remaining members of the Company to decide how they will finish the semester. Companies of three have worked in the past, although it makes a lot more work for **Manager**. Companies of two will not work, and must be disbanded, with the role-players moved into other Companies. Companies of five can work, although it is hard to find enough work to keep everyone productive. All **Managers** should work to encourage all members of their Company to stay involved, and not drop.

#### (7.) Written Records and Reports

Professional analytical chemists prepare progress reports, research summaries, and proposals in writing. Thus, it is appropriate that **Manager** have in writing something to bring to the **management interview**, as a report. What distinguishes the kind of reporting that **Upper Management** values in the role-playing lab from reporting you may have done elsewhere is the fact that only **Manager** prepares and submits a report, **during** the time the group is working. Current trends in the profession discourage lengthy written “lab reports” with subjective dialog or

commentary added. All lab records can be subpoenaed at any time by a host of legal bodies, and prudent management calls for elimination of narrative commentary that later could be litigated out of context.

**Manager** will often find that there are open times during the lab when responsibility is divided so well, and productivity is so high, that s/he will have open time to work on other things. Some in the past have chosen to read the sports pages. While **Upper Management** is not impressed with this, it is a choice that **Manager** can make. A better choice is to use any open time to prepare the lab records for the upcoming **Management Interview** while the work is actually going on. If this is done, the work will all be in the Analytical Chemistry Server when the period ends, and it seldom will require more than occasional editing to update after the period is over. When the period ends, all is done!

What should be in the lab records? A change from previous efforts that **Manager** may have made lies in the fact that **Upper Management** wants to have all of the experiment records in the Analytical Chemistry Server in some form. They need not be printed on paper. Then, during the **management interview**, they may be called up from the server and read on screen. Names of files that have been stored can be listed, as well as names of spreadsheets. In fact, it is not at all unusual during an interview to call up a spreadsheet and look at it, or its graphs, while a discussion of **Manager's** strategy is underway.

This does mean that **Manager** will have to develop a facility in using the word processor **Upper Management** uses (Microsoft Word) and also develop the ability to move files from the local microcomputer to the Analytical Chemistry Server. The files are best dragged from the local computer to the open server. It is one of the things that **Manager** and **Software** should work on together in the first introductory period.

A few sample reports, that until they were printed for this experiment were strictly electronic, are appended so **Manager** can see what has been done in the past. It is important for **Manager** to realize that when reporting is all electronically done, all records are available in their pure form, all graphs remain in their native spreadsheets, and the only narrative needed is names of files and simple explanations of what the reasoning behind management decisions were, following the "goals" previously presented.

The remaining pages of this introductory experiment will be added individually each semester to allow current software to be explored, and updated procedures seen. **Upper Management** will provide these at the start of the period, along with a schedule of tutorials and demonstrations to get everyone going.

An example of Manager's Notes taken during the lab on the Mock Robot Experiment follows so you can see what it means to keep good electronic records during the time an experiment is being executed. These notes were brought to the Management Interview and used while interpreting the results achieved.

**Tuesday March 23, 1993**  
**13:37**

**Software: Dianna Krause**  
**Hardware: Jim Bergstrom**  
**Chemist: Beth Gyllstrom**  
**Manager: Susan Green**

**Goals for this afternoon's lab:**

- Get some buffers made, based on Chem. 25 lab, and evaluate their usefulness.
- Make a cable for interface with 3B spectrophotometer and decide whether to use it or not.
- Come up with a robot programming language to use for software/hardware interface.
- Make a dry run with our robot language to get bugs out of the system and try to make provisions for possible problems.

**next week's lab:**

- run the experiment for real
- create Excel graphs for isosbestic point

**Chemist:**

Beth is filling out MSDS sheets, and then will begin making up buffer solutions and testing them. Then she needs to decide whether the robot will make solutions next week, or whether she will prepare them and have them ready for the robot. (I favor the second option)

**Hardware:**

Jim is making a cable, which then we need to decide whether to use or not. Then he will work with Software to come up with all possible commands, defined or understood between them explicitly. He then does a dry run of all of the "macro" commands and the entire experiment to make sure that our language covers all possible contingencies.

**Software:**

Dianna is learning how to run Quick Link to link to the spectrophotometer, and where the basic programs are to run the spectrophotometer. She will then work with Hardware to come up with the robot language and do the dry runs to make sure that all possible problems are covered by the language she and Hardware have worked out. She will also have to decide how spectra are to be recorded and by whom; electronically, on paper or both, by her or by the manager, etc. Dianna has said that she and Jim will start with the example language in the manual and build from there.

14:41

Dianna and Jim are working on the mock robot language, while Beth, along with the other chemists are working out a plan of attack for making the 8 solutions for the robot. The eight solutions must span fairly evenly the pH range 2-8. We have also been informed that we are not to share solutions between lab groups. (I'm not sure why, or if this is productive.)

At 15:30 the company is to attend a robot demonstration, to see why the restrictions for Hardware exist.

Some problems that are arising are mainly for chemist, with the restrictions on sharing information it is difficult to figure out what exactly needs to be done. Hopefully these problems will be solved and we can get some information this week to test Dianna's spreadsheet and spot potential problems for next week, since all solutions need to be made up fresh next week.

**Robot checklist:** before running experiment check the following...

- are all necessary solutions in place?
- place wastebasket to left of Robot for tissue waste
- make sure the strip chart is zeroed- Hardware will do this before becoming robotized

**Notes on solution making:**

Beth made up 100ml solutions of 1:1 0.2M HOAc/KCl and 0.2M NaOAc from stock solutions of the same molarity. The densities of each were calculated to be 1.0013g/mL and 1.0109g/mL respectively. Laura's chemist obtained densities of 1.003g/mL and 0.9999g/mL respectively. I decided that for today's rough calculations we would assume that the two densities were equal to each other and their practical density was 1.000. If today's results do not support this assumption we will use next week's calculated densities to obtain an average density to use to calculate the end weights for the eight solutions without approximation.

**Next week's to do list:**

- make up solutions and samples (Chemist)
- obtain pH's of said solutions, theoretically or practically (Chemist)
- run through robot checklist (Manager, Software, Hardware)
- recheck to make sure that all is in order for experiment (Manager, Software, Hardware)
- run experiment (All)
- import runs into Excel (Software)
- create graphs to show isosbestic point (Manager, Software)

**Before next week:**

- type up command list for Software/Hardware
- if solutions approximations do not work, meet with Beth and fix them

LOCATION OF SPREADSHEETS

spreadsheet for isosbestic graphs: wentue/susan manger/isosbestic point

**Tuesday March 30, 1993**

**13:30**

**Additions to robot check list:**

- are all necessary solutions in place?
- place wastebasket to left of Robot for tissue waste
- make sure the strip chart is zeroed- Hardware will do this before becoming robotized
- check on # of kimwipes
- make sure that only one cell is being used for the samples

**notes on isosbestic points**

Quantitative Chemical Analysis Daniel C. Harris (1991)

p. 522

If there are 2 absorbing species in solution, and the spectrum of pure X crosses the spectrum of pure Y, then any solution which is a mixture of these two species will

cross at that point, the isosbestic point

The existence of an isosbestic point during a chemical reaction is a good evidence that only two principle species are present

An isosbestic point occurs when  $x = y$  and  $[X] + [Y]$  is constant

### Data on solutions

#	pH	wt ind(g)	wt NaOAc(g)	wt HOAc/KCl	Total wt(g)
1	6.905	2.0076	18.9936	1.0244	22.0240
2	6.005	2.0083	17.0150	3.0023	22.1606
3	5.723	2.0043	15.0035	5.0188	22.0266
4	5.256	2.0096	10.0280	10.0075	22.0451
5	5.072	2.0064	8.0036	12.0054	22.0154
6	4.772	2.0040	5.0216	15.0036	22.0292
7	4.492	2.0062	3.0148	17.0021	22.0231
8	3.978	2.0084	1.0277	18.9959	22.0320

ave indicator wt (g) : 2.007

st deviation (g) : 0.002

## Workshop on Laboratory Computing

A blood sample is drawn. Trichloroacetic acid is added to it to precipitate the protein in it. It is spun down and the supernatant divided into 10 small portions. To each portion, a progressively larger amount of a lead standard is added, to produce a set of ten solutions starting from zero ppM lead and eventually ending at one that contains 32.1 ppM lead. These solutions are called "standard additions".

The lead is added from a concentrated solution, in very small amounts, so the basic nature of the original deproteinized blood sample is not changed appreciably by the additions.

Each sample then is analyzed in an atomic absorption spectrometer. The following data result. These data are plotted and a curve fit to the points. The equation of the curve is then used to back-solve for, as it were, how much lead would have to be subtracted from the original blood sample to give it an absorption signal of zero. This is how much lead it originally contained.

*This is the equation of the working curve:*

$$\text{Abs} = -0.0002 * (\text{ppm Pb})^2 + 0.0221 * (\text{ppm Pb}) + 0.0826$$

*It is entered in this cell:*

Abs @ 0 ppm Pb Added	ppM Pb Added
0.0826	0.00

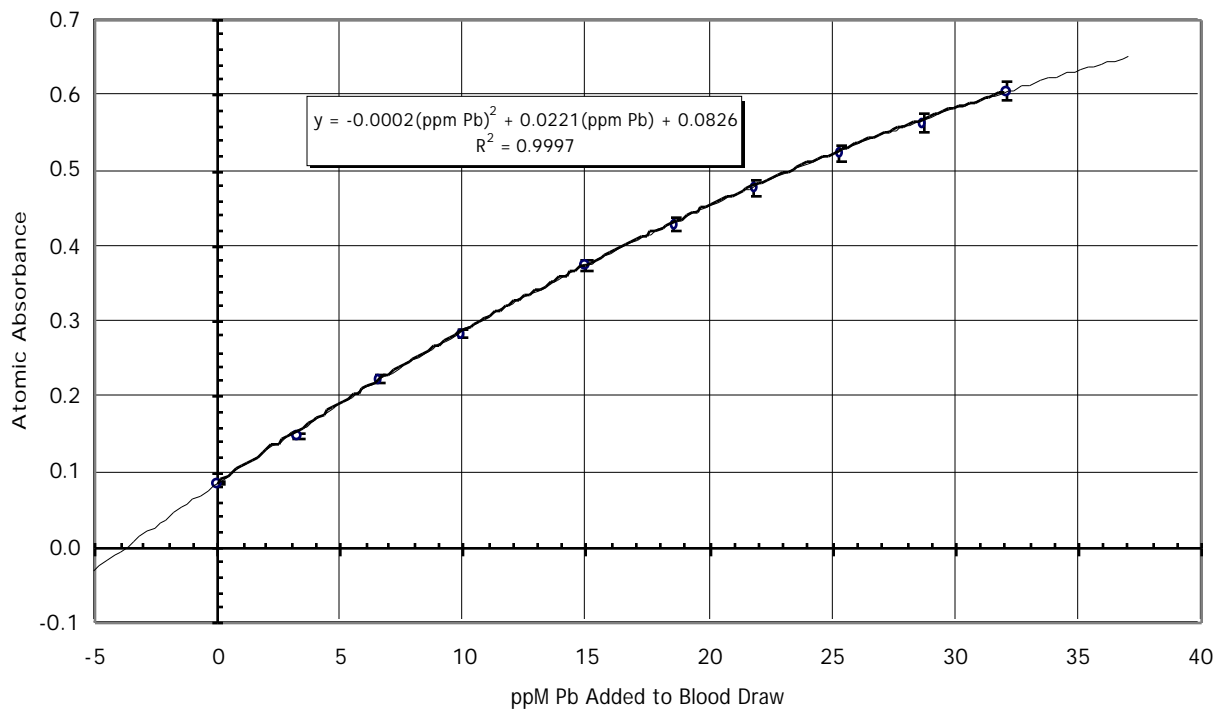
*This is the absorbance when: no Pb has been added to the original solution.*

Abs @ 0 ppm Pb Added	ppM Pb Added
2.86021E-14	-3.62

*This is close enough to zero to say that: this is how much Pb would have to be subtracted from the original sample to produce it.*

X - Axis	Y - Axis
ppm Pb added	Average Abs.
0.0	0.085
3.3	0.147
6.5	0.222
9.9	0.283
15.0	0.375
18.6	0.429
21.8	0.478
25.3	0.523
28.7	0.562
32.1	0.605

Determination of Blood Lead by Atomic Absorption  
John P. Walters & Paul T. Jackson - 8/11/98 @ 15:21



## Blood Copper Analysis

Karen Leigh Rood- 1/13/98- 14:34

This is the equation from the chart of ppM of Cu added vs. Absorbance.

$$y = -0.0022x^2 + 0.1325x + 0.1251$$

$$R^2 = 0.9999$$

ppM of Cu added	Absorbance
0.00	0.128
1.22	0.277
2.05	0.391
2.79	0.475
3.88	0.608
4.60	0.690
5.67	0.807
6.55	0.900
7.42	0.989
8.20	1.069
9.15	1.156

Abs	Cu added
-5.577E-09	-0.930

The number in the Cu added column equals the amount of copper that needs to be subtracted from the original sample to produce an absorbance of zero.

