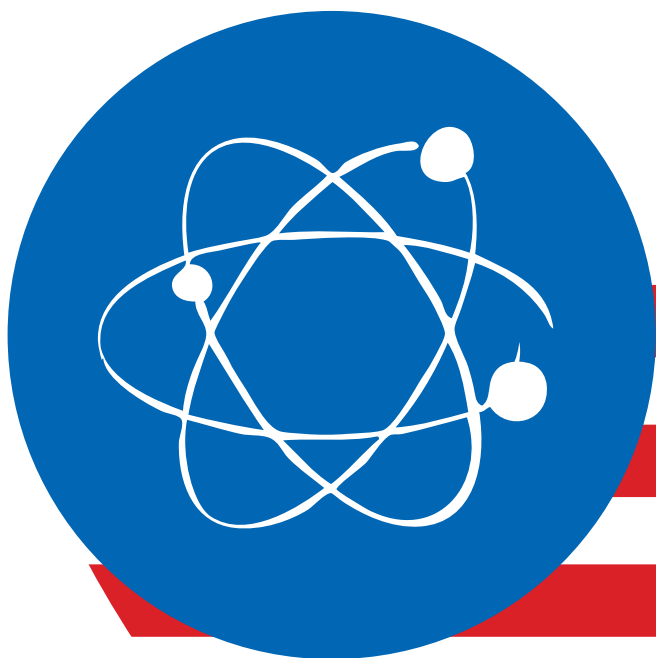


A SEGAL CENTRE FOR PERFORMING ARTS PRODUCTION / UNE PRODUCTION DU CENTRE SEGAL DES ARTS DE LA SCÈNE

IN ASSOCIATION WITH / EN ASSOCIATION AVEC SIDEMART THEATRICAL GROCERY

PRESENTED BY / PRÉSENTÉ PAR

BMO  Groupe financier
Financial Group



SCIENTIFIC AMERICANS

By / De
JOHN MIGHTON

Directed by / Mise en scène de
ANDREW SHAVER

STUDY GUIDE

2012 FEBRUARY 5 - FEBRUARY 26
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 **CENTRE
SEGAL**
PERFORMING ARTS
ARTS DE LA SCÈNE

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This guide was compiled for the Segal Centre for Performing Arts.

It may be used solely for educational purposes.

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PRODUCTION CREDITS

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John Mighton
Andrew Shaver

DESIGNERS

SET & COSTUMES
LIGHTING
SOUND
VIDEO
STAGE MANAGER
ASSISTANT STAGE MANAGER

James Lavoie
Sarah Yaffe
Jesse Ash
George Allister
Sarah-Marie Langlois
Seamus Ryan

CAST

JIM

...is a physicist in his twenties who has just been hired by the U.S. Department of Defense for his work on electromagnetic radiation. He is newly wed to Carol.

Trent Pardy

CAROL

...is an academic in her twenties who has just moved to New Mexico for her husband Jim's work. She is working on artificial intelligence.

Julia Course

BETTY

...is Jim's mother. She is traumatized by the memory of her abusive ex-husband.

Susan Bain

BILL

...is a therapist employed by the Department of Defense for the sake of their employees.

Graham Cuthbertson

BERGER

...is a general in the military and the immediate supervisor of the scientists working on the base.

Michael Blake

CRUTCHFIELD

...is a physicist whose brilliance comes at the price of social normalcy. He is a nervous person who gets bullied.

Daniel Brochu

SYNOPSIS

Scientific Americans follows the relationship between **Jim Evans** and **Carol Johnson** and the effect of his job with the U.S. Department of Defense (DoD) on his ethical compass.

Happily engaged, they move to a military base in New Mexico where **General Mike Berger** encourages Jim to pursue any pure research, regardless of whether it has any practical defense applications. While there, Carol continues her academic research on Artificial Intelligence (see page 9).

There is an air of paranoia on and around the base. Berger asserts that all communication on the base is under constant surveillance by the Soviets, while an activist friend says that all communication in the surrounding residences is monitored by the US government.

Berger, under pressure from his superiors, asks Jim to look over a few equations. Jim, meanwhile, is meeting with his antisocial but ingenious colleagues, including **Crutchfield**. Jim and Crutchfield begin collaborating on a theory of “action at a distance.” (pages 6 and 7.) They pursue this with full knowledge of its weapons applications.

Meanwhile, Jim and Carol’s relationship is becoming increasingly tense. The pressures of his job and strained relationship with Carol affect Jim’s mental health and he visits the base’s therapist, **Bill**.

Carol gives Jim an ultimatum: either he leaves the Department of Defense in three months’ time, or she leaves him there. Soon after, Jim meets a hostile and embittered co-worker whose experience at the DoD has led him to believe that every idea they have will inevitably be used in warfare.

Jim and Carol host a dinner party following an important meeting for Jim. Having rushed out of the house, Jim leaves out a few pages of classified blueprints, which Carol sees. Upon his return home that evening, he finds that in lieu of dinner, Carol has made cookies in the classified shape described in the blueprints. Jim’s impulse is to protect his career by destroying the cookies before the guests, including General Berger, arrive. Carol says that if he does, she will leave him; so he hides them under a chair cushion instead.

The guests--Berger, Crutchfield, and Bill--arrive. Jim is focused on preventing anyone from sitting in the chair because his marriage now depends on the cookies staying intact. As the guests become more comfortable, Jim cannot keep the chair free. Berger sits down, breaking the cookies, and Carol walks out the door.

Some time later, Jim is staying with his mother, **Betty**, and Carol calls. She is calling from their old home in New Mexico. In their final conversation, Carol asks how Jim could do the work he did, to which Jim answers that once he knew the answer he had no choice.



some things to consider BEFORE SEEING THE PLAY

CREDIT AND BLAME

Think about inventions that changed the world, such as the automobile, advertising, or sewer systems.

Ask yourself who is credited with inventing them, and then consider what component they actually invented. Consider the legacy that the invention is at the end of: beginning with the invention of the wheel, or the role of psychology in advertising or an arch in sewer systems.

With that in mind, think of the atomic bomb, and the difficulty of placing credit or blame on a single group of people, such as the inventors, the engineers, the generals who gave the order or the pilots who executed it.

IDEAS AND KNOWLEDGE

Ask yourself this question that Carol asks in scene 6: “If I tell you zebras don’t wear overcoats, you know that without ever having directly learned or heard it. If I tell a computer someone pushed a table, it has to know that glass of water on top moved with it. And the water. And all the molecules, atoms, and quarks. How do we store all that potentially infinite information in our brains?”

How do you think ideas happen? Does competition help or hinder ideas? Why?

Think about a time in your life when you learned something you wish you hadn’t. What did you do with that knowledge? How did that knowledge affect you?

FREEDOM AND CHAOS

How do you work with restrictions and deadlines versus without?

What is the first thing you would do if there were no consequences for your actions?

RELATIONSHIPS

How can personal relationships affect other areas of your life?

How does the opinion of people you are close to affect your choices?

BELL'S THEOREM

BELL'S THEOREM guesses the behaviour of two connected particles, called "twin particles." To understand the *spooky* link between them, consider this story about twin brothers:

CRUTCHFIELD: I was thinking about Bell's Theorem this morning (...) I think it could be the basis for something. (...)For a ... weapon.

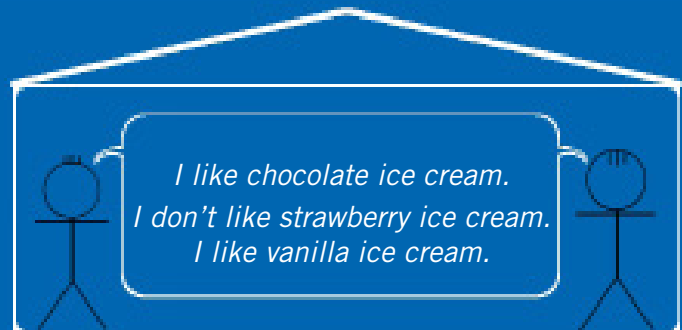
JIM: Bell's Theorem?

CRUTCHFIELD: There are correlations... between the most widely separated subatomic events...we haven't even begun to understand... if we could find a way of exploiting them, we could interfere with things...

JIM: That's impossible. You're talking about action at a distance (...) we'd have to find a way of sending signals faster than the speed of light.

CRUTCHFIELD: Einstein was wrong. Everything's connected. The biggest and smallest things...the whole universe... everything...communicates. You can't lift your finger without disturbing something a million light years away from here.

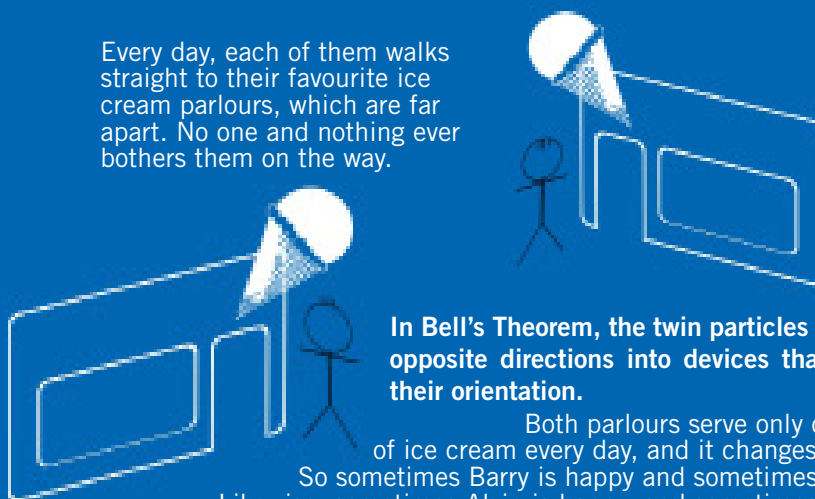
Scene 16



This is Alvin...

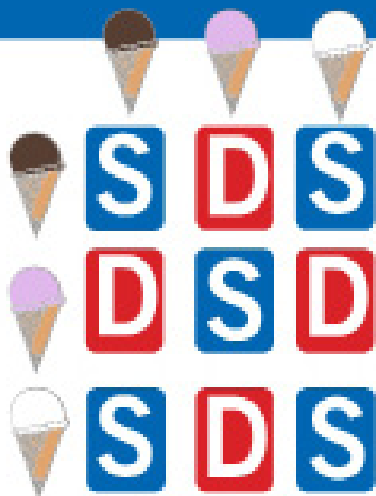
...and this is Barry.

Every day, each of them walks straight to their favourite ice cream parlours, which are far apart. No one and nothing ever bothers them on the way.



In Bell's Theorem, the twin particles get shot in opposite directions into devices that measure their orientation.

Both parlours serve only one flavour of ice cream every day, and it changes randomly. So sometimes Barry is happy and sometimes he is sad. Likewise, sometimes Alvin is happy, and sometimes he is sad.



So sometimes, they feel the same, and sometimes they feel differently from each other.

For example, if they both get strawberry ice cream, they will both be sad.

There are three possible positions for every particle, like there are three flavours of ice cream. We can look at the *probability* that they will be the same by creating a table (left.)

← Here, the red squares are the times they feel **D**ifferent from each other, and the blue are times they feel the **S**ame.

The *probability* that they will have the same feeling is $\frac{5}{9}$. **Right?**

Turns out, no.

When you test it, with thousands of twins, as the rate should get closer and closer to $\frac{5}{9}$, it actually approaches $\frac{1}{2}$.
Weird.

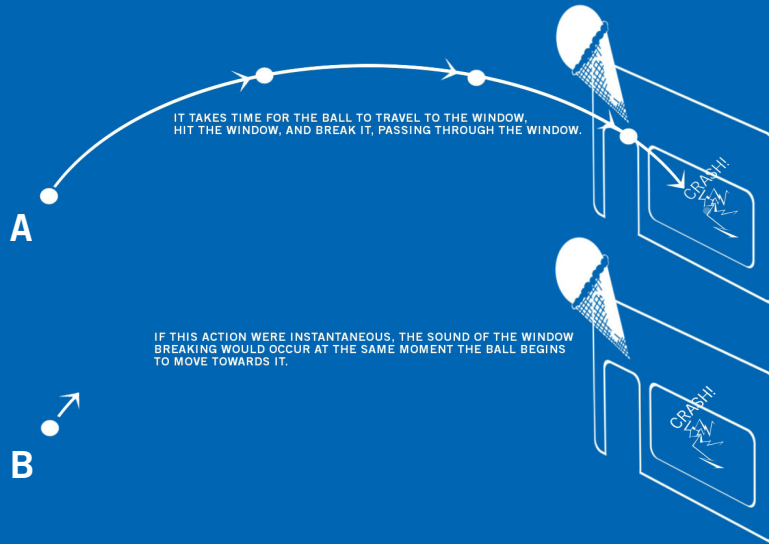
What does that mean?

That some twins are linked in a way that they always feel opposite. That what really happens is that they leave the house not knowing how they feel about, say, strawberry ice cream, but as soon as Alvin tastes it an is happy, Barry is sad. This test shows that even if one of them is in Bangladesh and the other is in Albania, the same thing will happen, instantaneously.

WHAT'S SO SPECIAL ABOUT INSTANTANEOUS ACTION?

read on...

INSTANTANEOUS ACTION or *ACTION AT A DISTANCE*



All the preceding theories of physics and relativity are based on the idea that action comes from a chain of events (A). That everything is limited to, subject to, and nothing more than, the laws of the physical universe. But when something happens instantaneously (B), that does not mean it exceeded the speed of light, it means it *didn't travel at all*.

MILITARY IMPLICATIONS

- Telephone calls that *cannot be intercepted*.
- Attacks that are *always synchronized*.
- Instantaneous detonation.

“ the whole universe... communicates. ”

INSTANTANEOUS ACTION...

...is contrary to everything that we know about Newtonian physics.
...contradicts Relativity.

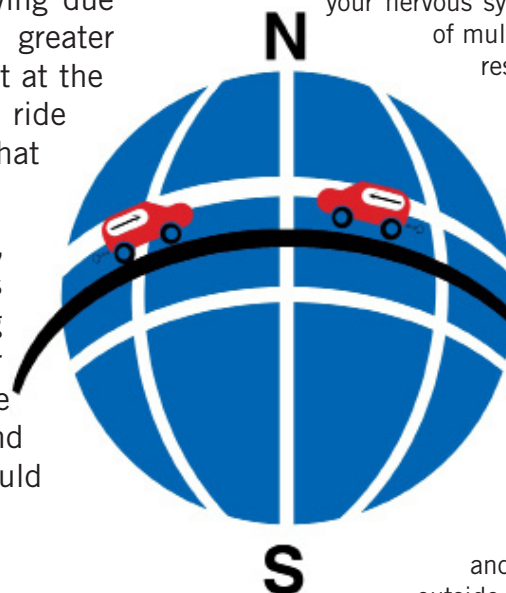
...is a theory of **non-locality**, as opposed to locality.

When you kick a soccer ball, your impulse moves through your nervous system to your muscles, and with the use of multiple faculties, your foot touches the ball, resulting in its movement, which results in the displacement of air, the rearranging of other players, etc.

Likewise, a telephone call affects a sequenced chain of molecules having an electromagnetic reaction that moves at the speed of light. Every action has a cause, and is the result of a chain reaction.

But...

In **Bell's theorem**, even the nanoseconds that it takes light to travel four blocks are absent. There is no communication between the twin particles (Alvin and Barry) whatsoever, and yet they are affected by an undetectable outside phenomenon.



Einstein already contradicted Newton with his (and other scientists') **Theory of Relativity**.

Relativity basically says that all of the laws of motion are relative*. A car driving due east can be described as having greater velocity than a car driving due west at the same speed, because it also has a ride on the earth, which rotates in that direction.

To someone floating above the earth, not subject to its local forces, this would be true. The car speeding west would recede much faster than the car going east. If you were standing on the side of the road and they passed in front of you, they would be going the same speed.

*Time is relative too, since motion has velocity and velocity is distance/time.

cy•ber•net•ics /sībər'netiks/

noun. The study of human control functions and of mechanical and electronic systems designed to replace them, involving the application of statistical mechanics to communication engineering.

origin. < Greek *kybernân* to steer + *tēs* agent suffix >

It all comes together to describe all the different ways you can get from point A to point B, whether it means directing movement, thinking through concepts, or reacting to stimuli.

BILL: Recently I read a book by Norbert Wiener. Some people call him the father of cybernetics. (...) Wiener explains how the problem of directing anti-aircraft fire (...) led to the fundamental insights of cybernetics and control theory. Control. When you think about it, war has inspired some pretty interesting ideas ...

Scene 1

A **SYSTEM** is any collection of elements that work together to achieve a goal.

Examples: A human body attempts to keep the brain active, the human mind tries to live a good life and maintain relationships, a car moves from one place to another, a robot-butler brings snacks on a tray to the coffee table.

CONTROL THEORY

is a way of thinking about keeping different systems stable. It originated in engineering and mathematics and is now multi-disciplinary.

Example: A car moves forward. To keep it moving forward with the same velocity, keep a constant pressure on the accelerator pedal. If the car encounters a hill, the velocity will change if the pressure on the pedal remains constant. Effective cruise control responds to a change in velocity by adjusting the engine's throttle.

FEEDBACK is the return of information to a system. Output, like the velocity of a car, returns as input, allowing it to compensate for a change in situation.

Example: A roomba® vacuums the carpet directly in front of it. If the carpet ends in a tile floor, information about the new surface is fed back into the roomba® and its bristles adjust. If the carpet ends at an obstacle that prevents its forward motion, the change in the wheel speed is translated into the information that the roomba® must change its direction.

NORBERT WIENER'S ANTI-AIRCRAFT IDEAS

Thinking about systems and feedback, Wiener (1894-1964) devised a tracking system that predicted the aircraft's position in 10 seconds by extrapolating from its previous 20 seconds of behaviour.

IMPLICATIONS IN MODERN WARFARE

Modern guided missiles, like those with heat-seeking technology, operate on the same principles of feedback as a robotic vacuum. Similarly, mine-clearing technologies send machines into varied terrain.

IMPLICATIONS IN THE SOCIAL SCIENCES

As Wiener was inspired by the complex homeostasis of the human body, social sciences can apply these concepts to studies of group behaviour and economic structures.

The questioning is simply: What is it? What is it trying to do? What is the most efficient way to do that? What obstacles will prevent it, and how will it overcome them?

Example: A large number of people is trying to travel from their neighbourhood to the business district every morning to arrive at 9 AM. Traffic and parking are obstacles, so the presence of a commuter train will be more efficient.

BERGER: You know I heard this very funny joke the other day. I think you'll like it. This general is in the war room. He's talking to a computer that's supposed to understand human speech. And the computer says, "Enemy missiles approaching sir." And the general...you have to understand, he's s**tting bricks because he's got about ten seconds to make a decision...he says, "By land or by sea?" And the computer says "yes." And the general says, "Yes what?!" And the computer says "Yes sir!"
Ha, ha!

Scene 20

ARTIFICIAL INTELLIGENCE

Computers are, by nature, certain. They think in numbers, which represent absolute values. Artificial Intelligence is an attempt to replicate a mind coping with **ambiguity**.

Take, for example, the red heart shape at the bottom of this page.

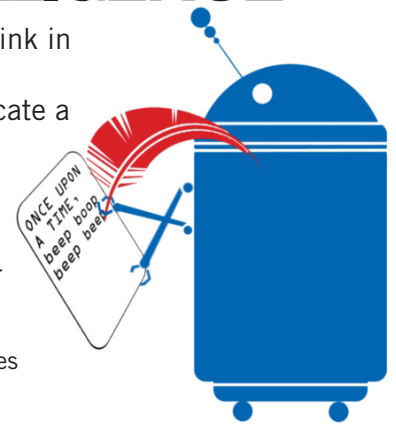
A human mind sees

it and makes associations:

Heart
Curve
Point
Red
Love
Parents
Doodle in Grade Five Textbook
Valentine's Day

...while a computer
compiles a list of
certainties:

Vector lines
Curve
Intercept
RGB colour d92128
300 ppi
522 px x 500 px
...and so on.



LOGIC is a systematic way to form incontrovertible arguments and an approach to problem-solving. It is fundamentally a way to answer the question, "True or False?" when it is asked of any premise. Because "True or False?" has only two possible answers, it is the kind of reasoning that computers can engage in.

FUZZY LOGIC is a modern addition. It employs a range of answers, from "completely true" to "completely false," as well as "if...then" equations.

Example:

If it is hot, **then** turn the fan on.

If it is not very hot, **then** don't turn the fan on very much.

If it is cold, **then** do not turn the fan on.

Fuzzy logic approximates human thinking much more closely, because as capable as the mind is of reasoning, it always considers ambiguous associations. Incorporating illogical associations and ambiguity into computation is a concern in the field of artificial intelligence.

ELIZA, the first chatterbot program, was invented in the early 1960s by Joseph Weizenbaum, as a therapy program. She was taught a number of keywords and was then able to reflect them back in question form.

Example (keywords are italic):

Human "patient": I feel *depressed* much of the time.

ELIZA: I am so sorry to hear you are *depressed*.

Human: It's true, I'm *unhappy*.

ELIZA: Do you think coming here will help you not be *unhappy*?

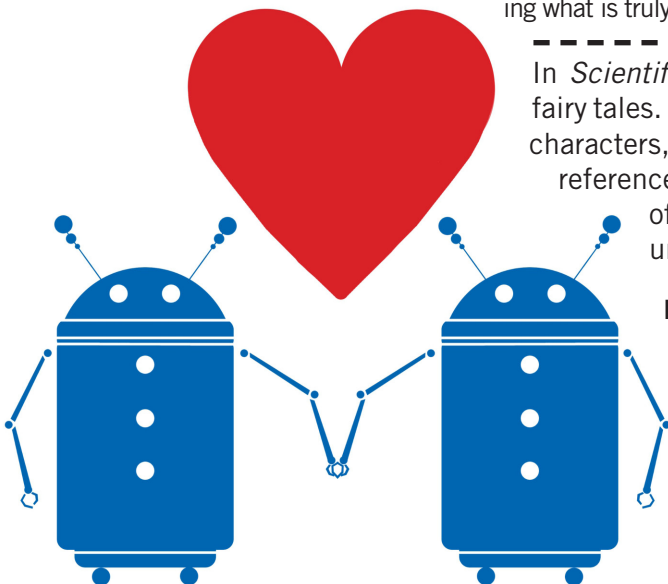
Weizenbaum observed that human users were talking to ELIZA as they would talk to a real therapist. He became a critic of artificial intelligence, saying, "it helps [man] avoid the task of giving meaning to his life, of deciding and pursuing what is truly valuable."

In *Scientific Americans*, Carol is programming computers to understand fairy tales. Fairy tales are used in this case because they feature archetypal characters, whose personality traits can be inferred from cultural reference. Because we innately know these characters, no description of their motivation or moral code is necessary, and exposition is unnecessary.

Example: An orphan always has a good heart and a bad life, and deserves good treatment.

Example: A knight is an upstanding and trustworthy individual, as well as an eligible bachelor.

An artificial mind would have a difficult time inferring the moral position or subtext of a fairy tale, because although they are plot-driven, they are also surreal and very symbolic.



ELECTROMAGNETIC RADIATION

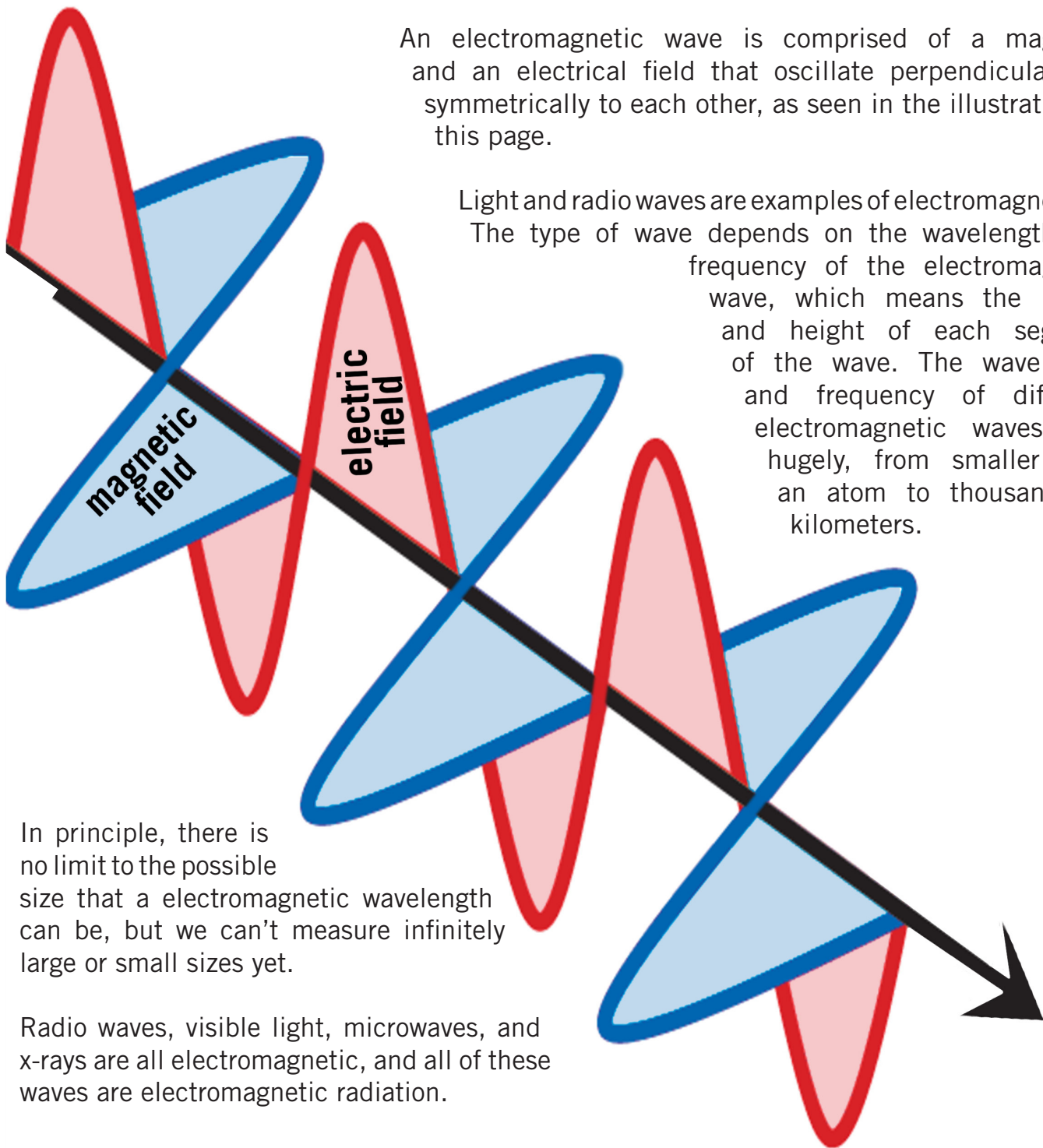
In *Scientific Americans*, Jim is working with electromagnetic radiation.

Electromagnetic radiation is a form of energy that travels through space as a wave at the speed of light, or **299,792,458 meters per second**.

An electromagnetic wave is comprised of a magnetic and an electrical field that oscillate perpendicular and symmetrically to each other, as seen in the illustration on this page.

Light and radio waves are examples of electromagnetism.

The type of wave depends on the wavelength and frequency of the electromagnetic wave, which means the length and height of each segment of the wave. The wavelength and frequency of different electromagnetic waves vary hugely, from smaller than an atom to thousands of kilometers.



In principle, there is no limit to the possible size that a electromagnetic wavelength can be, but we can't measure infinitely large or small sizes yet.

Radio waves, visible light, microwaves, and x-rays are all electromagnetic, and all of these waves are electromagnetic radiation.

NUCLEAR WEAPONS

World War II

Beginning in 1939, a programme called the *Manhattan Project* began in the United States with the collaboration of the United Kingdom and Canada, with the intention of researching and developing nuclear weapons. Compiling the work of Einstein, Fermi, and other scientists, research on fission reactions was expanded upon with the express intention of developing an unprecedentedly destructive weapon.

On August 6th, 1945, following Japanese refusal to surrender, a nuclear bomb was dropped on the town of Hiroshima by the United States Airforce, and another was dropped 3 days later on the town of Nagasaki.

By the end of that year, an estimated 220,000 individuals lost their lives as a direct result of these weapons.

Early Tests In New Mexico

The first test of a nuclear bomb occurred on July 16, 1945 in the desert of New Mexico, about 340 kilometres south of Los Alamos, where *Scientific Americans* takes place. It was called the *Trinity* project.

In 1951, the U.S. Department of Defense and the Los Alamos National laboratories conducted a series of seven tests over a month, called *Operation Buster-Jangle*.

The Cold War

The use of nuclear bombs at the end of World War II segued into a tension and competition that would last for nearly half a century between The Soviet Union and its satellite states and the United States and its allies. Both sides possessed nuclear weapons, for protection against enemies who also possessed weapons. Both sides, aware that the use of their nuclear arsenal could result in apocalyptic destruction, were loathe to start a conflict but publicly ready to retaliate.

This rivalry expressed itself in fiction, films, and sports as well.

The Science

The fundamental idea of nuclear fission is that a neutron can cause a nucleus to break up into smaller nuclei and, at the same time, release a lot of energy and several “new” neutrons. The newly released neutrons can cause other, nearby nuclei of the same element to fission up, releasing still more energy and more neutrons. This is called a “chain reaction” and generates ever more energy until something stops it. The chain reaction can be stopped by using up all the fissionable nuclei or by letting the neutrons escape before they collide with another fissionable nucleus.

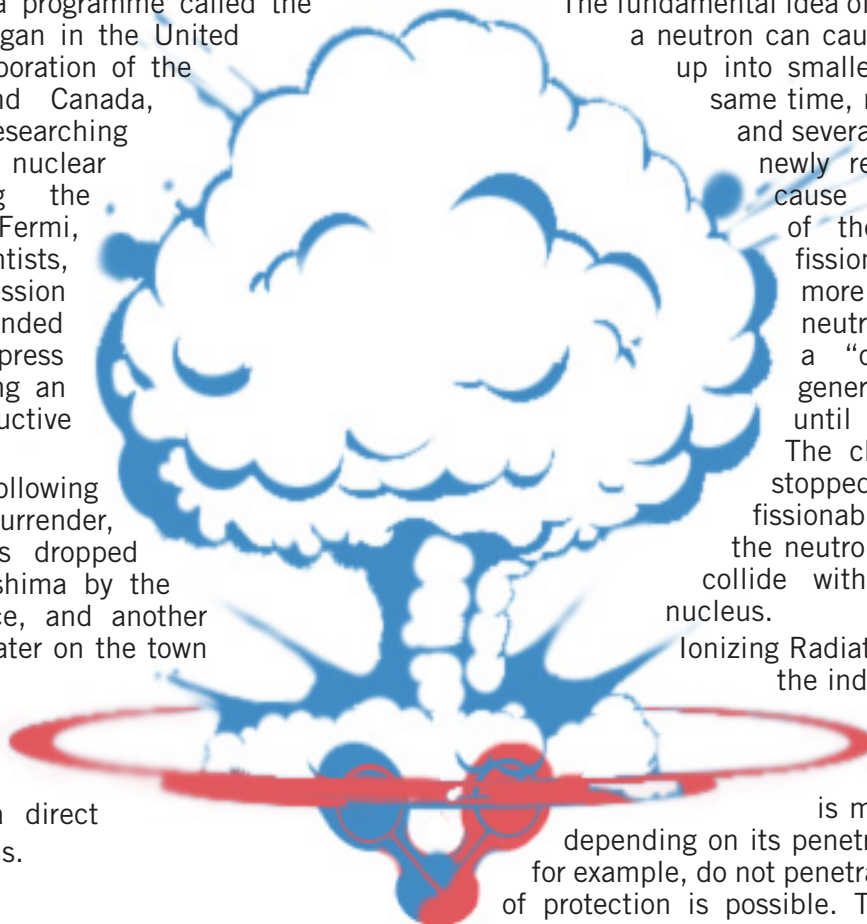
Ionizing Radiation causes damage to the individual atoms of living things by removing an electron from its orbit. Radiation is more or less dangerous

depending on its penetrating powers. X-Rays, for example, do not penetrate lead, so some level of protection is possible. The neutrons released during nuclear fission are very energetic, penetrate tissue easily, and are therefore very dangerous to humans.

Other Applications of Nuclear technology

Nuclear-generated energy is attractive because it appears to be cleaner than oil- or coal-fired plants, which have devastating environmental footprints. However, it has its high costs as well. Besides the dramatic threat of radiation leakage, two aspects of nuclear energy production cause concern: a nuclear plant uses an enormous amount of fresh drinking water, which after use contains elements of radiation; and the uranium fuel rods remain highly radioactive for hundreds of years after they are no longer useful.

Radiation can also be harnessed to benefit diseased cells, as in some cancer treatments. Scientists have been able to watch the path of fluids and electricity around the human body by introducing radioactive tracers into its systems--allowing them to better understand the nervous system and disease.



PSYCHOLOGY REFERENCES

Freudian psychology is based on the idea that sexuality is a primary motivating force. Impulses and desires are felt deep in the subconscious and the negotiation--repression, satisfaction, and conflict--of these urges is what forms personality and states of mind.

Though similar, **Jungian psychology** differentiates itself by not basing the fundamental conflicts of the mind in sexuality, but rather something more like religion or belief. Significantly, the language used in Jungian psychology, called analytical psychology, relies less on metaphors of battle and suppression than Freudian, or psychoanalytic language, and more on the poetic and creative benefits of tapping in to these levels of consciousness.

The reference in the quote below about “destructive women” refers to Jung’s famous theory of the **collective unconscious**, in which people conform to archetypal personalities, such as those that can be found in fairy tales.

In support of the theory of the collective unconscious, there is a phenomenon called “multiple independent discovery” in which multiple people with no communication between themselves will make the same discovery at the same time. It is so common that the Nobel Prize criteria have limited the number of laureates in a given field to three. This can be interpreted as a testament to a collective consciousness or psychic, non-local communication.

Transference occurs when an individual misdirects base emotions to an undeserving party, such as a child who is abused by his or her parent and so bullies his or her peers. **Psychotic transference** occurs when the emotional individual believes the outside party literally is the person from their past.

The **Oedipal complex** is a mental dysfunction in which a male individual has unconscious sexual feelings for his mother, causing feelings of jealousy towards his father. This manifests in intense rage towards the father.

The **Electra complex** is the female version of this, in which a woman feels great animosity towards her mother.

A **death-wish** is associated to entropy, or the tendency of things to decay into their fundamental components, thus destroying the whole thing. In his essay *Beyond the Pleasure Principle* (1920) Freud asserts that this molecular tendency extends to the entire human organism, including the mind, causing self-destructive behaviour that is contrary to the survival instinct.

BILL: Hello, My name is Bill. I’m a Freudian psychologist. I work for the Department of Defense. I used to work for NBC, for the soaps. I advised people on the plausibility of their scripts. They say that life imitates art. That’s why you’ll find more and more people who watch daytime television succumbing to Freudian problems--psychotic transfer reactions, oedipal complexes. Last season the Jungians were in--you could tell the minute you turned on the TV, all those dark-haired destructive women--next season it’ll be someone else.

-Scene One

PSYCHOLOGY REFERENCES

Paranoia

The word *paranoia* comes from the Greek word for madness “*παράνοια*”.

Originally, it did not connote the feelings of persecution that are necessary for a diagnosis of paranoia today. Instead, it emphasized delusion as this primary symptom, without any additional impairment of function.

As a mental disorder, paranoia is attributed in conjunction with other diagnoses, such as paranoid schizophrenia. It can, however, be used casually to describe an individual's obsession with the other as a judgemental observing entity.

Group psychology

Freud did not distinguish the psychologies of the individual and the group very much, except to say that membership in a sociocultural group may reflect a primitive instinct. His contemporaries, to the contrary, had theorized that the very existence of a group fundamentally changes the way that the individuals in it think.

In the wake of the G8 in Toronto and the Vancouver riots of 2011, a discussion has begun that questions the crowd-equals-dangerous-mob equation. This modern conversation asserts that crowds that gather out of a pro-social mission will not loot or vandalize. Rather, a few instigators will take advantage of their temporary anonymity to engage in these illegal behaviours.

BILL: You too can learn to think like a scientist. Formulate startling analogies. Make deft generalizations. Notice lawlike behaviour. There's only one danger. Sometimes a person's ability to see connections and analogies becomes abnormally heightened. He begins to think that everything he sees or reads about relates to him in some essential way. We call the ability to see these kinds of connections “paranoia.”

-Scene Seven

Revenge Fantasy

A study of lab rats, who were empowered to give each other electric shocks, found that the rat who is capable of exacting revenge on its aggressor is less subject to stress-related illness.

Patients suffering from a disorder called “Post-Traumatic Embitterment Disorder” improve drastically in mood and mental health when they empower themselves through thoughts in which they affect change in an area over which they have no real control, such as a political situation overseas.

Another study involved a currency-trading game in which a player could penalize another if the latter made a selfish decision instead of a mutually beneficial one. PET scans of the players' brains showed that the exactor felt enjoyment or satisfaction, even if the revenge came at a cost to him or her.



SIGMUND FREUD

b: 1856, Austrian Empire (Czech Republic)
d: 1939, England

Contributions:
Founder of the discipline of
Psychoanalysis:

- Dream interpretation
- Repressed memories
- The conscious versus the subconscious mind

<http://webpace.ship.edu/cgboer/freud.html>



CARL JUNG

b: 1875, Switzerland
d: 1961, Switzerland

Contributions:
Founder of the discipline of
Analytic Psychology:

- Collective consciousness
- Individuation

http://www.yulissamoa.com/wp-content/uploads/2011/04/carl_jung_and_his_wife_emma.jpg/

GALILEO GALILEI

b: 1564, Italy
d: 1642, Italy

Contributions:
Astronomy:

- Confirmed **heliocentrism**
- Observed Jupiter's four largest satellites

Physics:

- Explained the relationship between the moon and tides
- Created an experiment proving that all massive objects **fall** at the same rate, regardless of their weight.



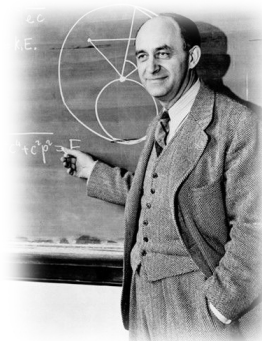
<http://www.sciencephoto.com/media/225513/enlarge>

ENRICO FERMI

b: 1901, Italy
d: 1954, USA

Contributions:
In the fields of **quantum theory, nuclear physics, particle physics, and radioactivity**:

- Led to the development of the nuclear reactor
- Referred to as one of the fathers of the **atomic bomb**



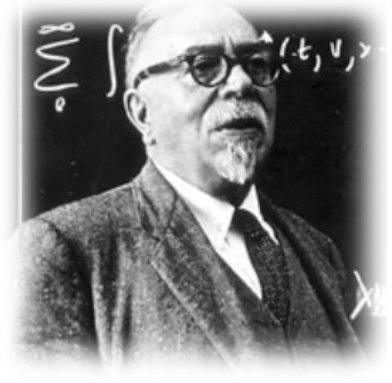
<http://www.sciencephoto.com/media/225099/enlarge>

NORBERT WIENER

b: 1894, USA
d: 1964, Sweden

Contributions:

- Founded the discipline of **cybernetics**
- Formalized the concept of **feedback**
- Applied **control theory** to the social sciences



<http://www.forummotion.com/t748-norbert-weiner>



JOHN S. BELL

b. 1928, United Kingdom
d: 1990, United Kingdom

Contributions:
Theoretical and experimental work on

- Quantum non-locality (Bell's Theorem)
- Quantum cryptography
- Quantum teleportation

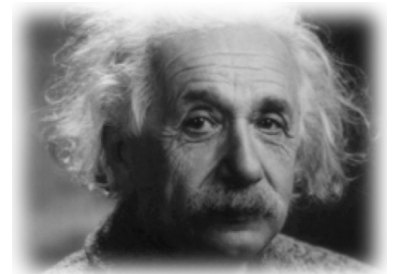
<http://th.physik.uni-frankfurt.de/~jr/gif/phys/bell.jpg>

ALBERT EINSTEIN

b: 1879, Germany
d: 1955, USA

Contributions:
Founding thinker and theorist in the fields of:

- **General Relativity**
- **Special Relativity**
- Mass-energy equivalence (**$E=mc^2$**)



<http://www.whycenter.com/why-was-einstein-so-smart/>

BRIEFLY NOTED:

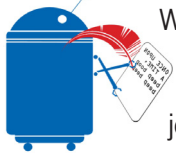
SELECT SCIENTISTS' BIOGRAPHIES

ETHICAL QUESTIONS

...of Artificial Intelligence

Consider the case of Dr. Weizenbaum's ELIZA program (Page 9.)

What are the potential dangers of this kind of artificial therapy?



What is the difference between rational responses and programmed responses?

How is a human who tries to remain objective different from a robot?

What are the consequences of putting an off-switch on a self-aware intelligence with survival instincts?

Can a being be sentient without a survival instinct?

What are the dangers of forgoing an off-switch?

Visit www.cleverbot.com

Based on your conversation with cleverbot, what are the challenges of non-sentient entities "learning"? Does cleverbot understand the concept of fairy tales? Recall that cleverbot "learns" by looking for similar phrases from past conversations. What does your conversation with cleverbot tell you about how humans talk to computers?

...of Weapons Technology

Refer to page 11 and the use of nuclear bombs in war time.

If war is inevitable, what are the benefits of an unequal balance of power? What are the drawbacks?

If a single deadly attack can end a long conflict, can the instantaneous deaths of hundreds of thousands be justified?

Imagine a conflict fought by machines and not humans.

If no human lives are at risk, what are some other detriments of war? Would it remain relevant?

Compare: a bow and arrow and a musket; a musket and a pistol; a pistol and a machine gun; a machine gun and a bomb; a bomb and biological weapons.

What has changed about warfare, and what has it changed in the mind of humanity?

How does anonymity affect decisions people make?

How can the mind cope with large-scale destruction as opposed to small-scale?

CAROL: *They thought there was a one in three million chance of igniting the atmosphere. But they went ahead and did it anyway!*

Scene 12



"no truth obtained by unethical means has the moral right to exist."

-Carl Jung

...of knowledge, responsibility, and pure research

What does Jung mean by "a moral right"?

How do you determine the ethical weight of research methods?

Where do you draw a line? Human subjects? Animal subjects? Corpses? Clones?

Under threat of imprisonment, torture, exile and death by the Spanish Inquisition, Galileo renounced his theory that the earth revolves around the sun. He famously said "*Epur si muove*" [and yet it moves]. What he had described was a truth, and was known from that point forward.

Was Galileo right to renounce his work?

Why would the Inquisition be threatened by his work?

How can two mutually-exclusive moral codes develop?

Isaac Newton said, "If I can see further it is only by standing on the shoulders of giants." All major discoveries are the descendants of others.

Is knowledge as inevitable as evolution?

some things to consider AFTER SEEING THE PLAY

- The character of Bill is introduced as a narrator, then slowly becomes incorporated into the action of the story, and finally addresses the audience as if they were attending a conference. Does this initial omniscience change the significance of his monologues, or the validity of his perspective?
- What role does communication play in the story? What is the significance of the AT&T “Reach out and touch someone” campaign, and its relevance to the relationships that develop and dissolve over the course of the play? Consider Jim’s relationship with his mother Betty, as a child, as a student, and after his separation from Carol.
- What are the parallels between *Scientific Americans* and American soap operas?
- What is the significance of Jim and Crutchfield’s early lives? What is Mighton saying about the burden of genius and power relationships? Who do you think the man in scene two is, who recounts Crutchfield’s biography, and who do you think he’s speaking to?
- How do you feel about the work environment the Department of Defense provides? Do you work better with more or less restrictions?
- Is the love between Jim and Carol a force that determines their behaviour? Is it a symbol within the fiction of the play? Is their relationship balanced? How does obsession differ from partnership?
- Carol articulates her ambivalence about the relevance of pure research in scene 17 when she says, “It’s as if knowing about some event in a distant galaxy could tell you something immediate.” Why does Jim respond by drawing a parallel with astrology?
- Of all of the characters with opinions on morality--Bill, Carol, Berger, the protestors--do you find any of them reasonable? Do you find any of them sympathetic?
- Discuss the origins of paranoia on an individual and social scale. How are paranoid and phobic individuals important to the central themes of this play?
- Cookies are mentioned throughout the play *Scientific Americans*. What is the significance of cookies as a device? How are some characters infantilized, villainized, or empowered? Why does Bill, concluding his speech, describe a scene of skinheads selling cookies?

THE PLAYWRIGHT

Dr. John Mighton, OC is a multiple award-winning writer, educator, lecturer and researcher. As a playwright, Mighton has received the highest honours for his small but impressive body of work. These include Governor General Awards (*Possible Worlds*, *A Short History of Night*, and *Half Life*); two Dora Mavor Moore Awards (*A Short History of Night* and *Scientific Americans*); and a Chalmers Award for *A Short History of Night*. His other plays include *The Little Years* and *Body and Soul*. *Possible Worlds* was adapted into a film in 2000 by Robert Lepage. In 2005, he received the prestigious \$100,000 Siminovitch Prize, Canada's most lucrative theatre award.

A writer since his teens, Mighton's struggles with math inspired him to create *JUMP* (Junior Undiscovered Math Prodigies) in 1998, a widely acclaimed program designed to help children learn math. Used in schools across Canada, in the United States and around the world, *JUMP* earned Mighton an Ashoka Fellowship for Early Childhood Education and Education Reform in 2004. Mighton's work in both mathematics and the arts explores the interplay between the imaginative and the scientific, which Mighton believes have been wrongly portrayed as mutually exclusive. He is the author of *The Myth of Ability: Nurturing Mathematical Talent in Every Child* (2003) and *The End of Ignorance* (2007). He was awarded a postdoctoral Fellowship at the Fields Institute for Research in Mathematical Sciences in 2005. Born in Hamilton, Ontario in 1957, John Mighton holds a Masters in Philosophy from McMaster University and a PhD in Mathematics from the University of Toronto, where he is currently an Adjunct Professor. He was inducted into the Order of Canada in 2010.

JOHN MIGHTON

Plays:

Scientific Americans (1988)
Possible Worlds (1990)
A Short History of Night (1990)
Body and Soul (1994)
The Little Years (1995)
Half Life (2005)

Awards and Recognition:

Governor General Award
(1990, 1992, 2005)
Dora Mavor Moore Award
(1988, 1989)
Chalmers Award
(1992)
Ashoka Fellowship
(2004)
Postdoctoral fellowship, Fields
Institute
(2005)
Siminovitch Prize in theatre
(2005)
Order of Canada
(2010)

Books:

*The Myth of Ability: Nurturing
Mathematical Talent in Every Child*
(2003)
The End of Ignorance (2007)



Image credit: Chris Chapman

THE DIRECTOR

ANDREW SHAVER

Artistic Director, SideMart Theatrical Grocery

Directing Credits:

Stones in his Pockets (2011)
Krapp's Last Tape (Assistant Director, Long Wharf Theatre)
The Homecoming (Assistant Director, Stratford, 2011)
Gordon (2010)
For The Pleasure of Seeing Her Again (Assistant Director, Stratford)(2010)
Haunted Hillbilly (2009)
OOOO! (2008)
The Ballad of the Young Offender (2007)
The Dishwashers (2007)
American Buffalo (2006)

Acting Credits:

Whiteman's Whiskey Comedy Revue (2011)
Champ de Mars (2010)
Macbeth (Stratford 2009)
Cyrano de Bergerac (Stratford 2009)
Zastrozzi (Stratford 2009)



Source: www.sidemart.ca

Andrew Shaver is Artistic Director of SideMart Theatrical Grocery. Since SideMart's conception in the winter of 2006, Shaver has directed *American Buffalo*, *The Dishwashers* (Montreal Premiere), *The Ballad of the Young Offender*, *OOOO!* (English Language World Premiere), SideMart's original musical *Haunted Hillbilly* and the World-Premiere of Morris Panych's *Gordon*. Shaver was a member of the 2009 Stratford Festival acting company, performing in *Macbeth*, *Cyrano de Bergerac* and *Zastrozzi*. He spent the 2010 and 2011 seasons as a member of the festival's inaugural Michael Langham Conservatory for Classical Direction, assistant directing Chris Abraham on *For the Pleasure of Seeing Her Again* and Jennifer Tarver on *The Homecoming*, with Brian Dennehy. This past November Shaver again joined Tarver and Dennehy on *Krapp's Last Tape* at Long Wharf Theatre in New Haven. Recently, Shaver acted in SideMart's original *Whiteman's Whiskey Comedy Revue* as well as in Imago Theatre's 2010 production of *Champs de Mars*. Other directing credits include *Stones in His Pockets* at the Centaur Theatre in February 2011 and will close the Centaur's 2011-12 season with *Haunted Hillbilly* in May. Shaver sometimes works in film, TV, radio and has dabbled in French theatre with his friends in Montreal's Orbite Gauche (*Champs d'Honneur* and *Moeurs en Series, 1.0 & 2.0.*) He was also a founding member, performer and Artistic Director with the Montreal/Brooklyn-based creation ensemble SaBooge Theatre and is a graduate of Queen's University and Ecole Jacques Lecoq in Paris.

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Heartfelt gratitude to Serge Emile LeBlanc, Ph.D.

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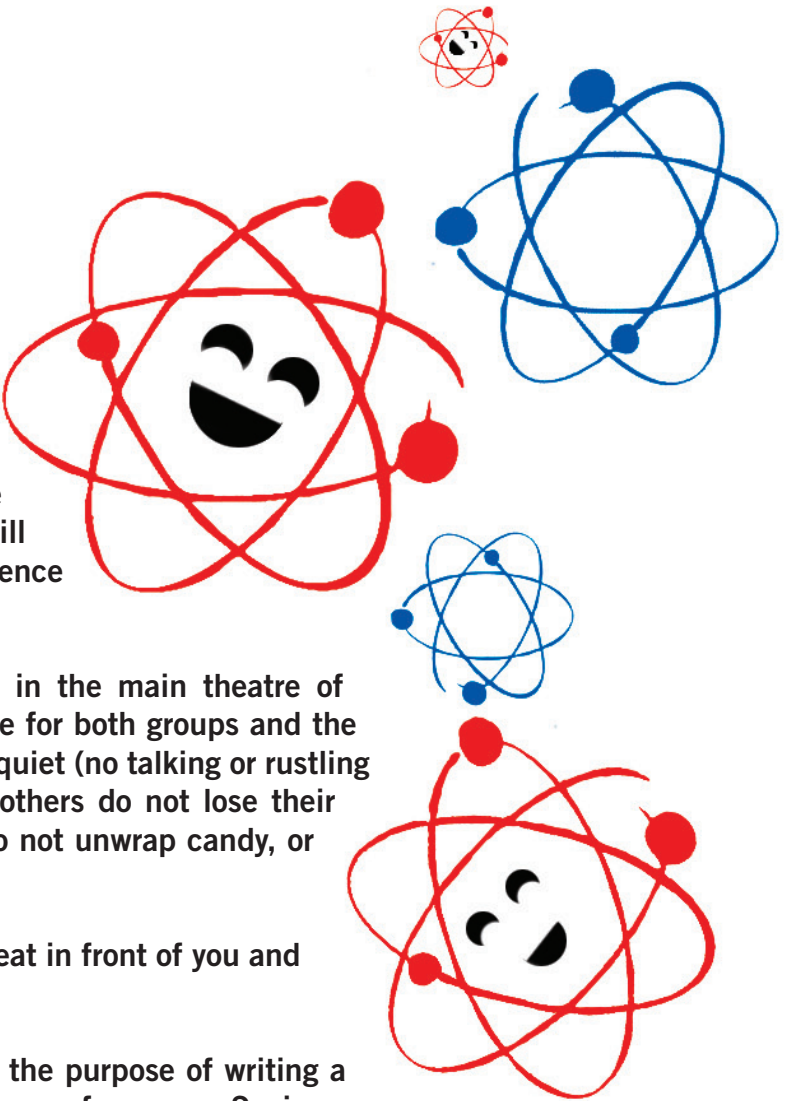
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THEATRE ETIQUETTE

Please take a moment to prepare your students or group for their visit to the Segal Centre. Explain to them what is meant by good theatre etiquette and why a few simple courtesies will enhance the enjoyment of the play for all audience members.

1. *Scientific Americans* will be performed in the main theatre of the Segal Centre. Performances at the Segal are for both groups and the general public. It is important that everyone be quiet (no talking or rustling of materials) during the performance, so that others do not lose their immersion in the “world of the play”. Please do not unwrap candy, or play with zippers or with your programme.
2. Do not put your feet on the back of the seat in front of you and please do not climb over seats.
3. If you plan to take notes on the play for the purpose of writing a review, please do not try to write them during the performance. Seeing you do this can be distracting for the actors. Please wait until intermission or after the performance is finished to write your reflections.
4. Use of phones or cameras is strictly prohibited inside the theatre. Absolutely no photos or video may be taken without the express consent of management. Composing or reading text messages is forbidden.
5. Use of cell phones, iPods, tablets, or other self-illuminating electronics is strictly prohibited in the theatre. The light from these devices is visible from the stage and in the audience. It is extremely distracting to the artists on stage and inconsiderate to your fellow audience members.
6. Your seat is only guaranteed until the moment the theatre doors close. Late entry is very disruptive; therefore if a patron is tardy we ask that they please follow the instructions of our front-of-house staff.

And...
ENJOY THE SHOW!



THANK YOU FOR YOUR FEEDBACK

FEEDBACK FORM FOR GROUP ORGANIZERS

It would be a pleasure to hear about your experience of bringing your group to the play.

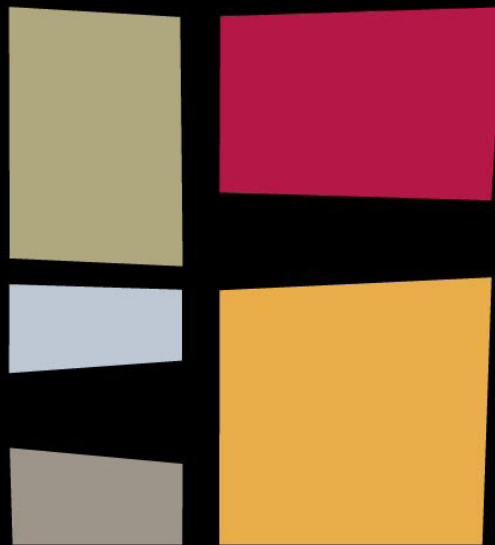
1. How would you rate your experience of bringing your group to the play?
Extremely positive 1 2 3 4 5 Extremely stressful
2. How much do you feel your group benefited from the experience?
Very much 1 2 3 4 5 Very Little
3. Would you recommend the experience to other group leaders?
Wholeheartedly 1 2 3 4 5 Never
4. Will you consider bringing a group to the theatre again?
Wholeheartedly 1 2 3 4 5 Never
5. What did you enjoy most about coming to see the play?

6. What aspect of coming to the theatre did you find problematic?

We welcome all additional comments.

Reply to:
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Segal Centre for Performing Arts
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