Ambiguity:
A Two-Edged Sword

David O. McKay Lecture
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Biographical Sketch

Don Colton is Professor of Computing Sciences at Brigham Young University–Hawaii where he serves as Associate Dean in the College of Business, Computing, and Government. He currently teaches Beginning Programming, Computer Networking, and Artificial Intelligence, and has written the text books used in two of those classes.

In 2011 he was recognized as a Distinguished Fellow of the Education Special Interest Group of the Association of Information Technology Professionals, where he served from 2000 to 2009 as senior editor of their journals and conference proceedings.

Dr. Colton holds a BS in Mathematics and an MBA, both from BYU Provo. His PhD is in Computer Science and Engineering and is from Oregon Graduate Institute (OGI). He joined the faculty at BYU–Hawaii in 1997 after teaching at U Mass Lowell, Griffin College (Seattle), and OGI. He also worked in industry for 10 years at Texas Instruments, a consulting firm in Boston, and Microsoft.

He is married to Lois Colton. They are the parents of six children and grandparents of 14.

1 Potatoes

I got this from the Internet, so I know it must be true.

To burn some serious calories you can do this simple exercise:

Begin by standing on a comfortable surface, where you have plenty of room at each side.

With a **5-lb potato bag** in each hand, extend your arms straight out from your sides and hold them there as long as you can. Try to reach a full minute, and then relax.

Each day you'll find that you can hold this position for just a bit longer. After a couple of weeks, move up to a couple of **10-lb potato bags.**

Then try **20-lb potato bags** and then eventually try to get to where you can lift a **50-lb potato bag** in each hand and hold your arms straight out for more than a full minute.

By the way, I am proud to say that I am currently at that level.

After you feel really confident at that level, put a potato in each bag.

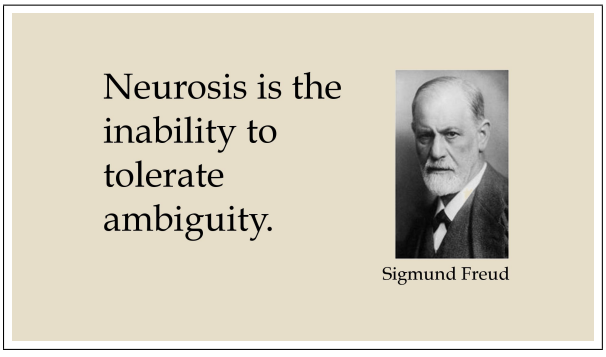
2 Aloha

Brothers and Sisters, Aloha!

It is a great honor to be invited to give the annual David O. McKay lecture. I always find these lectures stimulating and enjoyable. I hope that my presentation today will measure up to that high standard, and that you will find it both interesting and thought-provoking.

Ambiguity fascinates me. It is a two-edged sword. On the one hand, it delights us with the cleverness that underlies almost all humor. On the other hand, it injures us with the consequences that come from mistaken interpretations. It deserves our respect and should be used with care.

Noted psychologist Sigmund Freud said:

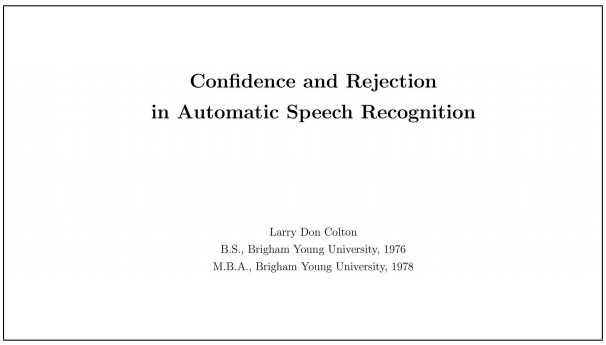


"Neurosis is the inability to tolerate ambiguity."

To be neurotic is to be overly anxious. But life is often ambiguous. It requires us to deal with the unknown, and to move forward with incomplete information. Healthy living requires the ability to tolerate ambiguity.

3 My PhD Thesis

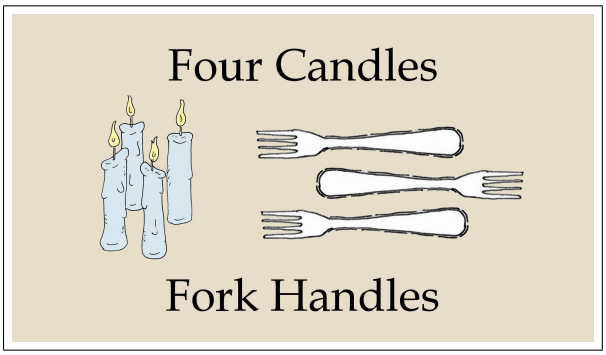
My background is computing. In particular, my PhD thesis is entitled:



"Confidence and Rejection in Automatic Speech Recognition"

Automatic Speech Recognition is becoming common. One example is where you talk into a microphone and the computer types out the words you are saying.

Confidence, in the case of my thesis, is a measure of probability. It strives to show just how certain you are of any given transcription. It can be based on the phonetic facts of the utterance. It can also be based on larger issues, such as what would make the most sense right now.



Take for example the utterance: "fork handles." Without context, can you tell which of the phrases I said?

I will say it again. "fork handles."

Computer Speech Recognition has difficulty when things are ambiguous. So do people. But people seem to be a lot better at resolving ambiguity.

4 Humor

Ambiguity is fun.

We love a surprise. Many forms of humor rely on unexpected changes in meaning.

In our potato bag joke, the natural assumption is that the bag is already filled with potatoes. At the end we discover that it is just the empty bag. It is an unexpected change in meaning.

4.1 Driven

Advertising slogans can be particularly fun. Companies have a huge desire to be remembered so that when you need their product, you will think of them. One way they do this is by creating cute slogans that have more than one meaning.

I recall a slogan from several years back. The car manufacturer said

"We. Are. Driven."

By this they clearly meant two things.

Number 1: They are compulsive about doing their job with excellence.

Number 2: People drive their cars.

This dual meaning gives us a sense of delight for its cleverness. And the emotion of delight makes it more memorable.

4.2 The Lady

Here is example that most of you have probably seen on the posters around campus.

The oldest example I found was a German post card in 1888. It shows up two years later as part of an advertisement about cars, or rather buggies.

http://mathworld.wolfram.com/YoungGirl-OldWomanIllusion.html

By the way, you can find all the pictures I am showing if you Google "Don Colton McKay Lecture" at your convenience later today.

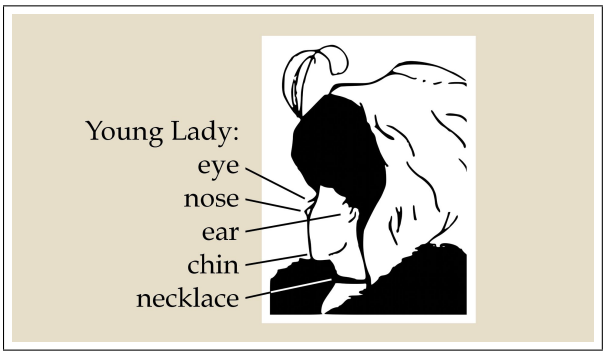
http://byuh.doncolton.com/mckay/

In this picture, how many of you can see a young lady looking away?

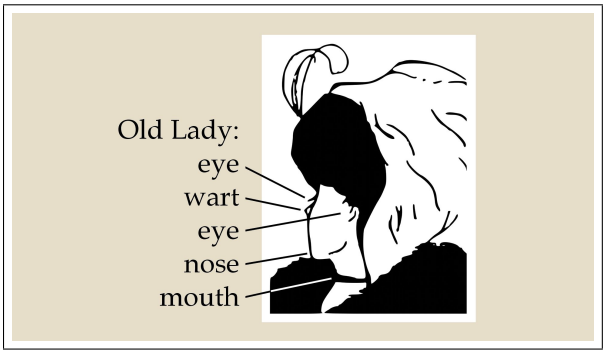
How many of you can see an old lady looking mostly forward?

How many of you can see both of them?

Most people have no trouble seeing the young lady. Here is a view with important features marked.

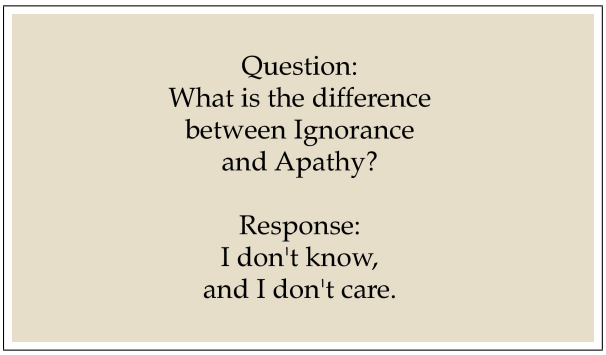


On the other hand, many people have difficulty seeing the old lady. Here is another view with important features marked.



4.3 Ignorance

Moving on, let's go back to ambiguous words. Here is a question and response.

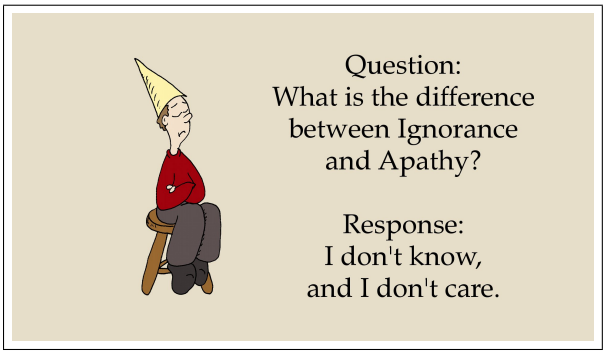


Question: What is the difference between ignorance and apathy?

Response: I don't know and I don't care.

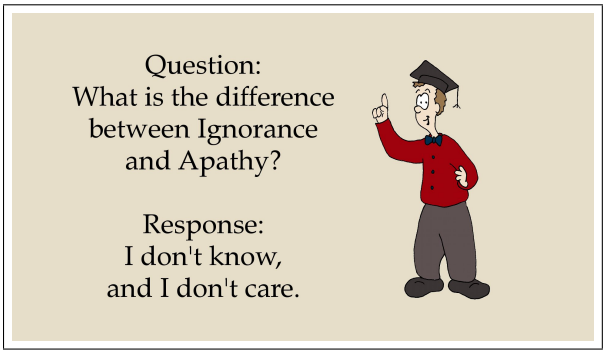
What exactly does that answer mean?

On the one hand,



the person may be unhelpfully saying "I don't know what the difference is, and furthermore, I really don't even care."

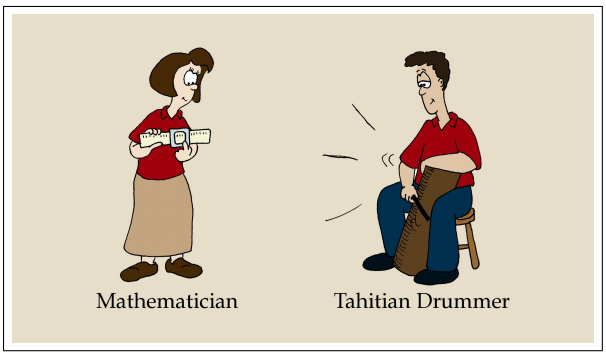
On the other hand,



the person may be helpfully saying "Ah, the difference is that ignorance means 'I don't know' and apathy means 'I don't care'."

5 Mathematics

Here is a question that I am sure many of you have pondered.



What does Mathematics have in common with Tahitian Drums?

Answer: They both rely on Log-rhythms.

Okay. Sorry.

5.1 Precedence

But speaking of mathematics, let's look at some more serious ambiguity.

$$3 + 2 \times 5 = ??$$

Three plus two times five.

Some calculators will tell you it is 25. Others will tell you it is 13.

In mathematics we can solve this ambiguity two ways.

$$3 + 2 \times 5 = ??$$

$$(3 + 2) \times 5 = 25$$

$$3 + (2 \times 5) = 13$$

First, parentheses can be used to **explicitly** show what we mean.

Second, rules of precedence can be used to **implicitly** assign a meaning. By these rules we normally agree that multiplication happens before addition.

5.2 Logic

Let's try a little logic.

I will now prove to you that a ham sandwich is better than complete happiness.

You may be thinking, "nothing is better than complete happiness."

I agree. But follow along carefully.

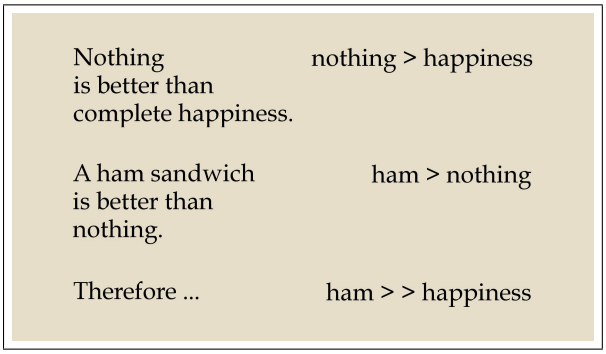
The law of transitivity tells us that:

The Law of Transitivity

If B is better than C	B > C
And A is better than B	A > B
Then A is also better than C	A > > C

If B is better than C, and A is better than B, then A is also better than C.

We will apply those rules to create our proof.



First: **Nothing is better than complete happiness.**

Second: **A ham sandwich is better than nothing.**

Therefore we can clearly see that a ham sandwich is better than complete happiness.

I trust that all of you are convinced. Or maybe not.

http://en.wikipedia.org/wiki/Fallacy_of_four_terms

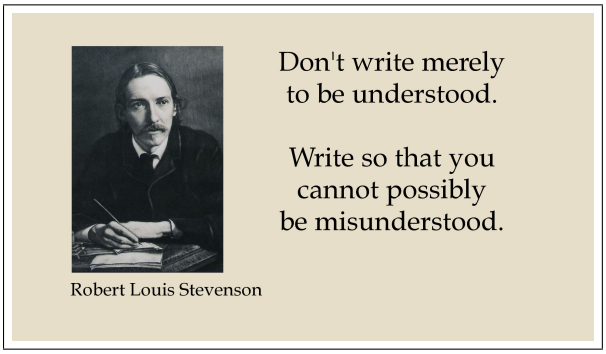
This particular abuse of logic is called "equivocation." It is a form of ambiguity. It is when you change the meaning of a term in the middle of an argument. In this case, we are changing the meaning of the word "nothing."

In the first instance, "nothing" refers to whether such a thing exists. Nothing exists that is better than complete happiness.

In the second instance, "nothing" refers to what I possess. Possessing a ham sandwich is better than possessing nothing.

6 Writing Clearly

The famous author Robert Louis Stevenson said:



"Don't write merely to be understood.

Write so that you **cannot possibly** be misunderstood."

Writing clearly is much harder than we might realize.

6.1 Computers

I teach a class called "Beginning Programming." One of the things I repeat over and over to my students is that Computers are Stupid. I tell them this because many people get frustrated when computers do not do what they want them to do. They expect computers to understand more than they do.

Actually, computers can only do a small number of things. But they are very fast, very reliable, and very cheap.

Programming is the art of breaking down the **complex tasks** that we really want done into the **simple steps** that computers can actually perform.

As a college student myself, I did some tutoring. One student was convinced that if he just got the right names for the variables in his program, the computer would understand what he wanted and would do the right things. I never did get him to understand that the computer **does not care** what he names his variables, and that the computer

does not understand what he wants, at least in the sense that another person would.

Instructing people is much easier than programming. People normally **get it** when you explain something. They get the big picture. They understand the context. There is seldom a need to micro-manage them. Point them in the right direction and say enough words to get them moving. Things will happen in a reasonable and correct way most of the time.

Programming is difficult precisely because computers do not **get it**. They do not understand the big picture. They always need to be micro-managed. But we still love them.

6.2 People

Understanding is an amazing achievement. Most human communication, it seems to me, happens not because we say what we mean, but in spite of **saying it wrong.** It is a wonderful gift that so often we understand each other even when we say things badly.

Take for example the ordinary question:

"Do you know what time it is?"

Simply answering "yes" would almost certainly be inappropriate.

In most cases, this question really means:

"If you know what time it is, please tell me."

As humans, we seem almost compulsive about guessing each other's real intentions and for the most part we are amazingly good at it. This allows us to be polite, and to skillfully hint at what we want rather than making formal requests or demands. This also lets others have the pleasure of going the extra mile beyond what was asked.

7 Time Flies

As humans, we normally do not recognize ambiguity unless it is between two or more **reasonable** alternatives. Somehow we filter out the unreasonable options with hardly a thought.

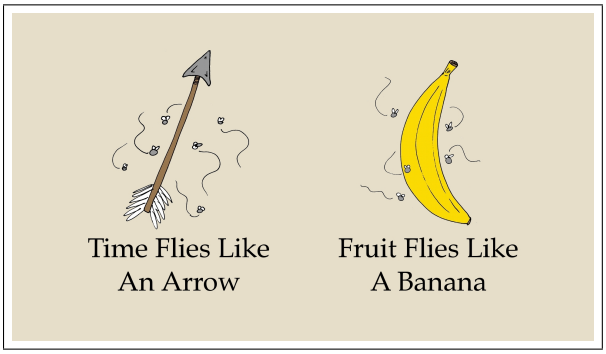
Consider this example, the venerable old saying:

"Time flies like an arrow."

What exactly does this mean? Each moment of life is a precious opportunity. We can turn it into results, or we can let it slip by. Whether we use it or not, it is gone. To get the most out of life, we should, as (LDS) Hymn 226 says, "Improve the shining moments; Don't let them pass you by." As students you certainly know this. There is never enough time.

In fact, this meaning is so clear and powerful to most people that we can easily fail to see other meanings in those same words. A computer, being stupid, might find these other meanings to be just as reasonable.

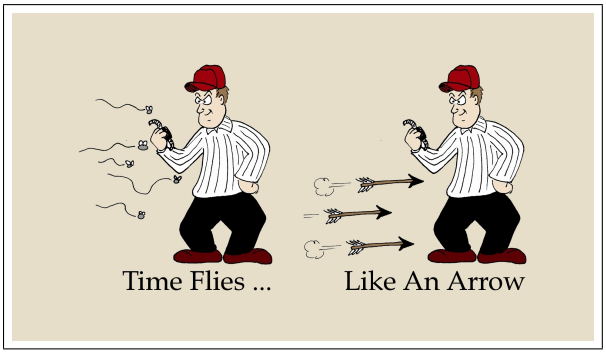
One amusing response, sometimes attributed to famed comedian, Groucho Marx, is



Yes, and "Fruit Flies Like A Banana."

If such a critter as a time fly existed, perhaps it would feed upon arrows. Hence, time flies like an arrow.

And, lest we think that this is the only alternative, we can introduce sports.



In a contest, we may wish to determine the speed of a fly. But we may not know how. In asking around, the local expert may simply tell us to

time flies the same way that you would time an arrow.

http://en.wikipedia.org/wiki/Time_flies_like_an_arrow

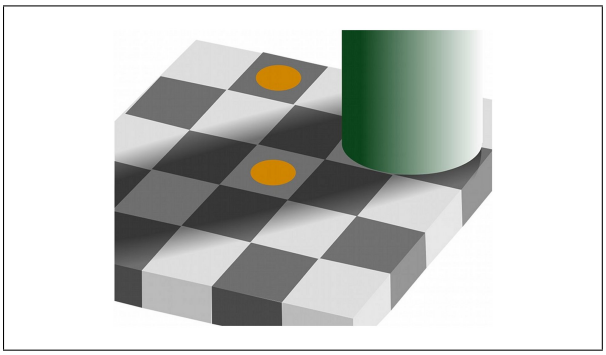
I thank my colleague, Geoff Draper, for many of these delightful illustrations.

Let me summarize my point by saying that ambiguity can exist but be **invisible** to us because we resolve it so quickly that we hardly notice it. The invisibility is due to our perspective.

And therein lies another point that I wish to address.

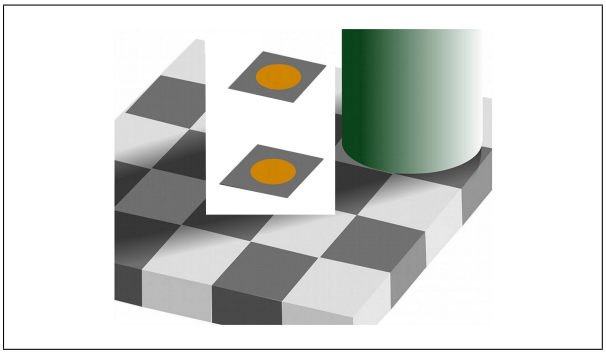
8 Context

What we can see depends in great measure on what else we see. Take a look at this checker board.



Look at the two buttons. Would you say that the one in the middle of the board is brighter than the one on the edge? They are actually the exact same color. Most people find that hard to believe.

Here is another view of those same two squares, with the surroundings removed.



The slides are on my web site. You can verify the colors yourself.

(This is called the Checkershadow Illusion, and is associated with Edward H. Adelson.)

What we see in these two pictures depends a

lot on what the context is. And it's not even the local context. The gray squares around each dot are also exactly the same shade of gray. For me, this really only leaves the influence of the shadow, which is a cognitive interpretation, rather than an optical one.

9 Perspective

My observation is that perspective can play a big role in whether something is ambiguous or not. And for any two people, their perspectives are always different. Normally they are similar enough that mistakes are rare. Sometimes they are surprisingly different.

For example, let's say I am working on my car. I have crawled underneath and I am laying on my back. My wife is by the tools ready to help me. I decide I need a particular tool. I forget what it is called, but I know where I laid it. I may call out to my wife, pointing in the general direction of the tool, and make my request: "Could you pass me that tool?"

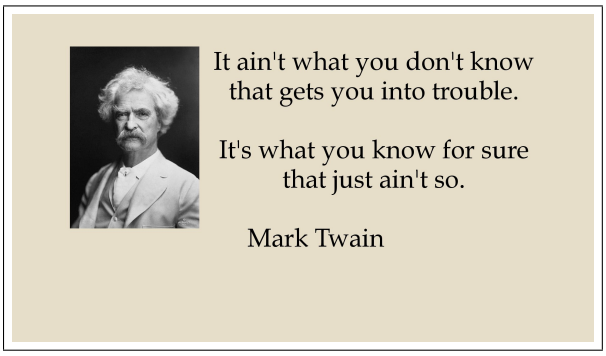
But maybe the tool I wanted is not in the direction I pointed. I have forgotten where I laid it, or maybe one of my children has moved it. My wife may have several tools in view, any of which could be the one that I need. What should she do?

She would probably just guess and hand me something.

In this case, my perspective is different than hers. My perspective is a memory of where I think things are. Her perspective is what she can actually see. I did not intend to be ambiguous but it came out that way because our perspectives differ.

10 False Confidence

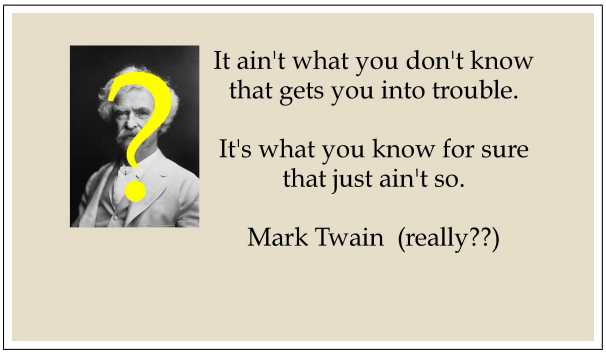
I **really** like this next quote.



It ain't what you don't know that gets you into trouble. It's what you know for sure that just ain't so.

I checked on the Internet. Most of the citations I found claim that Mark Twain said it. However, in all his published writings, nothing like that quote turns up.

http://wellnowbob.blogspot.com/2008/07/it-aint-what-you-dont-know.html



I find it delightfully amusing and a bit ironic that those bloggers who are claiming that Mark Twain said it are actually falling victim to the very truth that they claim he said.

They know for sure that Mark Twain said it, but it may not be so.

My interest in the thought is this: ambiguity, wrongly interpreted, can become the thing we "know for sure that just ain't so." And

that can get us into trouble.

Ambiguity is part of life. We have to deal with it. We have to interpret things without having complete knowledge.

But do not be over-confident. Remember that it is just your best guess at this moment, and later, with more perspective, you may find yourself changing your mind.

11 Mars

There is also rocket science involved. I have another story.

The United States National Aeronautics and Space Administration, NASA, provides us an interesting example in the realm of things we know for sure that just ain't so.

Mars Climate Orbiter

Mishap Investigation Board

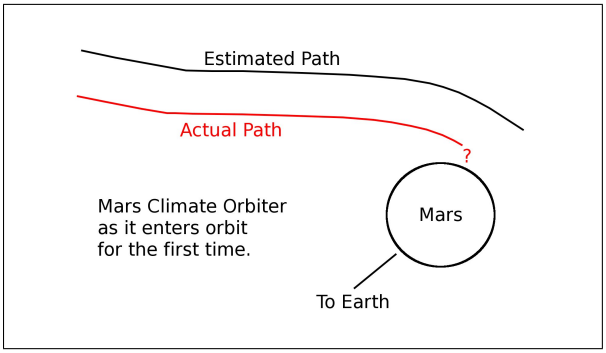
Phase I Report

November 10, 1999

I am speaking of the metric mixup that lead to the loss of the Mars Climate Orbiter on September 23, 1999.

http://en.wikipedia.org/wiki/Mars_Climate_Orbiter

In 1995 NASA got approval to create and launch the Mars Climate Orbiter. It was part of the larger Mars Surveyor program started a few years earlier. It was made ready and was launched December 11, 1998. Nine months later it reached the Red Planet. To achieve orbit, it had to slow down. A lot. The plan was to conserve fuel by coming in at an angle and then bouncing off the thin Martian atmosphere, back into space. This process is called aerobraking and it is well understood. The aerobraking was to be carefully repeated several hundred times over a two month period until the craft had slowed down enough to enter a circular orbit.



On September 23, the orbiter entered the atmosphere of Mars for the first time. But it was off course. It disappeared behind the planet 49 seconds earlier than expected. It did not reappear. For two days the team tried to regain contact without success.

Several review boards were created to investigate the mishap. As reported in the November 1999 report, they found that as early as April, five months before the mishap, the orbiter was known to be off course. Scientists investigated and made adjustments but did not find the real cause.

The MCO Mission objective was to orbit Mars as the first interplanetary weather satellite and provide a communications relay for the MPL which is due to reach Mars in December 1999. The MCO was launched on December 11, 1998, and was lost sometime following the spacecraft's entry into Mars occultation during the Mars Orbit Insertion (MOI) maneuver. The spacecraft's carrier signal was last seen at approximately 09:04:52 UTC on Thursday, September 23, 1999.

The MCO MIB has determined that the root cause for the loss of the MCO spacecraft was the failure to use metric units in the coding of a ground software file, "Small Forces," used in trajectory models. Specifically, thruster performance data in English units instead of metric units was used in the software application code titled SM_FORCES (small forces). A file called Angular Momentum Desaturation (AMD) contained the output data from the SM_FORCES software. The data in the AMD file was required to be in metric units per existing software interface documentation, and the trajectory modelers assumed the data was provided in metric units per the requirements.

During the 9-month journey from Earth to Mars, propulsion maneuvers were periodically performed to remove angular momentum buildup in the on-board reaction wheels (flywheels). These Angular Momentum Desaturation (AMD) events occurred 10-14 times more often than was expected by the operations navigation team. This was because the MCO solar array was asymmetrical relative to the spacecraft body as compared to

After the mishap, it was eventually noticed

that the small forces database, part of the orbiter computing system, had been returning values that were too small by a factor of 4.45. These values were used to control the thrusters on the space craft.

This was the metric mixup. One pound of force is equal to 4.45 Newtons. The small forces database was filled with numbers expressed in pounds of force, which is the classical English measurement, when they were required and expected to be expressed in Newtons, the modern metric equivalent.

This discovery explained the many months of puzzling discrepancies. It also explained the 49-second error upon entering orbit. The entry trajectory was far lower than expected, resulting in the loss of the space craft.

We can learn several things from this mixup.

First, even though the project called for metric units, somebody was not paying enough attention and provided English units instead. It is a clear example of "things we know for sure that just ain't so."

Second, as early as April, there were hints that something was wrong. The metric mixup might have been discovered and corrected, but due to the complexity of everything, it was not.

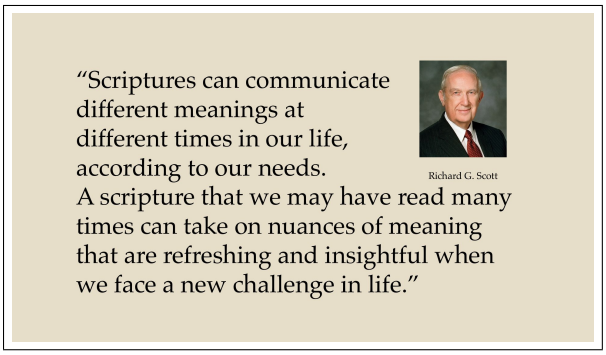
Third, life moves on, even when we are confused, and even when we know we are confused.

12 Gospel

Let's move from the celestial worlds of outer space to the celestial worlds of the gospel.

12.1 Different Meanings

A few months ago at General Conference, Elder Richard G. Scott taught:



Scriptures can communicate different meanings at different times in our life, according to our needs. A scripture that we may have read many times can take on nuances of meaning that are refreshing and insightful when we face a new challenge in life. (Richard G. Scott, The Power of Scripture, Oct Conf 2011)

What is it about the scriptures that makes this true?

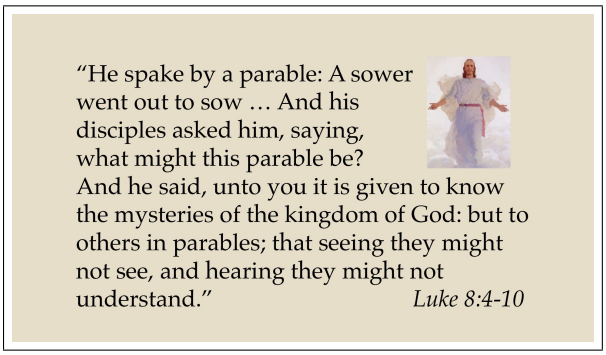
The first time, or even the tenth time we read something, we may not be ready to fully understand.

Some scriptures make reference to the mysteries of the kingdom. By definition a mystery is a secret. It is not something that cannot be understood. Instead, it is something that is not widely understood. And ambiguity may play a role.

12.2 Parables of Christ

Consider the many parables of Christ.

In Luke, chapter 8, we find this one:



Luke 8:4-10 ... he spake by a parable: 5 A sower went out to sow ...

9 And his disciples asked him, saying, What might this parable be? 10 And he said, Unto you it is given to know the **mysteries** of the kingdom of God: but to others in parables; that seeing they might not see, and hearing they might not understand.

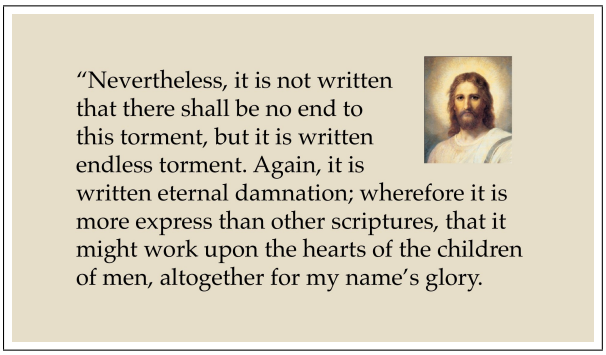
Here we have a stated reality involving sowers and seeds and harvests. But we also have a parallel and much more important reality involving preachers and the gospel and changed lives.

In this and numerous other cases, Christ seems to have expected his apostles to understand his symbolic language and they did not. Is this also true of us today?

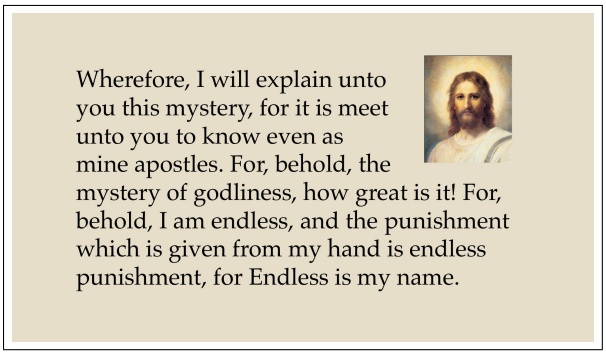
12.3 Endless Torment

Let's look at a very interesting and explicit example of scriptural ambiguity, both as it is used by God and as it is specifically explained by God.

In the Doctrine and Covenants, section 19, we read:



D&C 19:6-12 6 Nevertheless, it is not written that there shall be no end to this torment, but it **is** written endless torment. 7 Again, it is written eternal damnation; wherefore it is more express than other scriptures, that it might work upon the hearts of the children of men, altogether for my name's glory.



8 Wherefore, I will explain unto you this **mystery,** for it is meet unto you to know even as mine apostles. ... 10 For, behold, the **mystery** of godliness, how great it is! For, behold, I am endless, and the punishment which is given from my hand is endless punishment, for Endless is my name.

Wherefore—
Eternal punishment is
God's punishment.
Endless punishment is
God's punishment."

D&C 19:6-12

Wherefore– 11 Eternal punishment is God's punishment. 12 Endless punishment is God's punishment.

It seems that God's intention is to get a point across both to those that understand the **mysteries** and also to those that do not yet understand the mysteries. He is using ambiguity to communicate at two levels.

From God's frequent use of symbolic language, my feeling is that there are symbolic messages all around us. The temple, for example, is filled with symbolic messages to be pondered. We learn the gospel line upon line, when we are ready.

12.4 Private Interpretation

What about "things we know for sure that just ain't so"?

The apostle Peter taught:

"Knowing this first, that no prophecy of the scripture is of any private interpretation. For the prophecy came not in old time by the will of man: but holy men of God spake as they were moved by the Holy Ghost."

2 Peter 1:20-21

2 Peter 1:20-21 20 Knowing this first, that no prophecy of the scripture is of any private interpretation. 21 For the prophecy came not in old time by the will of man: but holy men of God spake as they were moved by the Holy Ghost.

If one person tells another person that a certain scripture means a certain thing, and nothing else, I think they are engaging in private interpretation.

There is no harm in telling someone what you "think" it means, or what you get out of it, or how you apply it in your life, but to me it seems presumptuous to declare that it means this and only this.

It may mean more than you imagine.

We quoted Elder Scott earlier: "Scriptures can communicate different meanings at different times in our life, according to our needs."

Maybe this is one reason we are instructed to ponder the scriptures.

In 2 Nephi 28:30 we read:

30 For behold, thus saith the Lord God: I will give unto the children of men line upon line, precept upon precept, here a little and there a little; and blessed are those who hearken unto my precepts, and lend an ear unto my counsel, for they shall learn wisdom; ...

13 Conclusions

In conclusion, I offer these thoughts.

Number 1:

Ambiguity may be an accident. Remember the dots on the checkerboard. Ambiguity depends on context, and for any two people, our perspectives are never exactly the same.

So, be kind to others. If they find your words to be ambiguous when you think they are perfectly clear, maybe it is because they see possibilities that you do not.

Number 2:

Ambiguity may be intended. When you notice it, ponder it and learn from it. You may find a lesson when you are ready.

Number 3:

In the spirit of things we "know for sure that just ain't so," try hard to keep an open mind.

Thank you.