Good morning.

We at the NAE are pleased to again host this annual convocation.

In keeping with the sense of urgency I hope we all feel, let me jump right in.

My message this morning has two parts:

1. "Houston, we have a problem," and

2. Man, do I wish I were young again, because there has never been such an exciting time to put the E in STEM.

We need to educate more engineers in the U.S. for at least three reasons:

1. U.S. industry, including the national security industry, is facing a wave of retirements in the coming years;

2. It is not crystal clear that we will forever be able to fill the engineering gap with the best and brightest from other countries;

3. Many high-tech companies report that they cannot find qualified U.S. citizens to fill critically important engineering and technology jobs, including in manufacturing; but most important of all,

4. We need a new generation of brilliant engineers, researchers, and entrepreneurs to create a vibrant future, just as preceding generations did.

Who will our new generation of engineers be?

Bear with me. It's interesting territory.

To see who the next generation of engineers will be, we need to understand who they have been in the past, and who they are now.

Here is a hint: Things are changing ... big time.

And guess what? This is not just about the United States. Let's start with the education of engineers.

- 30 years ago: U.S., Japan, and China each educated 70,000 engineers each year.

- Over time, the number of U.S. engineers graduated slowly dropped to about 60,000per year.

- Japan and even Korea now graduate more engineers than we do.

- What about China? 600,000!
  - There are good reasons and their quality varies. But the best are pretty darn good.
  - And they have 1.3 billion people.

- OK, so what about the fraction of university graduates who are engineers?
  - Asia: 21%
  - Europe: 13%
  - U.S.: 4.5% Houston, we have a problem indeed.

- How did we get into this mess? Is this a new thing? Nope.

- The fact is, that the number of U.S. engineering graduates has been almost stagnant for 50 years, starting at about 33,000 and moving to a little over 60,000. BUT ...

- But during this 50 years, the total number of bachelors graduates in all fields has grown by an astonishing 220%, from 500,000 in 1966 to 1.6 million today.

Now you can begin to see where I am leading and what it has to do with who will be tomorrow's engineers. The first Big Deal is gender.

- Women have totally dominated the growth in bachelors degrees. Their numbers grew by an astounding 350% until today they are almost 60% of all university graduates.

- But when you look at Engineering Graduates, you see a very different situation:

  - Women in America earn less than 20% of the engineering degrees.
  - Only 1.3% of women graduating from U.S. universities are engineers
  - What a horrendous waste of talent. **Bringing more women into engineering is Job 1.**
  - Fortunately, there is a lot of positive change [MIT 45%, etc], but we need to work harder still.
  - Here is part of the problem and a big hint about its solution:
    - We loose almost 70% of all students who as freshmen say they intend to major in Engineering! [Yes, you heard me right.]
    - Looked at differently, 3.1% of women enter college intending to major in Engineering, but only 1.3% of women graduating are engineers ... 1.3%!

        - 17% of men enter college intending to major in Engineering, but only 9.5% of men graduating are engineers.
    - We don't have a lot of time to spend on this, but let me just note that the retention in the natural sciences is much better, although it still is not great, and women drop out at a higher rate than men.

So, **lack of women has been a big part of the problem, and improving engineering education is a big part of the solution.** Both things are happening, so maybe we can just sit back and watch our output of bright and inspired engineers grow.

But I doubt it.

Because here is an even deeper and more complex problem:

The fastest growing segment of our population, minority kids, is today approaching 40% of the 18-13 year old population and yet they earn less than 13% of the engineering degrees.

If this trend continues, we are in for a workforce train wreck!

Why hasn't the U.S. already been steamrollered?

- Talented immigrants. Period.
- But this gravy train is slowing down, and our federal policies are not helpful.
- This is a topic for another day.

We need to press even harder to get this problem fixed.

Even more importantly, we need to actually get serious about improving K-12 education in America.

And we need to enlist all who understand the issue to work to change the conversation, and get kids to understand that "Dreams need doing," and that, "Engineering is essential to our health, happiness, and safety."

And we need to help them to understand that most the Grand Challenges facing humankind can only be solved with engineers at the center of the effort.

And finally, we need to work really creatively to improve engineering education across the country.

We cannot rest on our laurels.

Having been the best in the world for the last 50 years guarantees nothing going forward.

So, ... Houston we do have a problem.

But enough doom and gloom ...

On to why I wish I were young and what the next generation of engineers will do:

What will they do?

Suppose I had been asked this question when I graduated from college in 1963.

I would not have answered, "They will work in the IT industry."

Why? Because there was no IT industry! It didn't exist.

Yet a large fraction of engineers of my generation spent their careers in the IT industry.

But first they had to invent it.

And indeed, in one decade the IT revolution created 22 million U.S. jobs.

That's the point.

Engineers are job creators, problem solvers, and challenge meeters.

That's why we have to get the E into STEM.

Come to think of it, if I had listened more carefully to the emerging language of engineering in 1963 I at least would have caught an inkling that something called IT might blossom and grow.

I didn't have the necessary prescience, but we can listen to the language of engineering today.

I hear the same words I heard throughout my career … terms like:

Force	**Speed**
Size	**Tolerance**
Modulus	**Voltage**
Temperature	**Precision.**

This is the language of basic engineering, and it is as relevant today as it was when I started out.

But now I also hear things like:

Scale	**Scope**
State	**Complexity**
Integration	**Architecture**
Resilience	**Evolution**
Affordability	**Social Context.**

This is the language of engineering systems.

It is about how things are interconnected and interacting.

And it is about integrating what engineers know and can do with what social scientists, management experts, policy makers, citizens groups, lawyers, and politicians know and can do.

This integration is essential if we are going to create a vibrant future.

So our universities need to prepare engineering students accordingly.

Let me tell you what else I increasingly hear. I hear about things like:

Cellular Circuitry	**Adaptive Immunity**
Reprogramming Bacteria	**Synthetic Biology**
Natural Adhesives	**Bacteria-Laced Concrete**
Integrated Cancer Research	**Neuroprosthetics**

This is the language of a new bioengineering, of the Convergence of the life sciences with engineering and physical science that is beginning to range far beyond medical applications.

Bioengineering is more or less where computers were in 1963.

And there is yet another strand of language I am hearing.

I hope you are hearing it too because we at the National Academy of Engineering are making a concerted effort to purposely propagate it:

> Engineers are creative problem solvers.
> Engineers make a world of difference.
> Engineers help shape the future.
> Engineering is essential to our health, happiness, and safety.
> Engineers can meet the Grand Challenges of the 21st century.

This language is intended to change the public perception of engineering, especially among bright young people who aspire to prepare to make the world a better place … to

drive sustainability, to help advance the cause of better health, to make the world more secure, and to expand humankind's capabilities and enable more joyful, productive lives.

I look forward to talking with you more about this at lunch today.

Thank you for your attention and for all that you do to ensure a bright field of opportunity for the next generation of engineers.

Charles M. Vest