The Element of Surprise

Ivan A. Sag
Stanford University

I'm really quite an unlikely choice of speaker for today's Cum Laude ceremony. I got a good education here at Mercersburg and (except for the food and the social life) I liked the place all right, but, for reasons I'll tell you about shortly, the feeling wasn't mutual. I hope the experiences I have to share with you will have some value to those of you being recognized here today for your academic achievements.

What I probably liked best about the Burg was the music. No, not the Carillon, the Octet, or anything like that, but rather all the rock 'n roll, the R&B and the blues that I learned about from my classmates. I also really enjoyed the rock bands that me and my buddy Siggy got together.

Figure 1: A Motley Crew, circa 1965

We started out in freshman year. Ivan and the Terribles - alas the Mercersburg News said it all in their account of our first and only gig: ’Went to the pep rally - heard Ivan and the Terribles live up to their name' Ouch!
But Siggy and I lived to play another day. Our next band (The Motley Crew) was much more successful, defeating our arch-nemesis (Stark Ravin and the Madmen) in the now mostly forgotten battle of the bands in the fall of 1966.

Now I was a good student - I usually made the honor roll and got accepted early decision at the University of Pennsylvania. But I have to admit that I always had disciplinary issues. Our chemistry teacher Jay Quinn can tell you about the time I brought in salt instead of sugar for a Chemistry class demonstration.

![Figure 2: Mr. Quinn's Chemistry Lab, circa 1965](image)

Although I swear I didn't know this was going to happen, instead of a carbon rod emerging from a cloud of smoke, we had hydrogen chloride gas everywhere and Irvine Hall had to be evacuated. That ended my chemistry career, I'm afraid, but it was just the beginning of my career as a serious disciplinary problem, a career which culminated in February of my senior year when a bunch of us snuck out of a Molière play in Washington to drink beer in a bar somewhere around Dupont Circle on the infamous 1967 French Club fieldtrip. As Secretary-Treasurer of the French Club, of course I made sure everyone got sobered up and back to their theater seats before the last scene. I was sure we'd gotten away with it. But...

**Surprise No. 1:** A couple of weeks after the French Club trip, I was pulled out of bed in the middle of the night and dragged across campus to appear before a tribunal of a dozen or so brown-nosed, self-righteous and self-important student 'senators', some of whom went on to have brilliant careers on the alumni board of this august institution. These fine lads, acting without the benefit of faculty supervision, it seems, went on to conduct an intensive, Gestapo-like inquiry into the adventures of the Alliance Française: 'Did you leave the play'? 'Did you go into bars?' 'Did you drink alcohol?' These were tough guys; they were all puffed up; they were sweating and in
my face. I said 'No'. And that was rational: anyone caught drinking at this school had been automatically expelled, as far as we knew.

2 days later, I was summoned to the headmaster’s office where I received a personal, sanctimonious sermon, delivered literally and figuratively ex cathedra by William Fowle (we called him 'Bible Bill', among other things). The good headmaster (may he rest in peace) explained with all his heart and all his soul that he had 'no choice' -- it was his moral obligation to expel people like me from Mercersburg. I drank beer; I denied it; I was in a position of responsibility; I was irredeemable. QED. Apparently, the other 22 guys who confessed the dastardly drinking deed had souls that could be saved. Maybe it was their confessions; maybe it was something else. We'll never know.

**Surprise 2:** The aftermath. Apparently, Bible Bill never gave any thought to what he was condemning me to. Why did he think I'd been sent off to boarding school in the first place? I'll spare you the details, but within a few months my new evil stepmother had the locks changed on the doors of my family house: I was *persona non grata* in the home I grew up in.

Oh, and guess what else happens when you get expelled from a prep school? If you've been admitted 'early decision', they take it back. Or at least, that’s what happened with my early admission to Penn. So here it is -- March of my senior year -- and I don't even know IF I'm going to college, let alone WHERE.

**Surprise No. 3.** Now, as it turns out, there are excellent, independent-minded universities out there whose admissions policies aren't prescribed by the reprobation of college preparatory schools. The University of Rochester, for example, seemed more than happy to grant me admission, even though I had applied late. So off I went. But that was 1967 (the autumn of love, as it were) and the climate on campus took an immediate toll on my academic motivation: I spent my freshman year playing pool, drinking beer, and you can probably figure out what else. But I certainly knew how to coast by in intro college classes by doing just enough work, very efficiently. I learned how to do that right here at Mercersburg.

Then, in my sophomore year, I took a Linguistics class. Didn’t know what it was, but I needed a fourth course and I knew I liked languages. And that’s when the light went on -- when I figured out that what had really impressed me about Mr. Miller's French class back at the Burg was his command of historical linguistics -
He knew all about language families -- how languages evolve through time pretty much like biological species do.

And the U of R was a fantastic place - much more nurturing than Penn would have been, as it turns out. Penn may have had more Nobel Prize winners, but when you're an undergraduate, you don't need Nobel laureates, you need a good nurturing environment where things aren't
completely cutthroat and where professors spend quality time with undergraduates. Back in 1970, Rochester had it; Penn didn’t.

So I really got into linguistics, but I couldn’t quite get rid of this music bug that had been kicking around in my head ever since we won that battle of the bands back in the Boone Hall basement. As an undergrad, I got involved with the University’s Arts Committee, where we produced a lot of Blues Concerts. The guy in charge was my fellow Mercersburger and Rochesterian Chris Eisenhart, who taught me a lot about the blues -- the music, the culture, and the people. Thanks to Chris, I got to spend time with famous Blues people who we brought into town.

![Figure 4: Some Blues Legends we partied with in Rochester](image)

I actually got to get down and party with people like Howlin Wolf, Muddy Waters, Buddy Guy, Koko Taylor, and their bands! I even got a piano lesson or two from Otis Spann, the Chicago Blues piano legend... Those are amazing memories for me!

But alas, I once again heard the musical call of the wild. I just had to get another band together. And so -- of course -- I dropped out of college. (Guess which one of these guys is me!)
But I had a lot of fun. Played some big concerts, some music festivals. Almost signed a big record contract, too... Almost.

And after not getting the record contract, I dropped right back into college and applied to grad school, but not without first starting a concert production company - working with groups like Procul Harum, the Grateful Dead, and Ike and Tina Turner, to name a few... The moral here? Eh? You can always find your way back from a rock band into a university. Just never burn your bridges. That's the key. In this case, I was really lucky. I'm clearly functioning better as an academic than I would be if I were still hustling rock concerts in upstate New York.

Oh yeah - that was Surprise No. 4. And now here's No. 5.

Mercersburg taught me math; Mercersburg taught me languages. But Mercersburg never taught me that the two had anything to do with each other. Well it turns out they do, but I didn't learn that until graduate school. This was at Penn -- yes the same place that wouldn't accept me as an undergrad now gave me a fellowship to go to grad school. Sweet!

At Penn I discovered that I was theoretical by nature and that linguistics could be, too. The grammatical models that had been pioneered for the study of language were all based on algebra and logic, things I had really liked here at Mercersburg.
If this seems strange to you, let me remind you first that computers don’t understand human languages yet; you might wonder why not. Second, consider the fact that arithmetic is a language, too.

![Figure 6: Arithmetic is a Formal Language](image)

It has a small vocabulary: the digits 0,...,9, the phrase-forming operators +,-,\times,/ and the sentence-forming operator =. It has rules of syntax and hence only certain combinations of the expressions of arithmetic make well-formed sentences.

![Figure 7: The Compositional Semantics of Arithmetic](image)

And it has a straightforward semantics that lets you evaluate complex expressions systematically and determine whether a given sentence is true or false. You start from the bottom, giving each
number expression its meaning and then you work your way up the tree, node by node, computing the meaning of each complex numerical expression. When you get to the top of the tree the sentences is true just in case the meaning (or ‘denotation’ to be precise) of the expression to the left of `=` is the same as that of the expression to the right of `=`. Programming languages work the same way.

And linguists, working together with philosophers and logicians, have demonstrated that human languages basically work this way, too:

![Figure 8: English is a Formal Language](image)

A language like English just has a (much) bigger basic vocabulary and more elaborate constructions that license more complex ways of combining words and phrases into bigger expressions. But the semantics of a human language is compositional.

![Figure 9: The Compositional Semantics of English](image)
You start from the bottom: from the word *guy* you get the set of guys; from *talking* you get the set of talkers; so for the nominal expression *guy talking* you get the intersection of these two sets. Similarly, the expression *got expelled* gives you the set of people who got expelled and at the top level the sentence comes out as true just in case the individual you get from the subject (the unique person who is both a guy and a talker) is a member of the set of people who got expelled.

Now as it turns out, linguistic theory wasn't Penn's strong suit back in 1971. Once I figured out what I wanted to study, life got frustrating. But then I learned, and this was the surprise, that you can change schools, even graduate schools! Who knew? I transferred to MIT, where things were theoretically exciting and where I got to work with Noam Chomsky, who even my father had heard of, so he eventually stopped hassling me about leaving an Ivy League university to go to an engineering school. Same moral here - keep your options open.

And after grad school, guess where I got my first job? You guessed it, *Universitas Pennsylvaniensis*. But two years later, I resigned my position there to go to Stanford. Now, if I were a vindictive person, I might have called the score settled now at Ivan 2, Penn 1. But you've got to learn which grudges are worth keeping in life. At some point I understood that it wouldn't make any more sense for me to hold a grudge against Penn than it would, say, for me to blame your current headmaster, who seems to be quite a nice fellow, for the foul behavior of Bill Fowle, against whom I'll continue to hold a grudge, thank you very much. You've gotta know when to hold 'em and when to fold 'em.

So there's two more surprises I want to tell you about. The first concerns what I ended up really doing with my life. In fact, my research is actually part of what's usually called Cognitive Science. What's that, you ask?

Well, English is different from arithmetic, logic, or programming languages in at least one important way - it's full of ambiguity.

![Figure 10: Arithmetic is Ambiguity-Free](image-url)
I mean, no one in their right mind would design a mathematical language or a programming language where you aren’t sure what the symbols mean, or what bracketing conventions are in effect. No modern computer can deal with ambiguity.

But every human language we know of works in precisely this way: All languages have ambiguous words:

![Figure 11: Lexical Ambiguity](image)

All languages have structural ambiguity:

![Figure 12: Structural Ambiguity](image)

And when you combine these two kinds of ambiguity, you get even more possibilities:
My favorite is the last of these examples, which is ambiguous between two meanings, one of which could be paraphrased as 'I saw her perform a rapid, evasive downward movement', the other as 'I saw her barnyard fowl'.

And these ambiguities multiply out. Consider examples like the following:

Every time you add another modifier (like the prepositional phrase on the table), you create attachment ambiguities (which element does the prepositional phrase modify?) that are largely independent of the previous choices. Hence, the space of ambiguities is essentially multiplicative, not merely additive.

Basically, what we know about these ambiguities is that in context, people don’t even see all those other meanings - we communicate more or less accurately and very efficiently. But we don’t yet know HOW we do it. I mean it looks easy when you don’t think about it, but it turns out that there’s incredible intelligence involved in even decoding a simple sentence. You’re only aware of the relevant word meanings and the right structures; you know what the pronouns refer to instantly and what’s missing in ellipses, and so forth. No other biological species can do anything remotely like this and you can be sure no computer program can do it either. At least not yet.
So people work in teams to try to model complex cognitive processes like language comprehension and production. Researchers from psychology, linguistics, artificial intelligence, even philosophers and logicians, try to pool their knowledge to synthesize an understanding of how people are able to communicate with each other without getting bogged down in all the irrelevant meanings and structures, or any of the other things that could make communication go awry.

The mere mention of something related can be enough to ‘prime’ one meaning of a given word: the word cows will prime the ‘fenced enclosure’ meaning of pen, the word documents primes the ‘writing implement’ sense of pens, and so forth.

![Figure 15: Disambiguation](image)

Notice that the mere mention of some German city you don’t know much about (say, Bremen) may be enough to trigger a disambiguation by association: Bremen – ‘German beer’ – ‘good beer’; hence I forgot [how [good beer] tastes]. Similarly, we’re likely to go from Utah to ‘no alcohol’ to ‘no beer’ to I forgot [[how good] [beer tastes]].

How do people know what information is relevant? How do they use that information to get to the right meanings? When we solve these problems, we might have computers that can talk, understand and think like HAL (in the movie 2001) or the computers that are taken for granted in Star Trek episodes. This won’t happen tomorrow, but it’s exciting to see the progress that’s being made towards solving this problem. At Stanford, I’m the director of an inter-departmental program, the Symbolic Systems Program, whose mission is to train students in all these fields, with an eye toward enhancing our understanding of human cognition and learning and developing computers that are more human-like. It’s the perfect blend of ‘techie’ and ‘fuzzy. We’re hot.

Did I mention that I still have a rock band?
That's my last surprise. Dead Tongues, the unofficial rock band of the Stanford Linguistics Department - all linguists: 3 faculty and 5 grad students. But now I'm really clear about it. I'm not giving up my day job any time soon, no matter how much fun the band is...

So what am I trying to say here? You folks here today who have earned the Cum Laude distinction are obviously all smart. But that might not be enough to make you a success at anything. You might need to be wily, as well. I hope your lives have fewer twists and turns than mine has had, but I'm sure yours will have SOME surprises. Right now, you may have never even heard of what you're actually going to end up doing in life. And you might get blind-sided. If so, Hang tough! And don't let anyone tell you something's impossible. If you'd have asked me 40 years ago whether I was ever going to give a speech here at Mercersburg, I would have said that was impossible, but it seems Mercersburg knows when to stop holding a grudge, too.

Thank you very much.

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