

A Brave New World: Moving from Campus to Industry

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Leveraging

- **This talk has been extensively leveraged from material originating in Proctor & Gamble**
 - **PowerPoint Presentation by A.H. Ullman and T.M. Thorpe**
 - **“Preparing Analytical Chemists for Industry”, T. M. thorpe and A.H. Ullman, Analytical Chemistry 1996, 68, 477A-480A.**
 - **“Choosing and Preparing for an Industrial Career in Industry”, D. Parry, Applied Spectroscopy 2001, 55, 268A-277A.**

Universities and Industry are different.

- Open information
- Equipment is valuable.
- Ph.D. project is known and is intensely focussed.
- A Ph.D. student has a specific, hierarchic interaction with one professor.
- Proprietary information
- Elapsed time and employee time are valuable.
- Multi-tasking is the norm.
- Teams require multiple, cross-cultural interactions, and authority and/or mentorship may not be clear.

Moving from US to India?

- The technical skills are the same.
- Everyone speaks English.
- But everything else is different. Not wrong, just different.
- Anxiety goes up, and caution rules.

Which project?

- **Jonathan Worstell (Shell Chemicals) emphasized in a talk at UT-Dallas that**
 - **In order to advance in a modern process industry company, one must choose the right projects from a range of “too many projects”.**
 - **The “flattened management structure” of many companies has removed the group leaders who formerly taught such skills.**
 - **A new hire may not even realize that he/she does not know this skill.**

Material from P&G

- Try to hear it, not as a seasoned industrial analytical chemist, but as a bewildered new hire.
- D. Parry's article lays out many things that she anticipates news hires do not know:
 - culture
 - expectations
 - teams
 - etc.
 - rapid learning
 - communications
 - project management

ANALYTICAL CHEMISTS IN INDUSTRY: SCIENTISTS, PROBLEM SOLVERS, COMMUNICATORS, AND MORE

**T. M. Thorpe† and A. H. Ullman*
Procter & Gamble Company**

†Hunt Valley, Maryland

***Cincinnati, Ohio**

Traditional Programs

Provide:

- **Foundation in basic chemical theory**
- **Core courses in**
 - **quantitative analysis**
 - **instrumental analysis**

Typical Instructional Material

- **Chapter 11 Raman Spectroscopy**
 - Theory of Raman Spectroscopy
 - Instrumentation
 - Applications of Raman Spectroscopy
 - Applications of Other Types of Raman Spectroscopy
- **Chapter 26 Gas Chromatography**
 - Principles of Gas-Liquid Chromatography
 - Instruments for Gas-Liquid Chromatography
 - The Stationary Phase
 - Applications of Gas-Liquid Chromatography
 - Etc

“Principles of Instrumental Analysis”, 3rd. Ed., D.A. Skoog, Sanders Publishing, 1985

Traditional Programs

But,

- Recent studies indicate graduate students are weak in
 - applying “their knowledge...in concert with others”
 - effective communication
 - creativity, flexibility , and problem-solving abilities

Industry Needs

Problem Solvers!

Analytical Chemists in Industry: Roles

- **Standard Methods**
- **Methods Development**
- **Technique Development**
- **Science Resource**
- **Problem Solving or Firefighting**

Industry Needs

- **Chemists with a broad range of technical and non-technical skills**

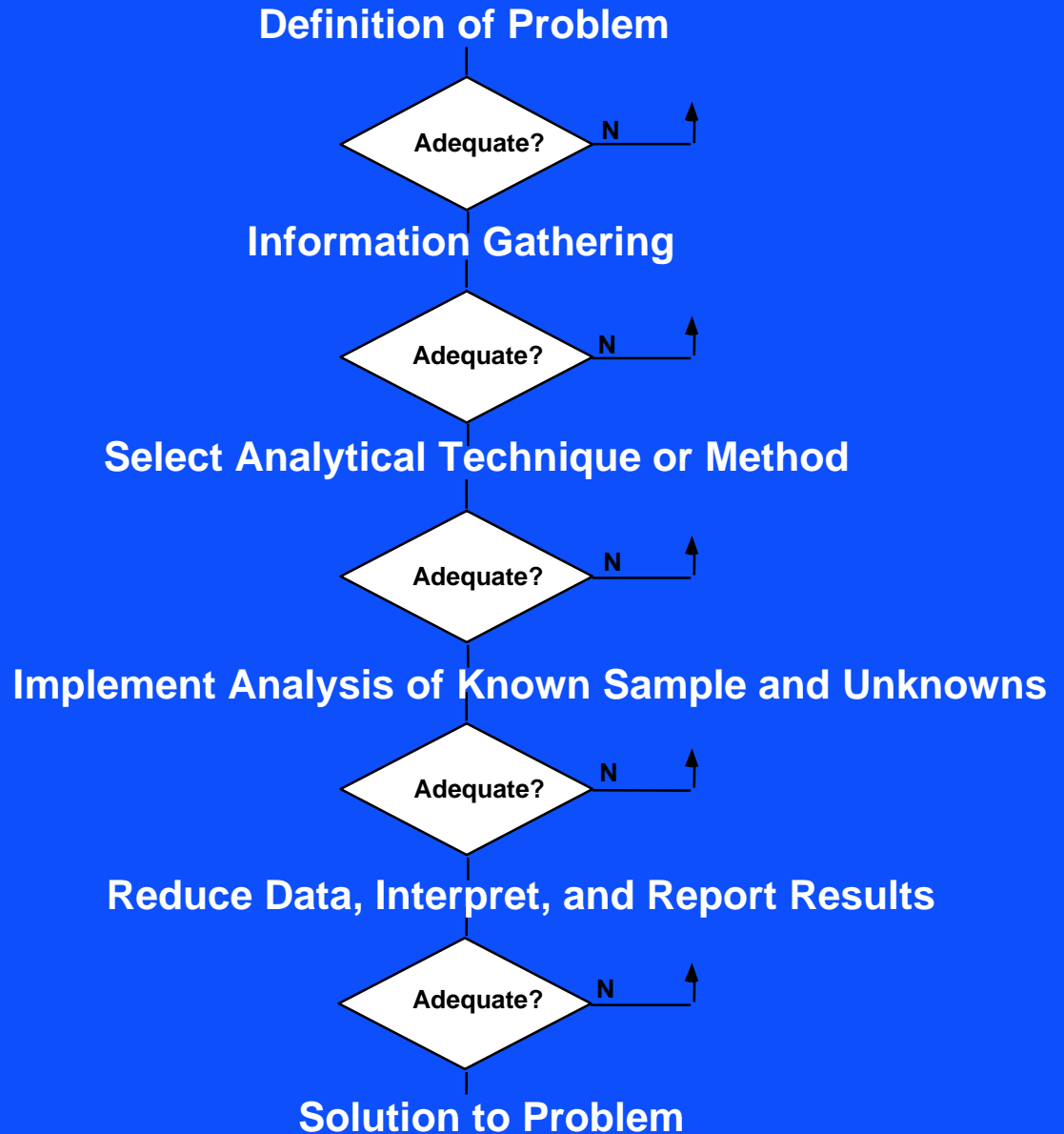
Skills Needed by Industry

- Technical competence, breadth, depth
- Oral and written communication
- Clear goals and objectives
- Utilizing and managing ideas and information
- Taking initiative
- Working with others
- Thoroughness

Industry Needs

Problem Solvers!

The Problem Solving Process



Sample Problem: Using Recycled Plastics

A major consumer products company wishes to convert to recycled plastic for packaging its hard surface cleaner products. A team is chartered to investigate the feasibility of such a move. You, a newly hired analytical chemist, are assigned to the team.

Your First Thoughts

- “What’s the big deal anyway? Plastic is plastic!”
- “I don’t know anything about plastic, let alone recycled plastic.”
- “I’d better get some information.”

Gathering Information



PLASTIC RECYCLING PROCESS

1. Collection of waste materials — green bins

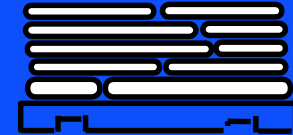
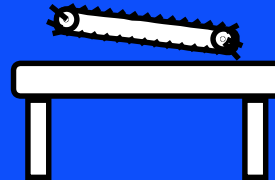
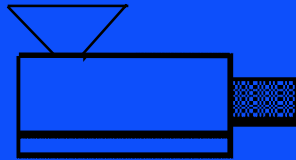
2. Sorting: glasses (by color)
paper, metals, plastic bottles



5. Flaking, pre-washing

4. Shredding, magnetic separation

3. Compaction of Plastic

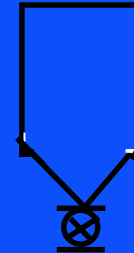
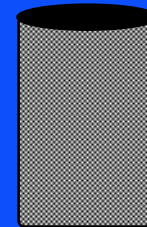
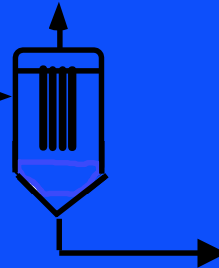
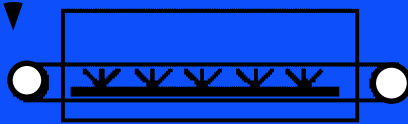


6. Washing/Rinsing

7. Thermal drying

8. Storage

9. Extrusion/repelletizing



Team Composition

- Analytical Chemist
- Process Engineer
- Packaging Engineer
- Product Chemist
- Toxicologist
- Purchasing Agent (Buyer)
- Polymer Chemist
- Microbiologist
- Marketing/Advertising
- Lawyer (government liaison)

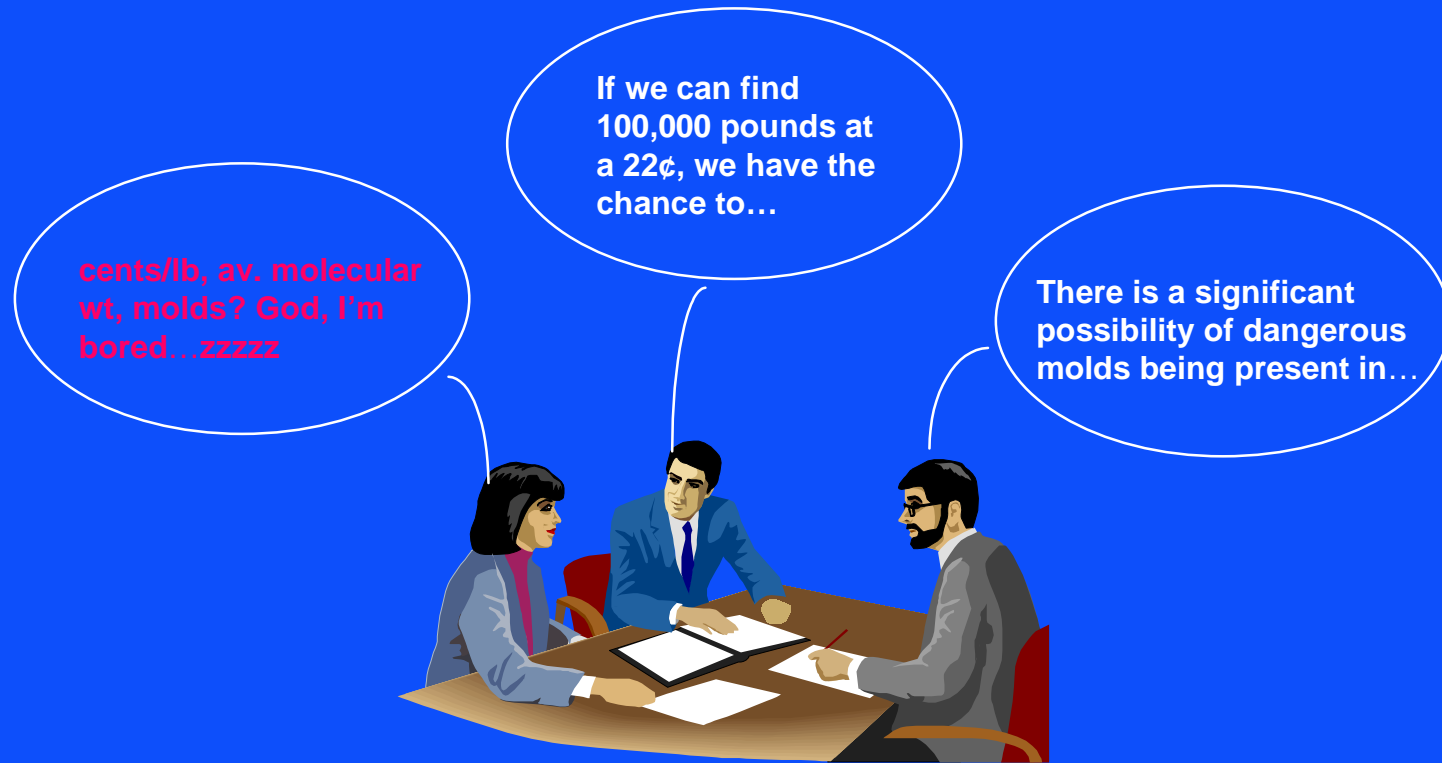
Team Tries to Define Problem

- **Issues Concerning Use of Recycled Plastics**
- **Supply/economics: variability**
- **Physical properties of recycled vs. virgin plastic as they affect package strength, etc.**
 - melting range
 - viscosity
 - molecular weight distribution
 - polyolefin mix (purity)
 -
 -
 -

Team Tries to Define Problem

- **Gross contamination: specks, color, odor...**
- **Trace Contamination: leachable into products?**
 - bacteria, mold
 - dyes
 - heavy metals
 - motor oil/gasoline
 - pesticides, herbicides, fertilizers...

The Team Meets



Team Identifies Key Considerations

- Supply and Demand, Cost
- Package Strength
- Gross Contamination
- Legal, Government issues
- Heavy Metals
- Micro-organisms
- Gross Quality Issues

Sub-teams

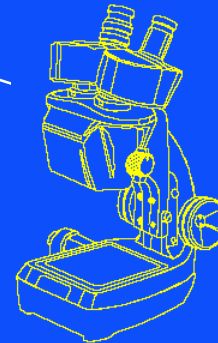
I think we need to divide into smaller groups to study different aspects of the problem. Joe and I will look into supply, demand, cost, etc.



I'll research the trace contaminant question.

Finally something I can do!!

Good idea. I'll check into the microbiology issue.



Trace Contamination Sub-Team

- Led by Analytical Chemist
- Membership:
 - Polymer chemist
 - Chemical engineer
 - Toxicologist
 - Packaging engineer

Trace Contamination Sub-Team

Issues: Do trace contaminants leach into product?
Do they affect strength, etc.?

- Bacteria

- Mold

- Dyes

- Heavy metals

- Motor oil/gasoline

- Pesticides

- Herbicides

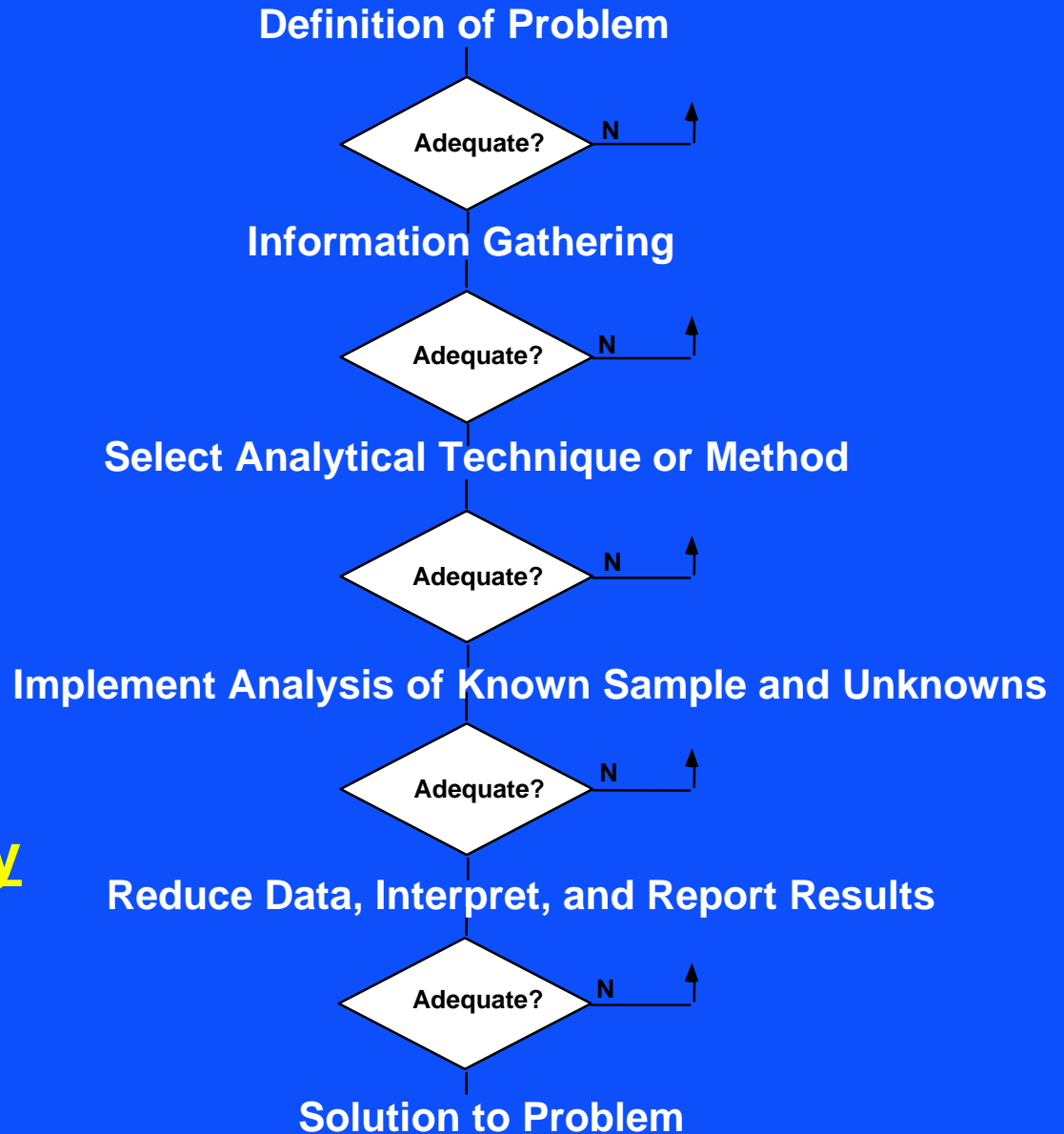
- Fertilizers

Second Thoughts

“What do I do now? I need to impress them with results and soon. But my Ph.D. research was building a femtosecond laser for high speed spectroscopic kinetic studies. I don't even know how to begin!”



**The
Problem
Solving
Process —
now applied to heavy
metals only!**



Steps Use to Solve Problems

- **Definition of problem**
 - Which trace contaminants are most likely to be an issue?
 - What levels might reasonably be expected?
- **Information gathering**
 - Bio-contaminants less likely to survive process
 - Heavy metals arise from a variety of sources
 - Many different metals likely to be present
 - Metals deemed most likely to survive recycling process
 - Five metals deemed most likely problem: As, Cd, Cr, Cu, Pb, (based on input from toxicology, regulatory and legal team members)

Steps Use to Solve Problems

Definition of Problem

What levels of As, Cd, Cr, Cu, & Pb are present?

Do they leach into product?

Steps Used to Solve Problems

+ Get Team to agree to focus on these!

Implementation of the Analysis

Planning: plan experimental program and methods

+++ Get Team agreement on plan +++

Preparation: assemble chemicals, apparatus, instruments,

Sampling: recycled samples and selection of appropriate controls

Pretreatment: select extraction material, extraction treatment

Implementation of the Analysis

Calibration or Standardization:	reagent standards, spikes
Analysis:	samples, blanks, controls
Reduce Data:	assess precision and accuracy
Interpret Results:	estimate risk

The Team Meets to Share Data

Here you see that the US supply of recycled polypropylene is only

I asked Joe to join us later and share his findings on moldability of the plastic.

I have the leaching results for the 5 metals we agreed to study.

It appears that the temperatures used in the remelting process are sufficient to kill 99.9% of the pathogenic bacteria



Team Meeting & Output

- Share results with entire team
 - Team members discuss implication of data from all sub-teams
 - Team estimates risk; special input from toxicology, safety, regulatory and legal sub-team members.
- + **Team prepares report to management, with recommendations!**

Steps Use to Solve Problems

- Definition of problem
- Information gathering
- Select analytical method/technique
- Implement analysis with standards and unknown samples
- Reduce and interpret data
- Report results
- Solution to problem

Factors Which Predict Success

- **Technical competence, breadth, depth**
- **Oral and written communication**
- **Clear goals and objectives**
- **Utilizing and managing ideas and information**
- **Taking initiative**
- **Working with others**
- **Thoroughness**

A quiz for ALMA

- Professors always want to give quizzes!
- Surely you have already resolved this issue, so just pop up with the answer!

How did this situation arise?

- An analytical laboratory manager at a big chemical company called to discuss this situation:
 - “We hire only the very best Ph.D. graduates in the technique we need, from the very best universities.”
 - “It seems like all they want to do is to develop new techniques within their particular instrumental area.’
 - “How can I get them to function as ‘problem solvers’ for the plant operations? After all, that’s where we make money.”

Doctor of Chemistry (DChem)

- Preparation for careers in industry
- Emphasis on innovation and problem solving
- Year long Industrial Practicum (in third year) leads to “industry savvy” graduates with practical attitudes
- Analytical courses emphasize optimal choice of techniques and problem solving.
- Process analytical chemistry
- <http://www.utdallas.edu/dept/chemistry/dchmchrt.htm>

Acknowledgements

- UT-Dallas faculty and students
- Dow Chemical Company (LAM worked at Freeport, TX site in 1998-1999 year)
- Many industrial friends who have taken me aside and said “This is how it is. ... “
- ALMA
- This presentation may be downloaded from <http://www.utdallas.edu/~melton>