



Personal Experiences & Lessons Learned in 20+ Years of Industrial R&D

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What is your Greatest Fear?



- Speaking to a group 41%
- Heights 32%
- Insects and bugs 24%
- Financial problems 23%
- Deep water 22%
- Sickness 20%
- Death 19%
- Flying 18%



***“All the
great speakers
were
bad speakers
first.”***

— Ralph Waldo Emerson
American essayist and poet



A Case Study....



Leadership Speaking Tips



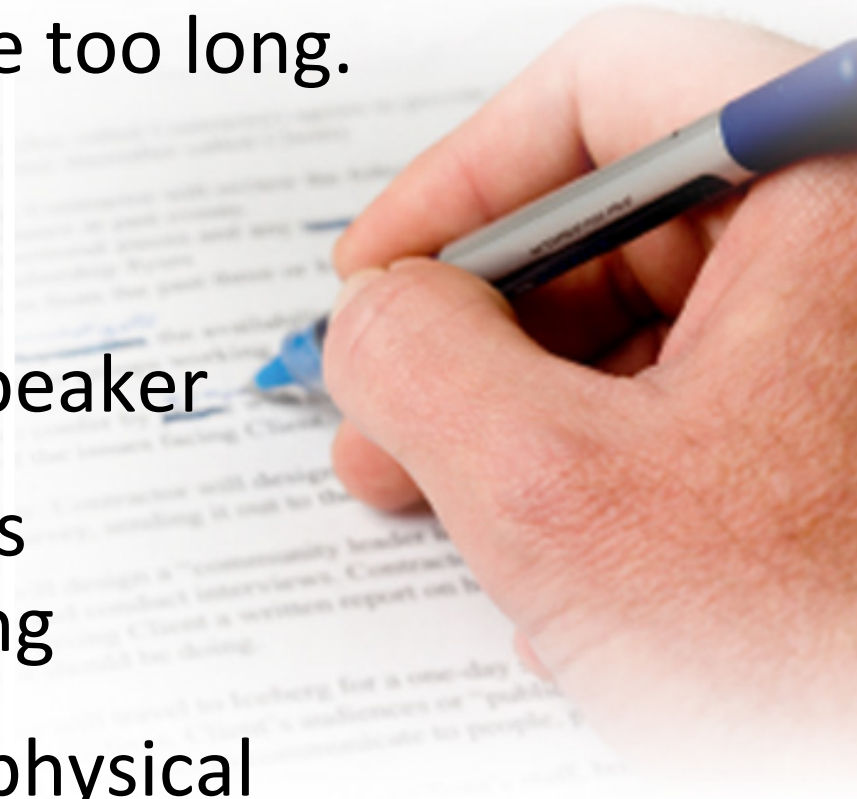
- Know your audience
- Never agree to give someone else's presentation
- Develop your **Key Point**
- Come prepared
- Always dress for success
- End before your allotted time



Leadership Speaking Tips



- First draft presentations are too long. Second and third drafts are also too long
- Never say you're the last speaker
- Never admit you're nervous or inexperienced at speaking
- Never make references to physical or human characteristics



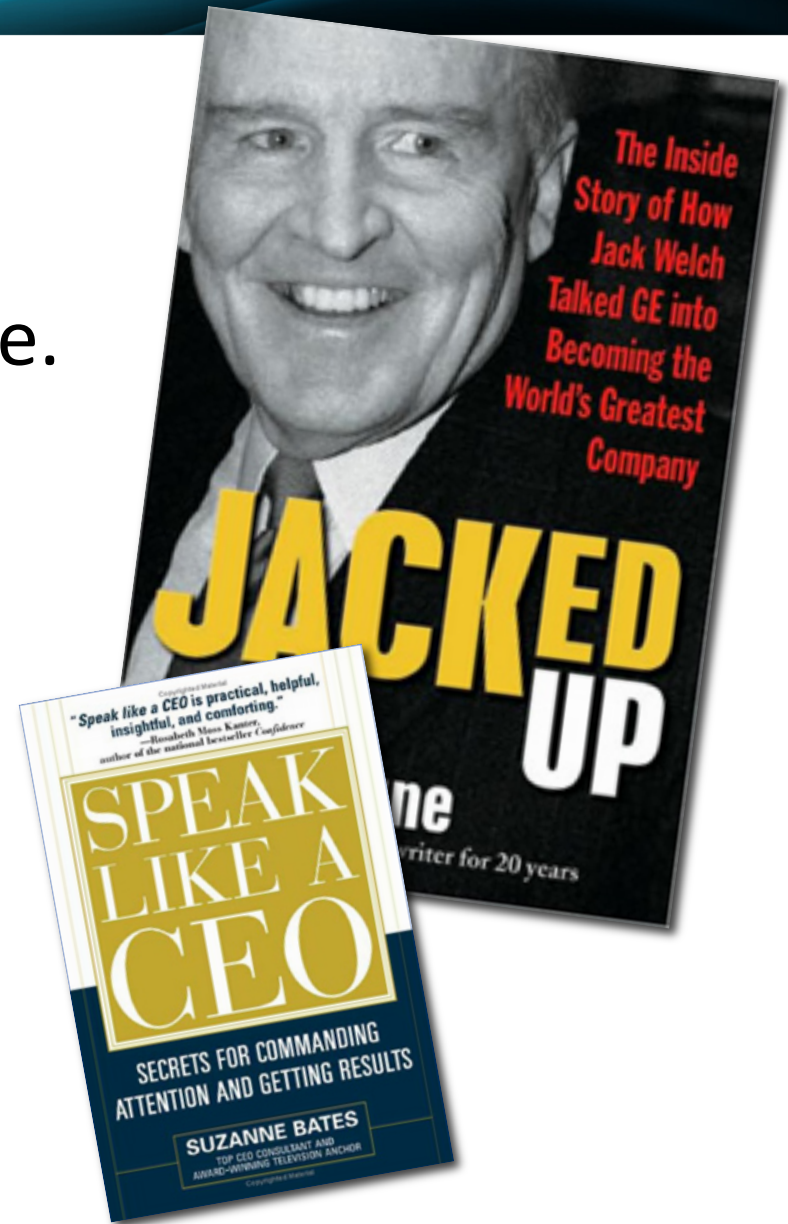
Your Call to Action



- Two great resources
- Practice, Practice, Practice.

“Every time you get up to speak you are auditioning for leadership.”

— James Humes
Author, Speaker, Attorney



Stealth Material Development



Problem

- Exhaust engine nozzle increases radar cross section.
- Normal Radar Absorbing Materials deteriorate in exhaust ambient

Approach



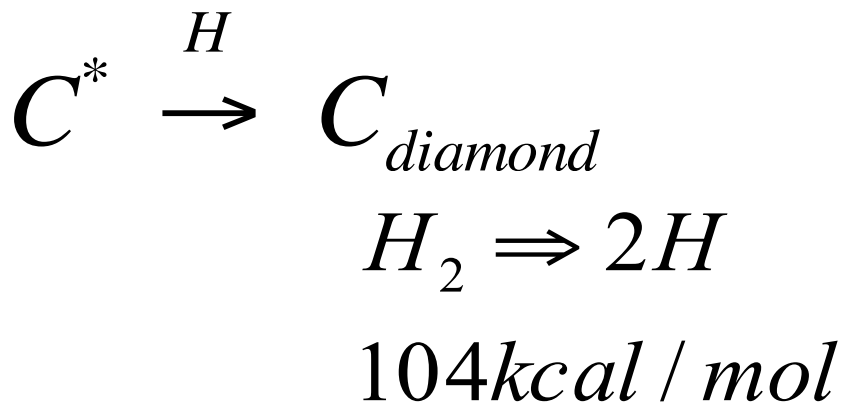
Classified

Results/Key Learning

- Don't let prior failures deter you
- Solving hard problems is what distinguishes us

Safe is mediocre at best

CVD Diamond

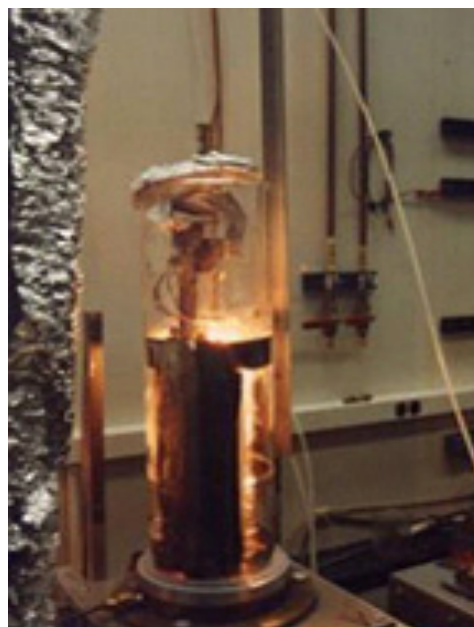
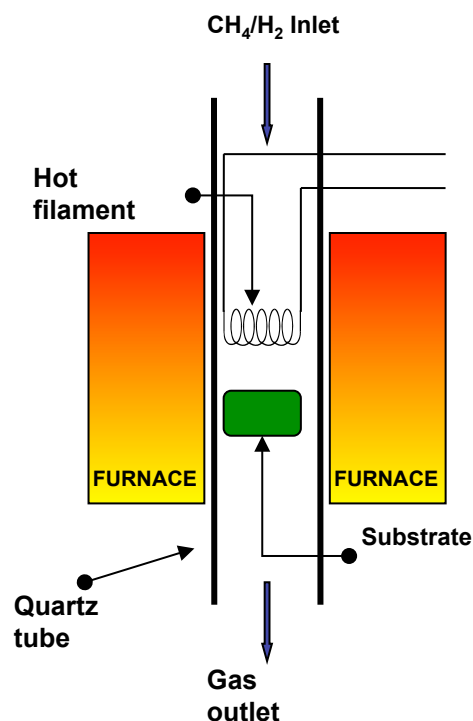


Problem

- Low-pressure route to diamond threatens current products and offers new opportunities

Approach

- Apply standard engineering efforts to explore and optimize

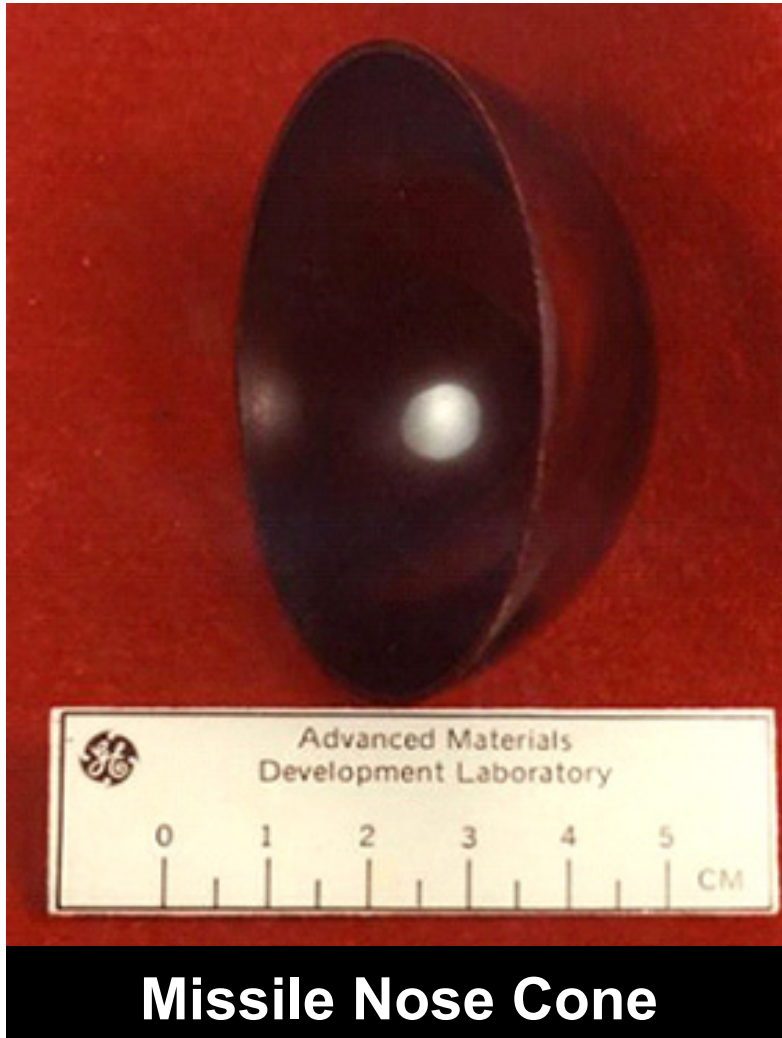


Results/Key Learning

- Great new product BUT not cost effective = business miss

Know when to STOP

CVD Diamond - Bulk



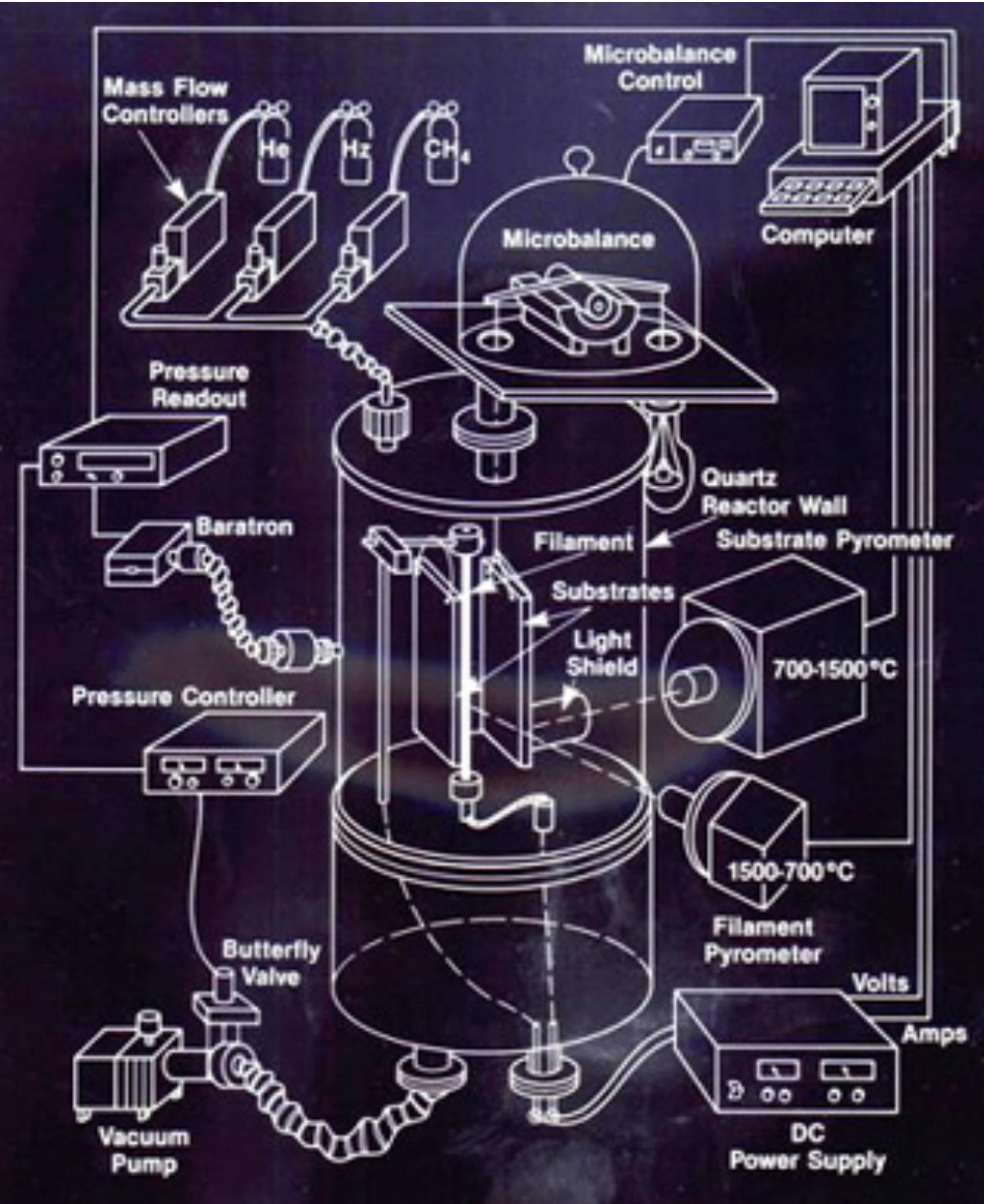
CVD Diamond Tools & 3D Shapes/Coatings



Issues

- Cost
- Adhesion
- Quality
- Investment Cost

CVD Diamond



- Kinetic experiments confirm importance of atomic hydrogen
- Cost modeling dominated by energy costs, and investment costs
- Adhesion difficult

***Kill Projects When
No Clear Win***

Properties vs. Isotopic Composition

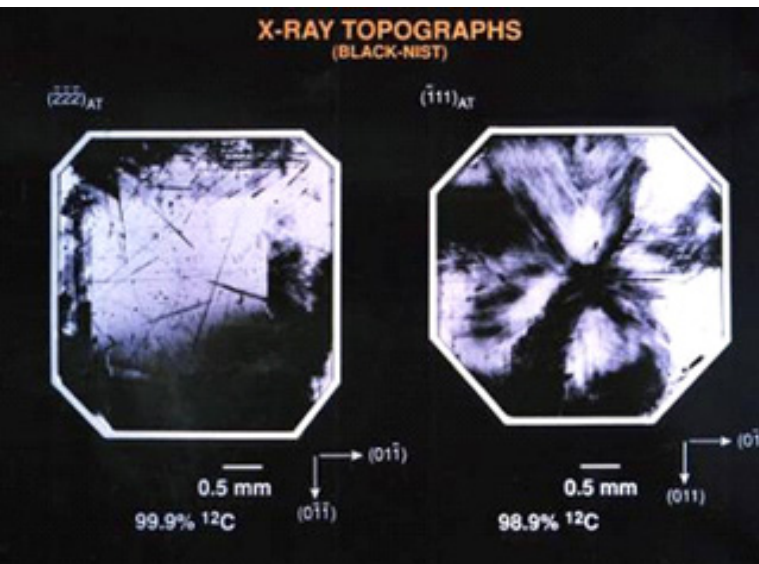


Problem

- Quantify effect of isotopic impurity on limiting intrinsic material properties

Approach

- Grow high quality crystals with varying isotopic properties and measure properties

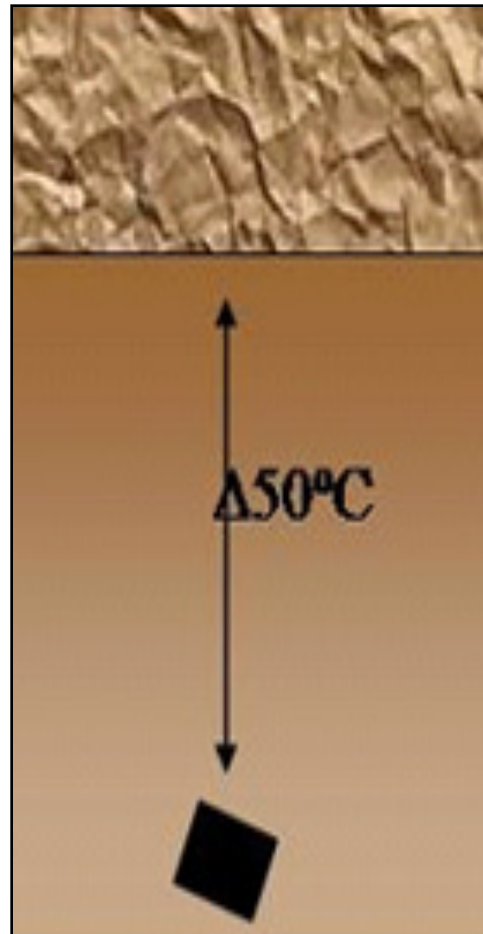
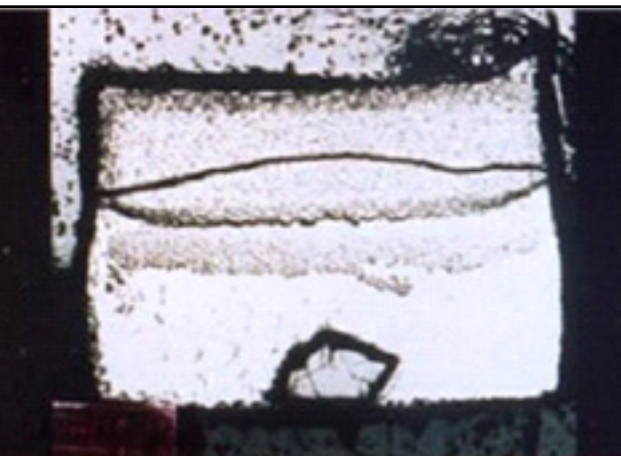
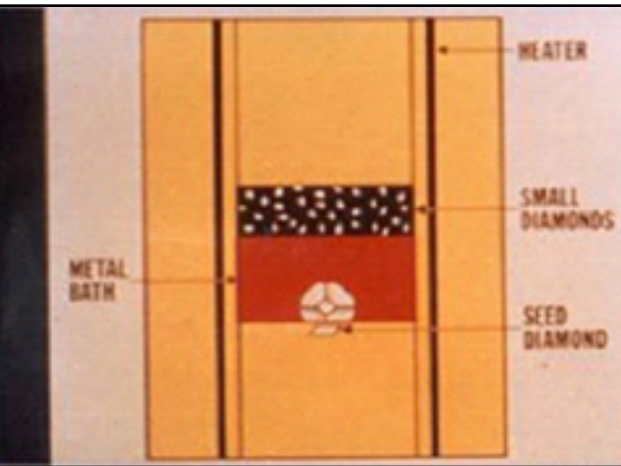


Results/Key Learning

- World record for highest thermal conductivity, and bond energy density

World-class science doesn't necessarily lead to business success!

Single Crystal Growth

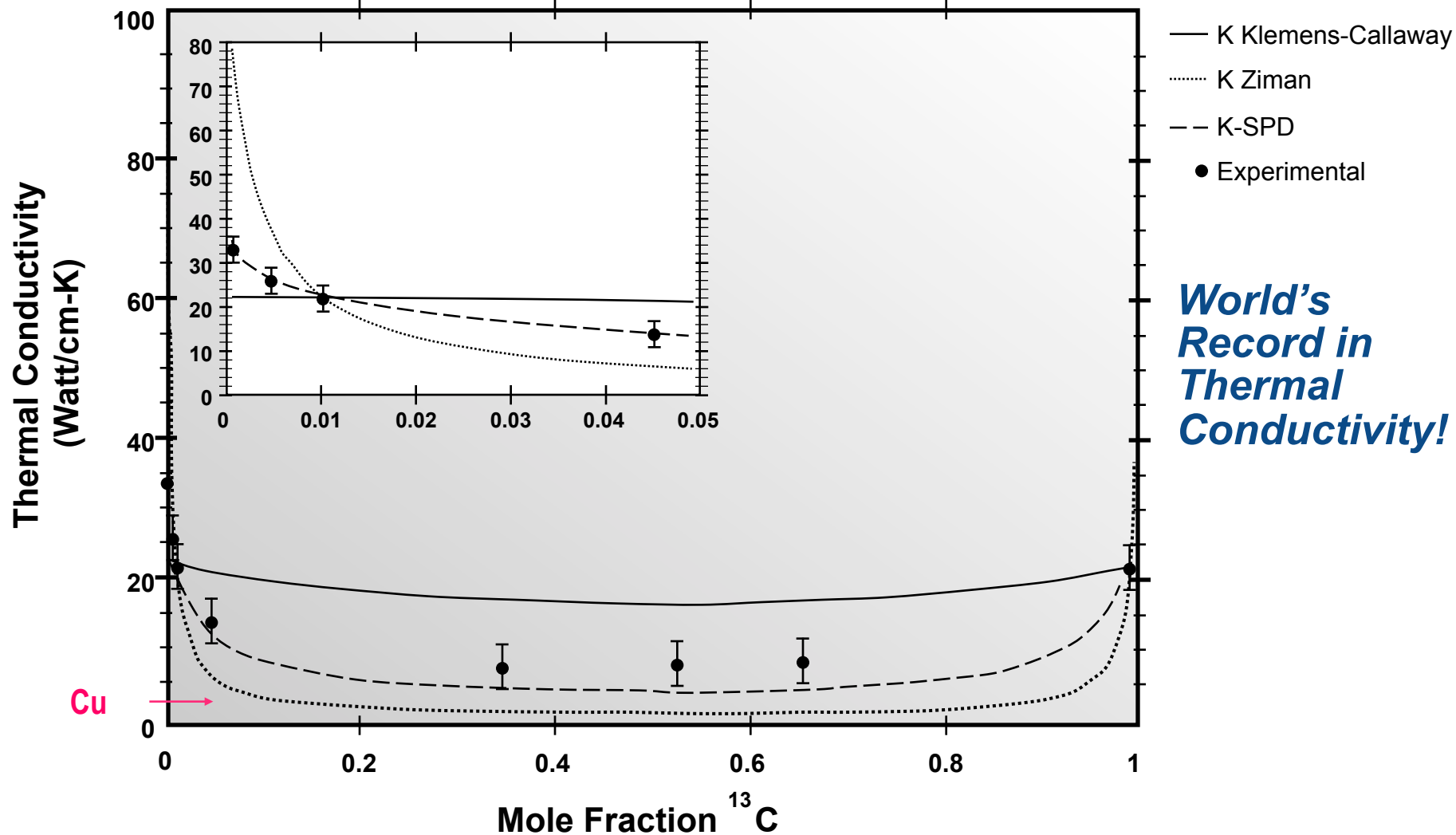


**High-Pressure
Temperature
Gradient Growth
of Single Crystal
Diamond**

Thermal Conductivity vs. Isotopic Composition



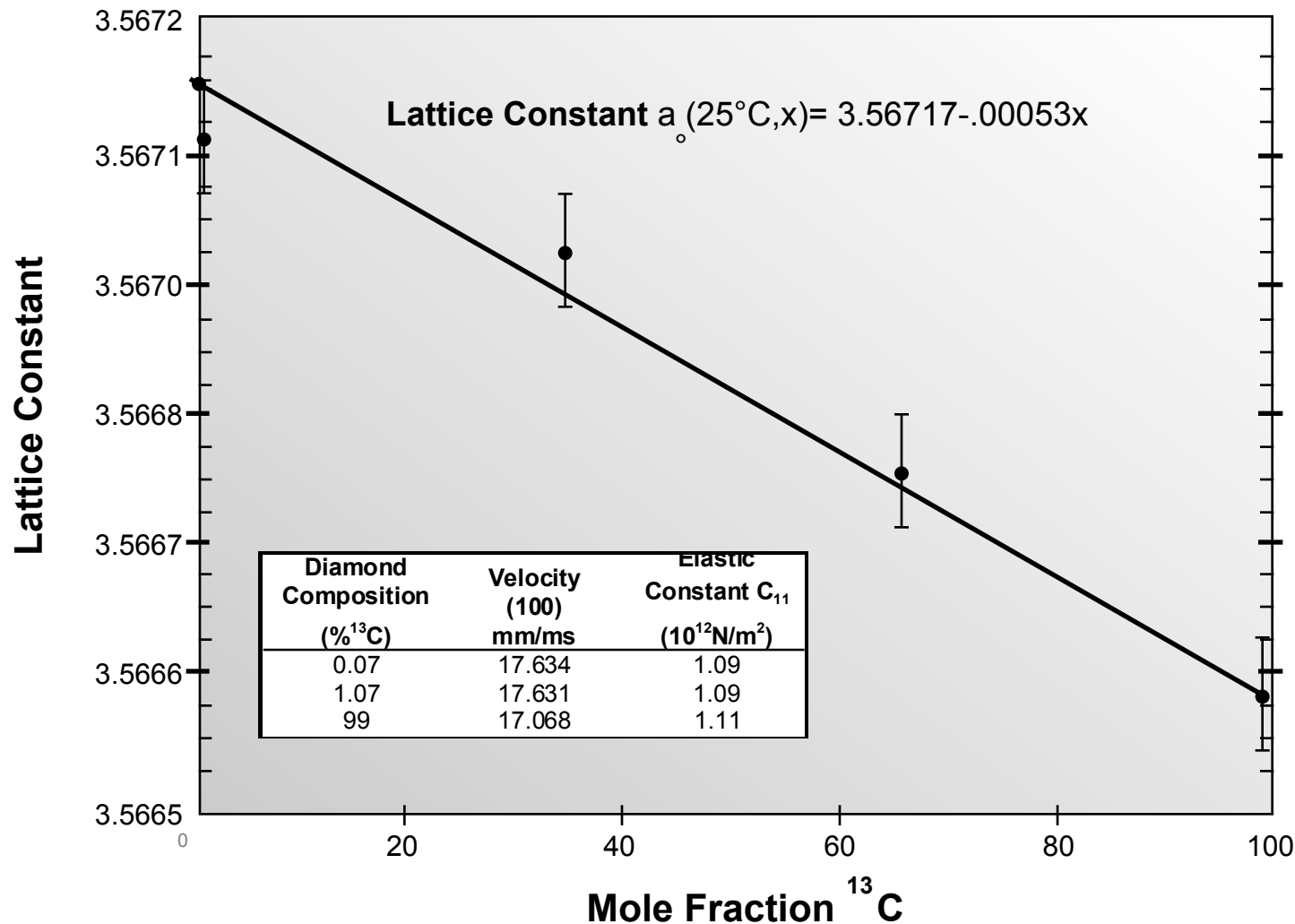
Thermal Conductivity vs. Isotopic Composition



Lattice Constant vs. Isotopic Composition



Lattice Constant for Diamond as a Function of Isotopic Composition



*World's
Record for
Bond Energy
Density!*

Saw Diamond Product



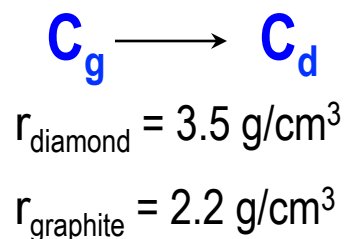
Diamond Crystals

Application

Diamond Synthesis



Diamond Synthesis Conditions



$$\left. \frac{\partial G}{\partial P} \right)_T \propto \nabla \rho$$

Problem

- Decrease cost, and improve quality of diamond grit products

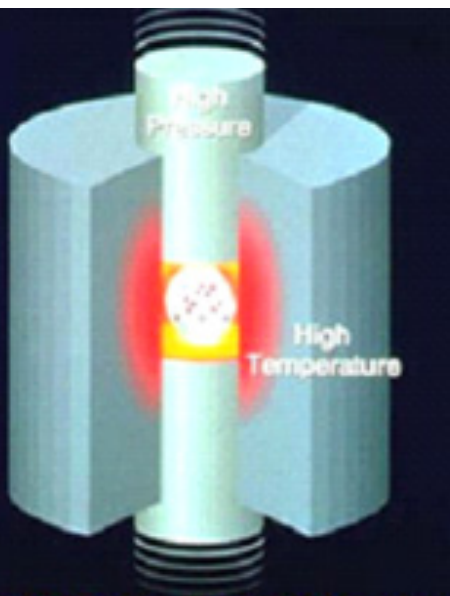
Approach

- New cell design

Results

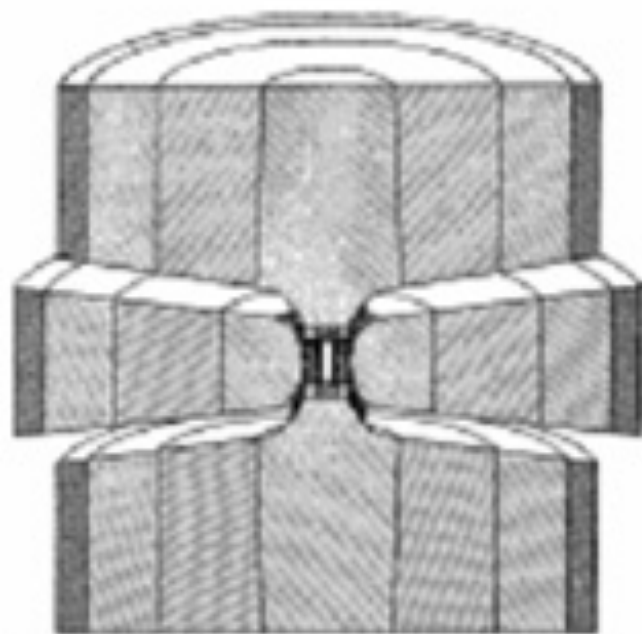
- >50% reduction in variable cost

Pressure >750,000 psi, temp >1300°C
(yield strength of tungsten carbide
~ 500,000 PSI, M.P. Stainless Steel = 1370°C)



Manufacturing Process

High Pressure Apparatus



"Bell" apparatus.

How to define P , T , t
trajectory for new
reaction cell?

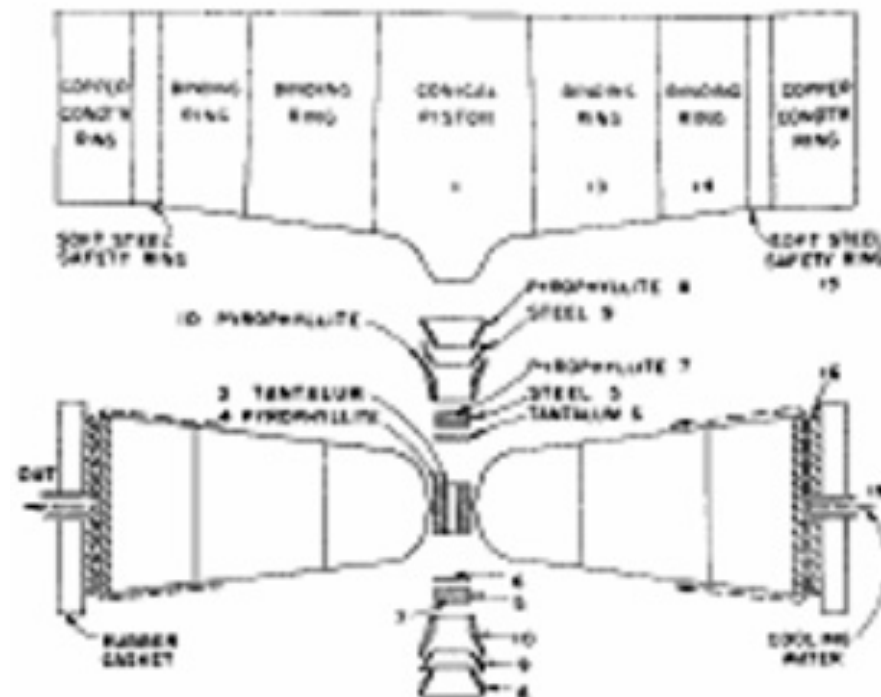
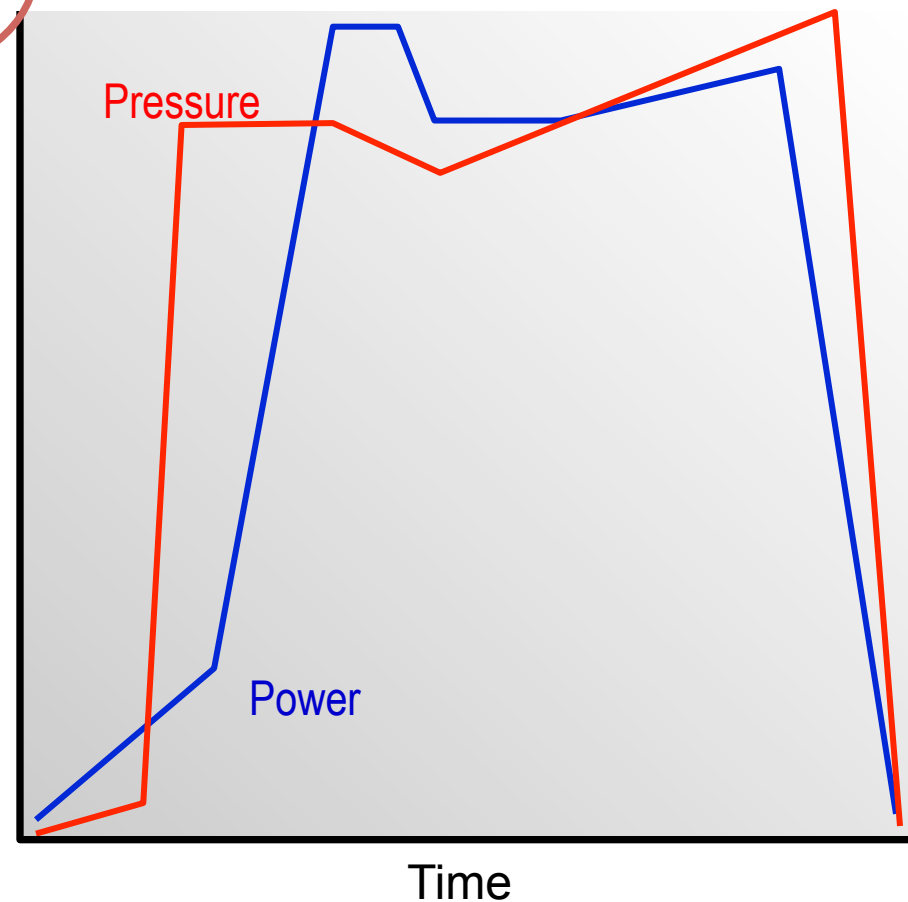


Figure 4. The "Bell" high-pressure, high-temperature apparatus, "exploded" view.

P,T Profile Development



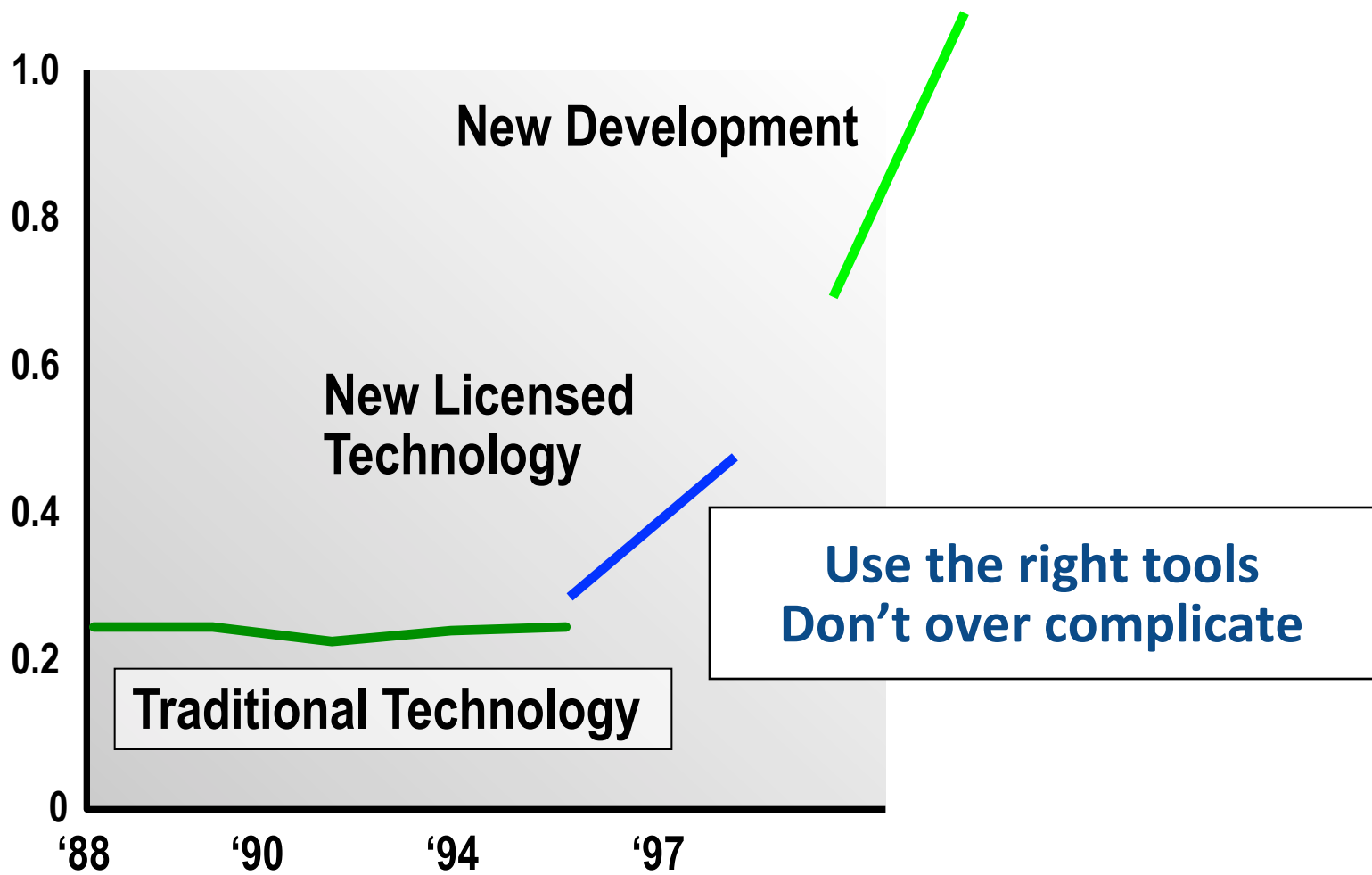
*I don't have the fundamental properties for the constitutive equations and I can't solve the equations even if I did.
2? Combinations... What do I do!?*



Yield Variable



Normalized
Yield



Summarizing My Lessons Learned



- **Take on hard problems.** Playing it safe means that at best you will be mediocre. Wayne Gretzky said, “You miss 100% of the shots you don’t take.”
- **Follow the scientific process.** Just because something is important doesn’t mean you should work on it. You have to have a hypothesis. “Optimism is admirable - but hope is not a strategy.”
- **Failure comes with taking risk.** Make mistakes as fast as you can but never make the same mistake twice. (*Note this does not apply to safety*).
- **Understand what people will pay for.** Great science is not sufficient for commercial success.
- **Take initiative & be accountable.** Don’t wait to be told what to do.
- **Document your work.** You must institutionalize the knowledge you create.

Some Thoughts on Career



- Never run from something; always run to something.
- Never take a job to get another job.
- Treat every job as if it is your last and as if your performance in that role will be your legacy.
- Have fun and do not take yourself or your position too seriously.
- Leadership is determining what you DO NOT have to do.
- End every meeting asking what you can do to help.
- How you communicate is just as important as what you communicate.



Thank You