Strategies for Total Quality in Radiation Therapy

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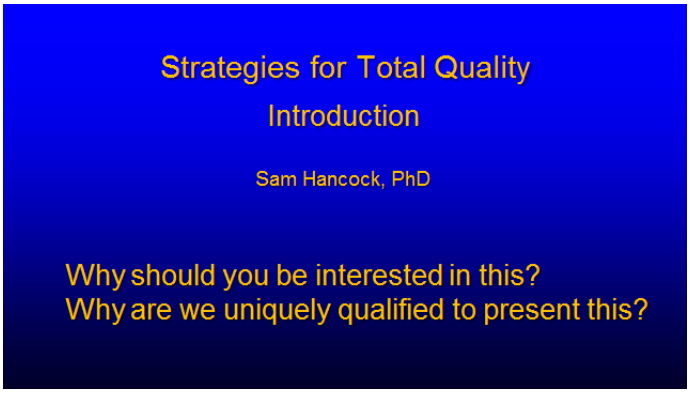
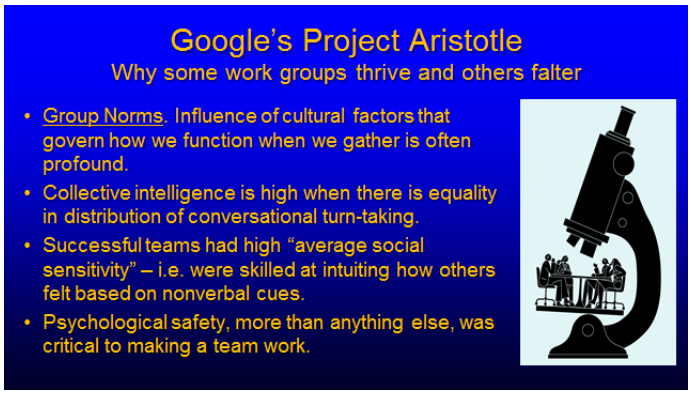


Introduction

Sam Hancock

This is an unusual topic for a medical physics conference, and so I want to first address two questions:

- Why is this subject worth considering?
- Why are we, Sam and Utahna Hancock, qualified to present this topic?

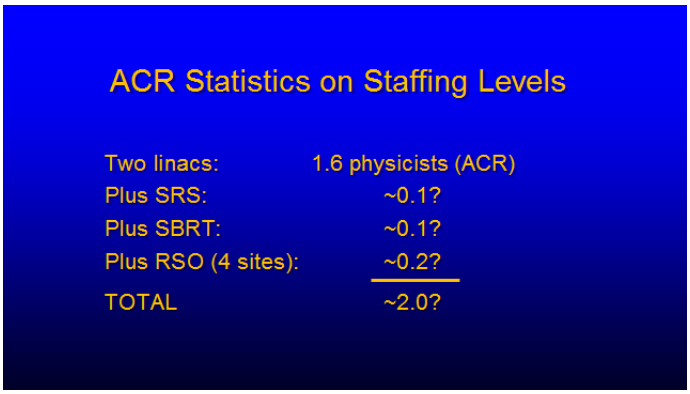


Google Corporation performed a study called Project Aristotle in 2014 of their thousands of work groups to determine why some groups thrive and others falter. (Duhigg, What Google Learned From Its Quest to Build the Perfect Team, 2016) (Duhigg, Smarter Faster Better: The Secrets of Productivity in Life and Business, 2016) They found that the influence of group norms is often profound. Group norms are the cultural factors that govern how we function when we gather together. They found that the collective intelligence of the group is high when there is equality in distribution of conversational turn-taking. Everyone doesn't necessarily talk equally about each topic, but in the end everyone contributes about equally. Successful teams had high "average social sensitivity," i.e. they were skilled at intuiting how others felt based on nonverbal social cues. And they found that psychological safety, more than anything else, was critical to making a team work.

Medical physicists, as we will explain later, have a lot in common with Google's programmers. They went into computer programming not because of their aptitude for social skills. In both cases, though, their success depends on the ability to collaborate successfully with members of a team. And that means fitting into the cultural norm. It means being able and willing to listen and to pay attention to social cues. It means promoting a culture of psychological safety where people don't fear speaking up when they have something to contribute. These attributes are typically not very strong among physicists and the skills are not taught in a medical physics training program.

Why am I qualified to present this topic. Is it because I have an exceptional aptitude for social skills? To the contrary, unless you mean exceptionally poor aptitude. However, I have achieved a notable level of success in spite of my low aptitude for social skills.

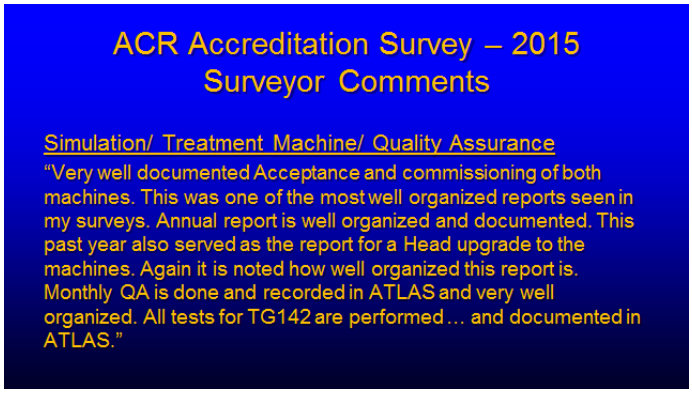
By some estimates, I'm performing a role that normally requires two physicists. Southeast Missouri Cancer Center, where I work, is accredited by ACR in radiation therapy. According to their statistics, the average accredited site with two linacs has 1.6 physicists. This does not include special treatment modalities or other duties. I'm RSO for Southeast Health with four locations of use on our NRC license. I estimate that 0.2 FTE is typically required to fulfill those responsibilities. SRS and SBRT each require about 0.1 FTE each. That totals about two FTEs.



How do I do that, and how well am I doing it, you might ask. How I do that is the subject of this presentation. How well is a question I will address now. It's difficult for a physics working alone to judge his performance objectively, so I look for external indicators.

For example, we passed an ACR accreditation survey recently in November, 2015. Some comments of the physicist surveyor are quoted here:

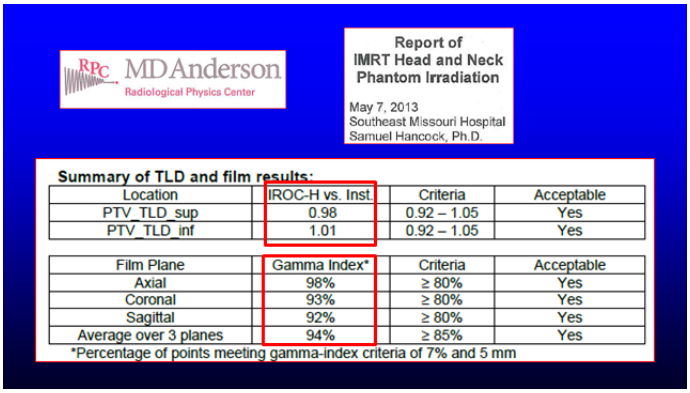
> *"Very well documented Acceptance and commissioning of both machines. This was one of the most well organized reports seen in my surveys. Annual report is well organized and documented. This past year also served as the report for a Head upgrade to the machines. Again it is noted how well organized this report is. Monthly QA is done and recorded in ATLAS and very well organized. All tests for TG142 are performed … and documented in ATLAS."*



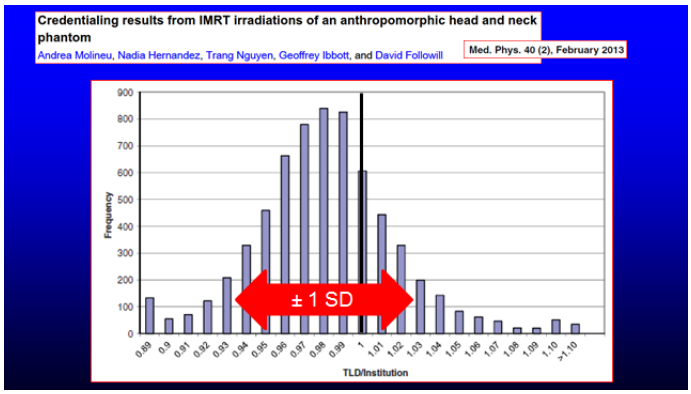
Commissioning two head upgrades is almost like commissioning two new machines, and yet I got the job done in an impressive manner. I must say, though, it wasn't easy.

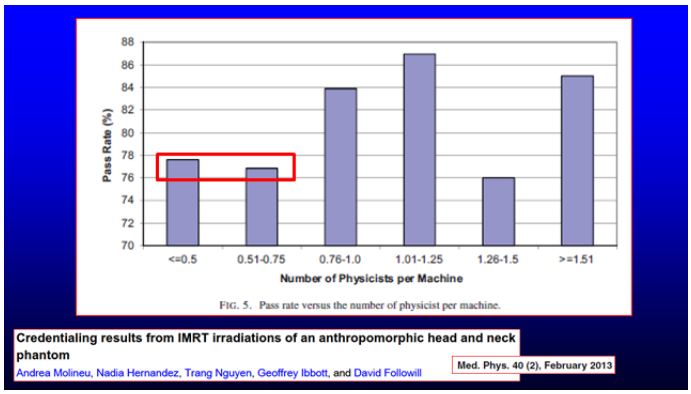
We participate in clinical trials, and we are required to pass the scrutiny of IROC, formerly known as RPC. Shown here are the results of our IMRT Head and Neck Phantom Irradiation in 2013. Our point dose calculations were within 2% of the TLD measurements. The Gamma Index pass rate was 94% average over 3 planes, compared to passing criteria of 85%.

How does that compare to others?

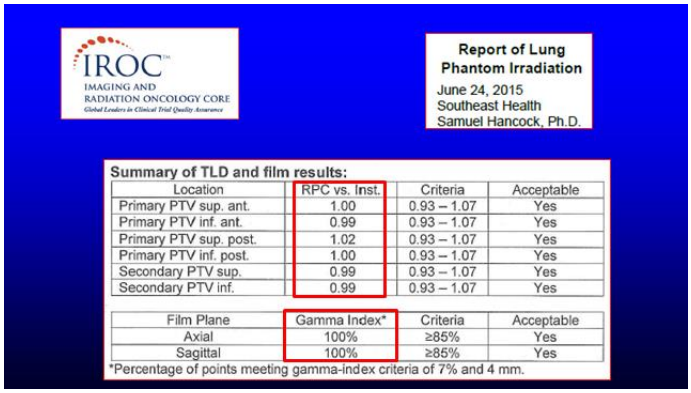


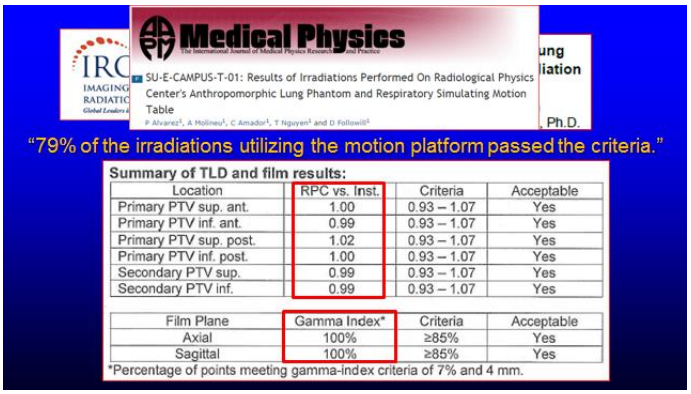
According to RPC in Medical Physics, 2013, one standard deviation in the distribution of relative TLD readings covered the range of 0.935 to 1.025. My results were better than the vast majority. The next figure shows that the pass rate for my level of staffing was about 77%.



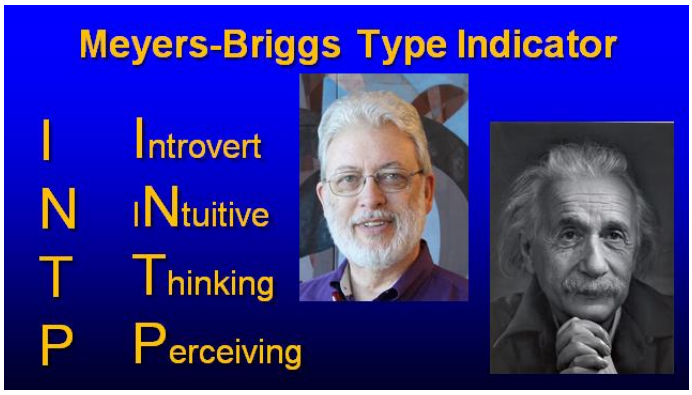


The figures here show the results of our IROC lung phantom irradiation with respiratory motion simulator. Our point dose calculations were within 2% of TLD measurements, and Gamma Index pass rates were 100%. Only 79% of irradiations of this phantom using the motion platform passed the criteria.





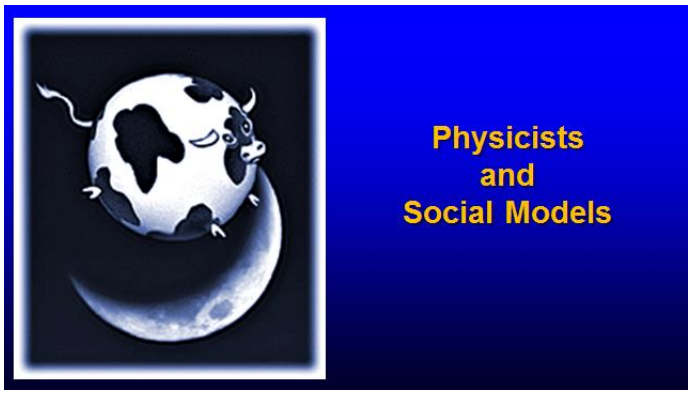
Utahna is going to explain about Meyers-Briggs Type Indicator (MBTI) and its relevance to the success of medical physicists. MBTI is a method for characterizing a subject's personality type. There are sixteen different personality types in this model. One personality type of notable interest for physicists is INTP. This stands for Introvert, Intuitive, Thinking, Perceiving. I have this personality type, as did Albert Einstein and many other physicists.



Asperger Syndrome (AS) is a cognitive neurological condition that shares a lot of characteristics with the Meyers-Briggs INTP personality. It has been suggested that Asperger Syndrome is an extreme case of INTP. There is a higher incidence of AS among physicists than the general population. Some AS characteristics give one advantages in the field of physics, but there are inherent limitations in the ability to process social information that limits effectiveness in a social milieu, both personal and professional. Albert Einstein is reported to have had Asperger Syndrome, and I clearly have strong Asperger characteristics that often cause me to struggle, especially in group social situations, such as the work groups studied in Google's Project Aristotle.

My difficulty was noticable starting at age five in first grade. My brain would simply stop processing the auditory information coming from the teacher's mouth. Repeatedly, I would be sitting quietly at my desk, completely clueless that I was probably supposed to be doing whatever the rest of the class was doing. I was always surprised to be called on by the teacher to leave the classroom and go see the principal.

It continued to happen in college. My Calculus 4 professor called on me to come to the board to demonstrate a problem-solving method that he had been teaching us. Class attendance was required, but I had not processed much of his auditory instruction, nor had I read that section of the book yet. I was totally clueless, and the professor was furious. I survived the encounter, though, and passed his class with the top grade of 97% by reading the text book.

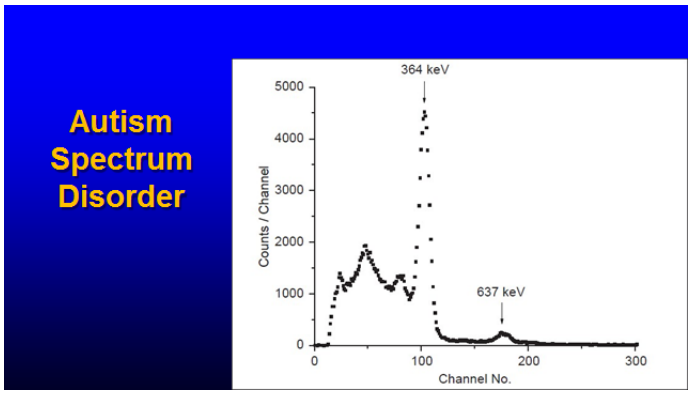


Physicists and Social Models: There is a story of a dairy farmer whose cows stopped producing. He tried everything he knew, including changing their feed, controlling the temperature of the dairy barn, and playing different kinds of music, all to no avail. He requested assistance from the local university extension service, and they formed a research group led by a theoretical physicist. After some time had passed, the leader of the group reported to the farmer with a solution to his problem. His report began with, "First we must assume a frictionless spherical cow."

Social problems are like that. There is no Unified Theory of Social Behavior. If there were, there would be so many variables, and so many dimensions to the problem, that it would impossible for me to apply the model in a cognitive fashion. During the course of my career, though, I have repeatedly noticed that other people with lower IQ than mine seem to know what's going on while I'm clueless. Now I have come to realize that neurotypical people perceive and understand things of a social nature intuitively, while I lack the perception and can understand only through deliberate cognition. I have been able to achieve a level of success by using a collection of relatively simple models of

social behavior that appeal to my intuition. I can explain these models to you, in spite of my limited aptitude for social skills, because I have had to learn to apply the models explicitly, while neurotypical people do it intuitively without needing to learn how they do it.

The criteria for diagnosis of Asperger Syndrome is controversial among mental health professionals. AS is defined in the DSM-V as a special case of Autism Spectrum Disorder, and the characteristic AS traits must be rather severe to make the cut for a diagnosis. However, it's of value to recognize that the spectrum of AS characteristics can have a significant effect on one's abilities without being severe enough for a diagnosis. Here is an analogy that helps me better understand Asperger Syndrome. The Asperger spectrum is analogous to the characteristic spectrum of a mix of radionuclides, whose relative abundance can be discerned by the relative heights of the photopeaks. The relative severity of an Asperger trait is analogous to the relative abundance of a nuclide in the mixture.



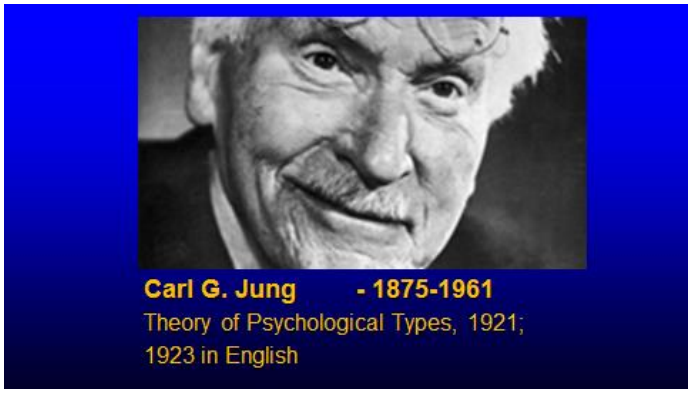
Utahna is perhaps uniquely qualified to present the next segment of this presentation to you. She is a practicing psychotherapist with master's degrees in Art Therapy and Mariage and Family Therapy. She has been studying me since age 10 when we began seven years of competing and collaborating on the clarinet in the school band. It's probably a testament to my lack of social skill that I missed the opportunity to marry her until 28 years later. At that time, I was not very socially skilled, but I had learned to be bold and quick. When we were reunited after 28 years, I thought it was remarkable that she was able to enlighten me about some of my personality traits that she knew from our youth.

A short anecdote will illustrate her perceptive abilities.

> We had been married three months. Her young adult daughter was visiting. I was driving them while they conversed in full duplex, talking and listening simultaneously. Since I have trouble processing auditory information under the best of circumstances, I zoned out and started thinking about how much it would cost to replace the carpet in the house that my ex-wife had vacated. As I was driving and silently calculating, converting square feet to yards, and so on, Utahna stopped talking, looked at me and said, "Oh, stop thinking about carpet." I was incredulous, but her daughter said, "Get used to it, Sam. She does that all the time."

Personality Types of Medical Physicists

Utahna Hancock



Jungian Theory and the Myers-Briggs Types Indicator Questionnaire

Carl Gustav Jung, often referred to as C. G. Jung, was a Swiss psychiatrist and psychotherapist who founded analytical psychology. In 1921, Jung published his theory of psychological types, in which he categorized people into primary types of psychological functions.

Katherine Briggs and Isabel Briggs-Myers

Katharine Cook Briggs was a college educated woman who researched and wrote essays on childhood educational and social development theories. At the age of 22, Katharine married a physicist named Lyman James Briggs. Born in 1897, Isabel was their only child to survive infancy.

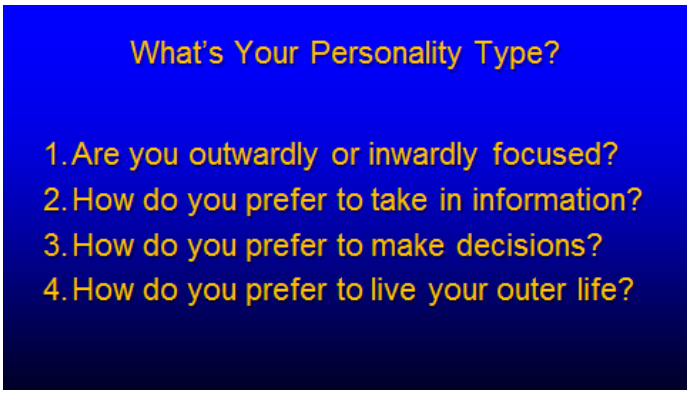
Katharine Briggs believed that children have an innate curiosity and that education is what fuels this natural instinct. Her earliest research led her to identify what she called four main personality types; meditative types, spontaneous types, executive types, and sociable types. In 1923, Katharine stumbled across C.G Jung's theory of psychological types, after which she abandoned her own theory and began to focus more in-depth, on the ideas of Jung.

Katharine introduced Dr. Jung's theory to her highly educated and now grown daughter, Isabel, and eventually convinced her to join in her efforts. The Myers Briggs Type Indicator questionnaire was first published in 1943, and in 1945, Katharine and Isabel, with the help of Lyman Briggs, ran the first assessment on George Washington Medical School students. Katharine Briggs was primarily the driving force and inspiration behind the creation of the Myers-Briggs Type Indicator (MBTI) and Isabel was the work force that created the 93 question paper and pencil questionnaire that we see today.

What's Your Personality Type?

The MBTI is based on four basic questions:

1. Are you outwardly or inwardly focused?
2. How do you prefer to take in information?
3. How do you prefer to make decisions?
4. How do you prefer to live your outer life?



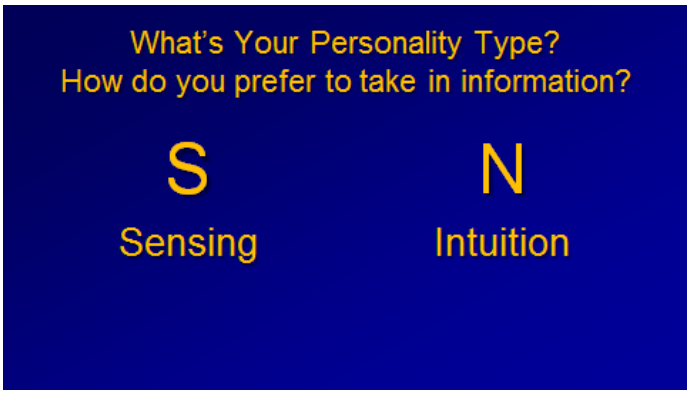
Katharine and Isabel built upon the research developed by Jung and came up with their own theory of psychological types showcasing 16 personalities.

Inward or Outward focus: **E** extraversion or **I** introversion.

The terms **E**, extraversion or **I**, introversion are often referred to as attitudes. In MBTI terms, an **extravert** is more interested in the outer world of people and things, and will talk through an issue or problem. An **introvert** is more interested in the inner world of ideas, and will be more likely to think through an issue or problem.

Taking in or processing of information: **S**, sensing or **N**, intuition:

Sensing prefers to receive data primarily from the five senses. **Intuitive** tends to focus on the future with a view toward patterns and possibilities. These people prefer to receive data from the subconscious, or seeing relationships via insights.



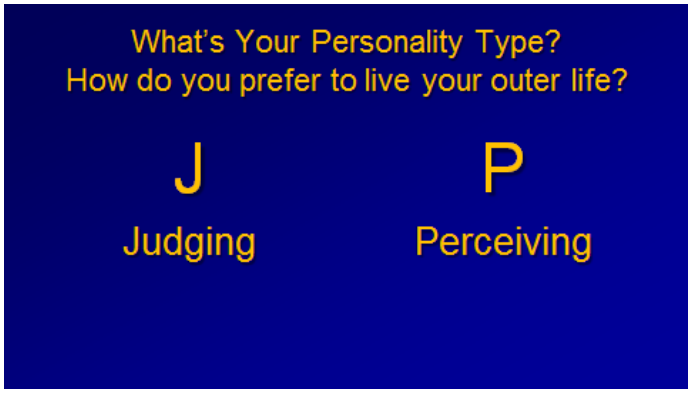
Making Decisions: **T**, thinking or **F**, feeling

Thinking people tend to base their decisions on logic "true or false if-then" connections, and on objective analysis of cause and effect. **Feeling** people tend to base their decisions primarily on values and on subjective evaluation of person-centered concerns. It could be said that thinkers decide with their heads, while feelers decide with their hearts. This is not to say that Thinkers are heartless, but it can be said that they are less prone to allow feelings or emotions to influence the decisions they make.

Dealing with the External World: **J**, judging or **P**, perceiving

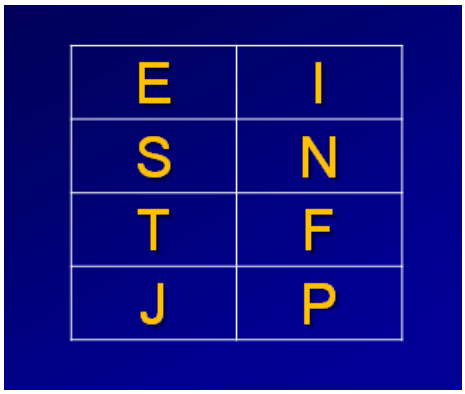
Judging types tend to like a planned and organized approach to life and prefer to have things settled.

Perceiving types tend to like a flexible and spontaneous approach to life and prefer to keep their options open.

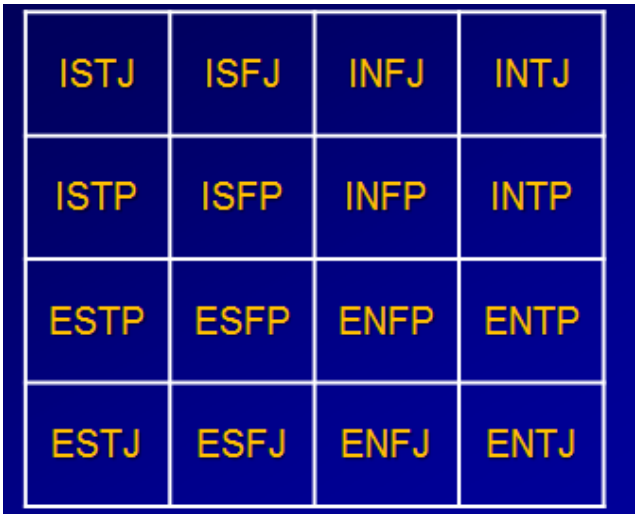


Type Dynamics

The interaction of two, three, or four preferences are known as type dynamics, and a four preference combination, like INFP or ESTJ, for instance, is called a type. In total, there are 16 unique types, and many more possible two and three letter combinations, in which each have their own descriptive name. Additionally, it is sometimes possible to observe the interactions that each preference combination will have with another combination, although this is more unorthodox. Complete descriptions will contain the unique interactions of all four preferences in that person, and those are typically written by licensed psychologists based on data gathered from thousands of interviews and studies.



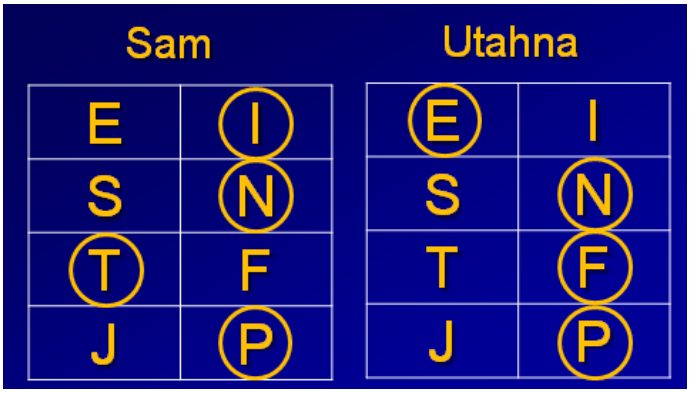
The Sixteen Types

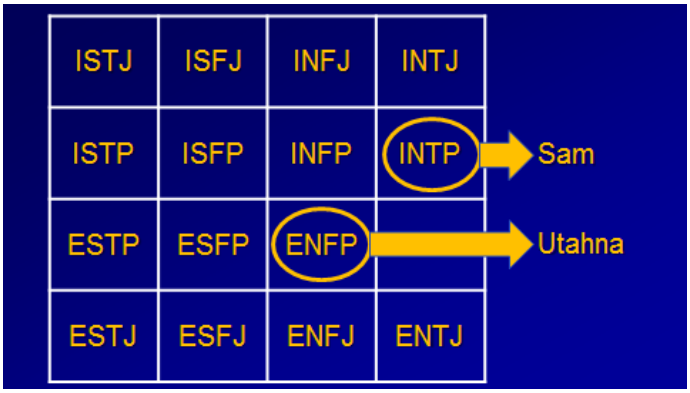


Sam and Me

Sam's type is **INTP**: **I**ntroversion, I**N**tuitive, **T**hinking, and **P**erceiving

Utahna's type is **ENFP**: **E**xtraversion, I**N**tuitive, **F**eeling, **P**erceiving.





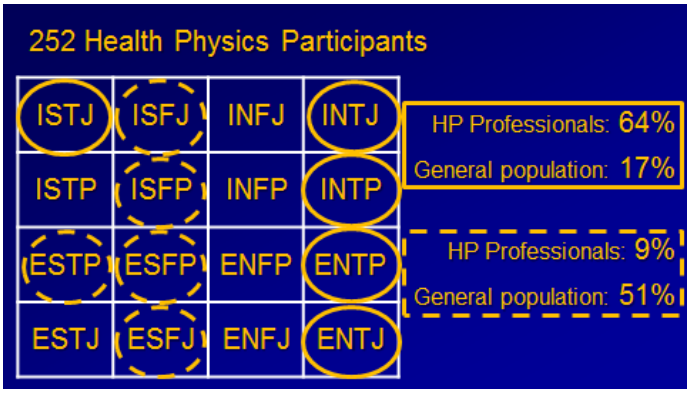
INTP's make up about 4% of the population. Although typically INTP's prefer to work alone, and do not necessarily prefer to work with others, they can do so.

- INTP's can identify problems and envision the best ways to solve them.
- INTP's have the rare ability to consider both theoretical ideas, as well as the practical implications.
- They have been known to enjoy pointing out flaws in others' logic and plans. This can make them come off as harsh and insensitive to others; particularly their subordinates, so they must remind themselves to consider the feelings of others, rather than focusing solely on finding potential problems, and to let others know how appreciated they are, which is something INTP's often forget to do because
- their minds are always on **un**emotional issues.
- Once something catches an INTP's interest, he or she usually becomes an expert quickly and will often reach the top of their field.
- They make good photographers, mathematicians, professors, computer programmers, systems analysts, technical writers, physicists, or engineers.

ENFP's make up about 7% of the population. Because our focus is about physicists, very little will be said about this type, except to report that more individuals in the field of psychotherapy, counseling, and clinical psychology have the type ENFP than the other MBTI types

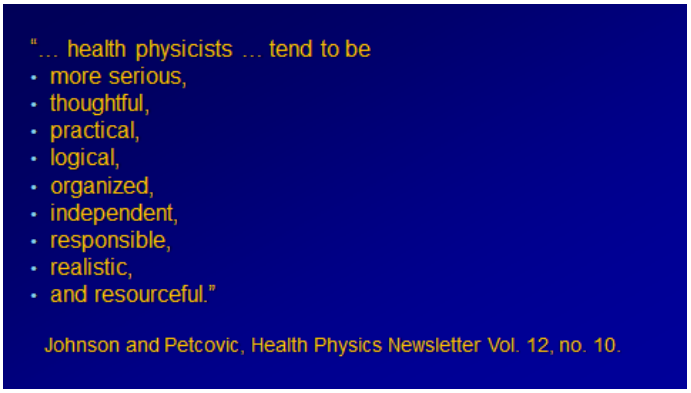
Study of Personality Types of Health Physics Professionals.
(Johnson & Petcovic, 1983-84)

In a study of 252 health physicists who participated in a MBTI study conducted by the Baltimore Washington Chapter and the Communication Sciences Institute, 62 to 75 percent exhibited a strong preference for I, N, T, and J. Moreover, of the 16 possible MBTI types, five types account for 64 percent of all radiation protection professionals: ISTJ, INTJ, ENTJ, INTP, and ENTP. In contrast, five other categories (ISPJ, ESFJ, ISFP, ESFP, and ESTP) exhibited by 51 percent of the general public, are represented by only nine percent of the health physics profession.



Findings indicate that in general, health physicists tend to be

- More serious
- Thoughtful
- Practical
- Logical
- Organized
- Independent
- Responsible
- Realistic
- And resourceful
  (Johnson R. , Challenges in Communication - Know Thine Own Self First, 1984)



The majority of health physicists tend to be less people-oriented and less feelings-oriented. As was stated previously, however, they generally prefer to make decisions and communicate on the basis of analytical thinking rather than on how they feel or how others may feel. Because many people that health physicists work with do not have the same preferences, this can be problematic.

The Myers-Briggs studies clearly point the way for health physicists to develop more effective communication skills for dealing with the public. Namely, health physicists might do well to tune in to the public's preferred sensing-feeling wavelength. Since these styles are least developed in the field of health physics, they represent the areas for greatest learning and growth potential. Health physicists should recognize, however, that for a dominant intuitive-thinker, to function effectively in the sensing-feeling world will be very difficult; kind of like trying to write with the non-dominant hand. The development of skills in the sensing-feeling domain is not recommended for everyone, especially not for the younger members of your profession, who may not yet be comfortable with their primary styles. Many people will not achieve that facility until age 40 or later. Even then, the development of skills opposite to your preferred style will require considerable energy.

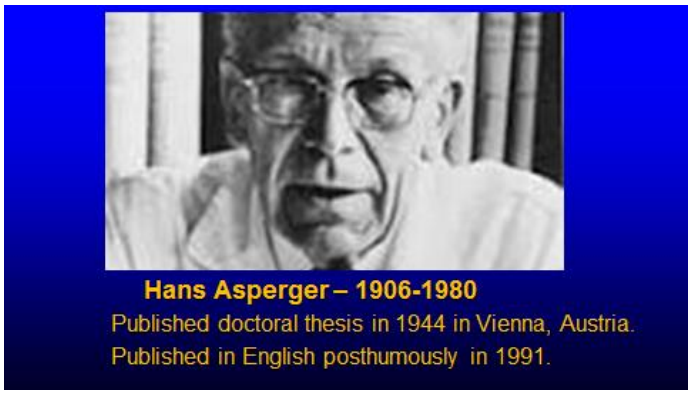
The way to begin putting some thought and effort into using your opposite styles, may be to, start trusting your feelings and start being concrete and specific about risk analyses. You may take a few

bumps in the process, but they will be no worse than the knocks you took in developing your primary style. Some of you are willing to take the initiative and will devote the energy to expanding your communication skills

Physicists and Asperger Syndrome

Sam has already informed you that he has Asperger Syndrome, and has stated that he thinks there may be many others in the field of health physics who also have similar characteristics to his.

Hans Asperger was a Viennese child psychologist who, as a child, exhibited features of the very condition named after him. He was described as a remote and lonely child, who had difficulty making friends. He was talented in language; in particular he was interested in a particular Austrian poet, whose work he would frequently quote to his uninterested classmates. He published his first definition of Asperger Syndrome in 1944, which he described as a very high functioning form of Autism, based on investigations of more than 400 children. His findings were not published in English until 1991.



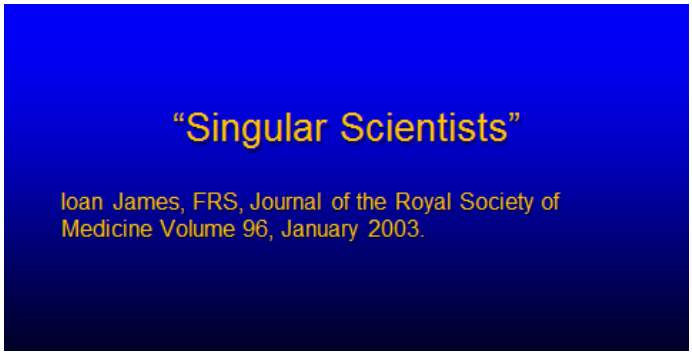
Of his findings, Asperger wrote, “To our amazement, we have seen that autistic individuals, as long as they are intellectually intact, can almost always achieve professional success, usually in highly specialized academic professions, often in very high positions, with a preference for abstract content. We found a large number of people whose mathematical ability determines their professions; mathematicians, technologists, industrial chemists, and high ranking civil servants.”

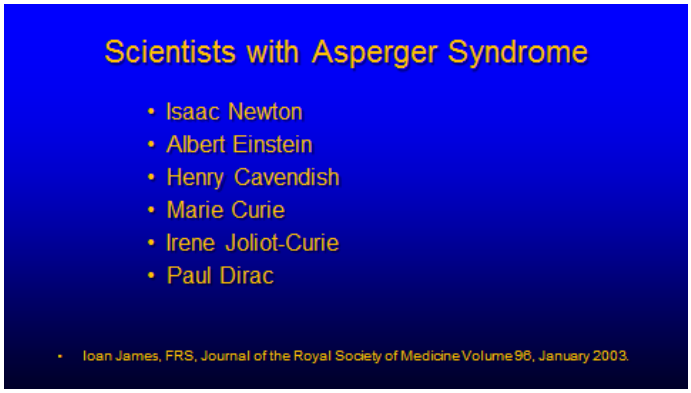
Singular Scientists

Ioan James, FRS, Journal of the Royal Society of Medicine Volume 96, January 2003

According to an article entitled, Singular Scientists, published in 2003 by Ioan James in the Journal of the Royal Society of Medicine, people who have Asperger characteristics are quite common in the general population, but it is not fully appreciated how many well-known people in the arts and sciences had the Asperger syndrome. (James I. M., 2003)

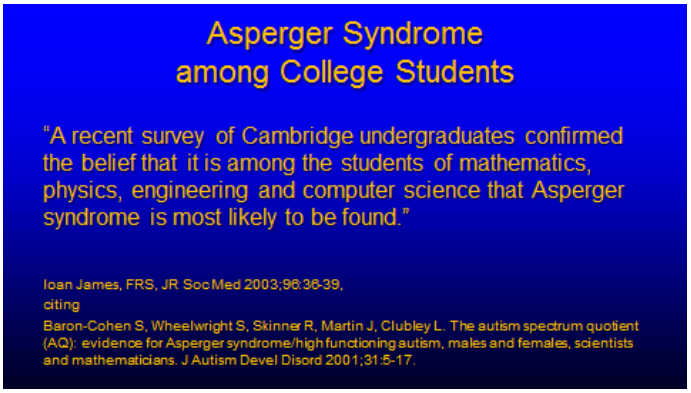
Several possibilities he named are Isaac Newton, Albert Einstein, Henry Cavendish, Marie Curie, her daughter Irene Joliet-Curie, and Paul Durac. Some that James did not mention are Thomas Jefferson, Thomas Edison, Andy Warhol, Dan Akroyd, Susan Boyl, and Bill Gates.





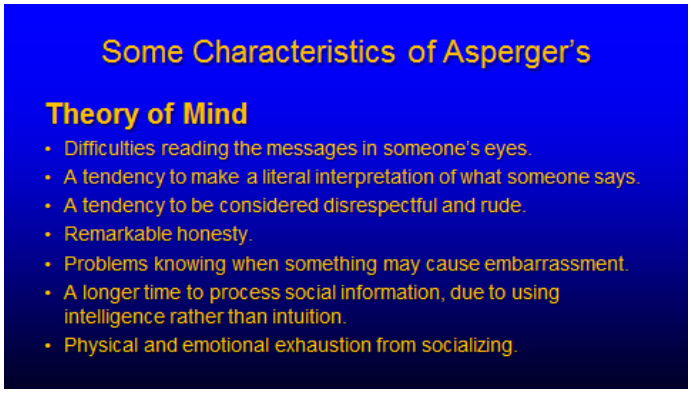
Asperger Syndrome among College Students

According to Ioan James, a survey of Cambridge undergraduates confirmed the observation that it is among the students of mathematics, physics, engineering and computer science that Asperger Syndrome is most likely to be found.



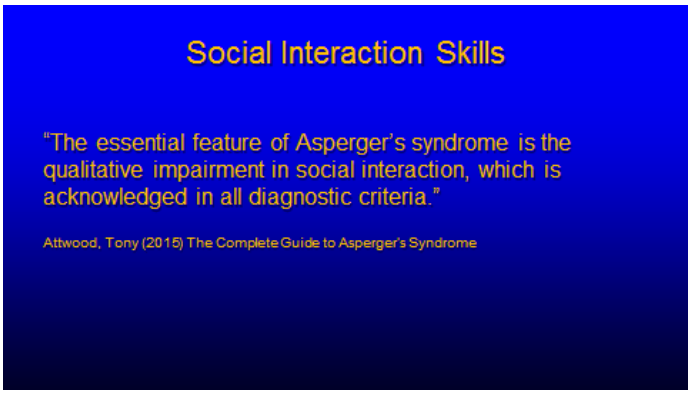
Some Characteristics of Asperger's

- Difficulty with **Theory of mind** (the ability to attribute mental states — beliefs, intents, desires, pretending, knowledge, etc. — to oneself and others and to understand that others have beliefs, desires, intentions, and perspectives that are different from one's own.)
- Difficulty reading the messages in someone's eyes
- A tendency to make a literal interpretation of what someone says
- A tendency to be considered disrespectful and rude
- Remarkable honesty
- Problems knowing when something may cause embarrassment
- A longer time to process social information, due to using intelligence rather than intuition
- Physical and emotional exhaustion from socializing



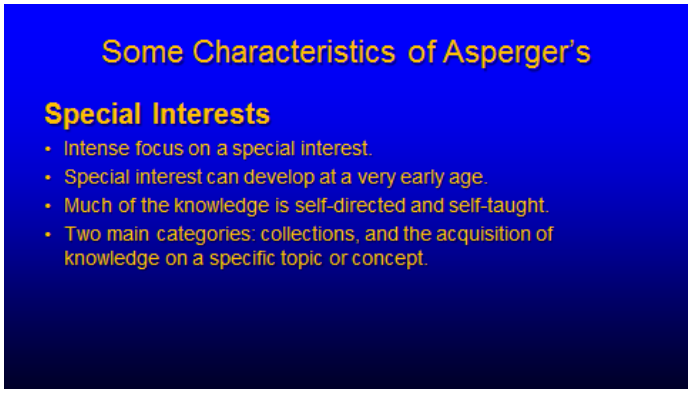
Social Interaction Skills

According to Tony Atwood in The Complete Guide to Asperger's Syndrome, the essential feature of Asperger's syndrome, as it relates to social skills, is a qualitative impairment in social interaction. (Attwood, 2007)



Special Interests

- Intense focus on a special interest
- Special interest can develop at a very early age
- Much of knowledge is self-directed and self-taught
- Two main categories: collections, and the acquisition of knowledge on a specific topic or concept

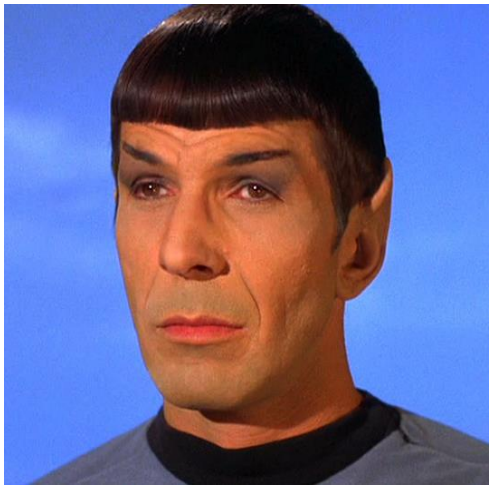


In the sketch from The Big Bang Theory, Sheldon displays a special interest about which he loves to talk. He seems oblivious to the fact that Amy does not share his interest. Having difficulty picking up on voice inflection and social cues, Sheldon also seems oblivious to Amy's sarcasm. A person with Asperger Syndrome may find little humor in this segment because he or she just doesn't get it.

On more than one occasion, I have accused my husband of being like Mr. Spock:

- Logical to a fault
- Can keep a cool head under pressure
- Will not allow emotion to stand in the way of "clear headed" thinking
- Is highly intelligent
- Does not understand the negative opinions of others

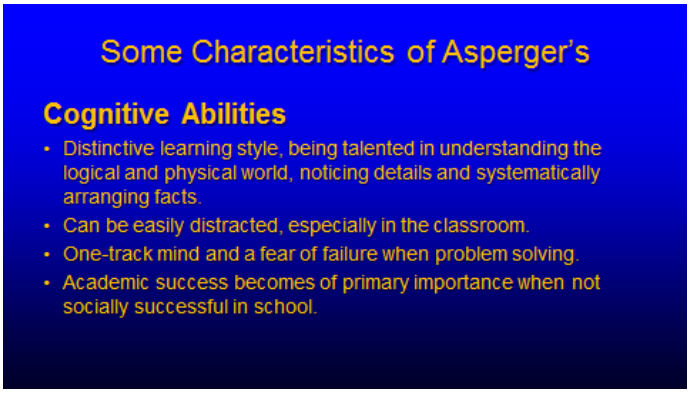
Unlike Sam, however, Spock is a man of few words.



Some Characteristics of Asperger Syndrome (Cont.)

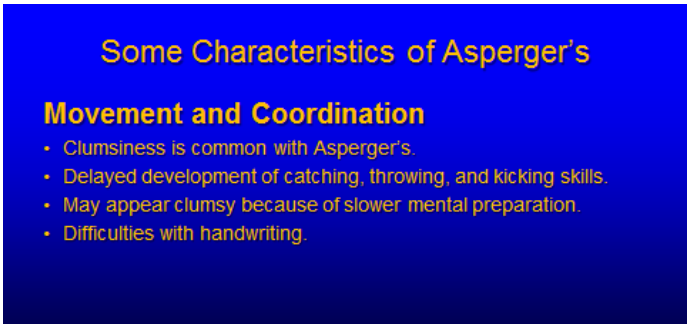
Cognitive Abilities

- Distinctive learning style, being talented in understanding the logical and physical world, noticing details and systematically arranging facts.
- Can be easily distracted, especially in the classroom
- One-track mind and a fear of failure when problem solving
- Academic success becomes of primary importance when not socially successful in school



Movement and Coordination

- Clumsiness is common with Asperger's
- Delayed development of catching, throwing, and kicking skills
- May appear clumsy because of slower mental preparation
- Difficulty with handwriting



Emotional Issues

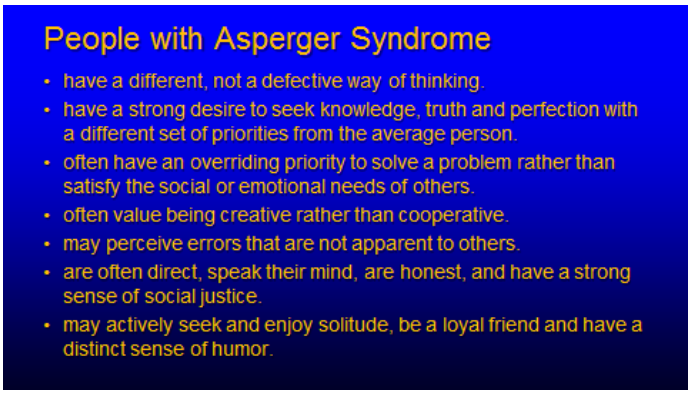
- Delayed emotional maturity
- Difficulty describing emotion and expressing love and affection
- Higher incidence of depression and anxiety disorder

Sensory Sensitivity

- Increased sensory sensitivity to specific sounds, tactile experiences, light intensity, or taste and texture of some foods
- Under-reaction or over-reaction to pain and discomfort

People With Asperger Syndrome

Although my Myers-Briggs Type Indicator of ENFP is represented by 7% of the population, in the world of those who have Asperger Syndrome, I am identified as a neuro-typical. I and many others who know and love people who have symptoms of Asper Syndrome see these positive things about them.



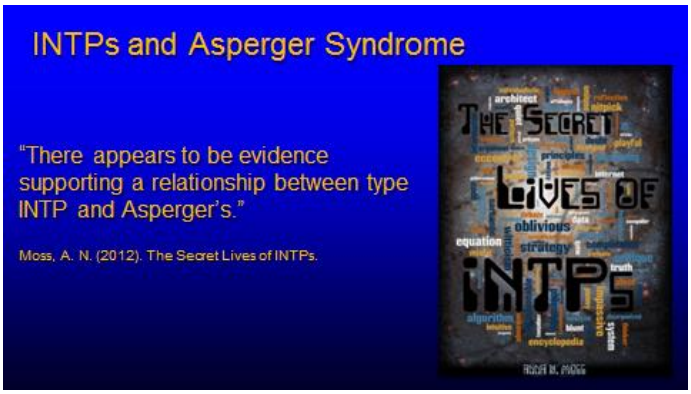
People with Asperger Syndrome:

- Have a different, not defective way of thinking
- Have a strong desire to seek knowledge, truth and perfection with a different set of priorities from the average person
- Often have an overriding priority to solve a problem rather than satisfy the social or emotional needs of others
- Often value being creative rather than cooperative
- May perceive errors that are not apparent to others
- Are often direct, speak their mind, are honest, and have a strong sense of social justice
- May actively seek and enjoy solitude, be a loyal friend and have a distinct sense of humor

In his 2014 book Zero to One, Peter Thiel and his co-author Blake Masters write: (Thiel & Masters, 2014)

"The hazards of imitative competition may partially explain why individuals with an Asperger's-like social ineptitude seem to be at an advantage in Silicon Valley today. If you're less sensitive to social cues, then you're less likely to do the same thing as everyone else around you. If you're interested in making things or programming computers, you'll be less afraid to pursue those activities single-mindedly and thereby become incredibly good at them. Then when you apply your own skills, you're a little less likely than others to give up your own convictions; this can save you from getting caught up in crowds competing for obvious prizes." (Baer, 2015)

This segment of Strategies for Total Quality began with Myers-Briggs Type Indicator, and end with a short tutorial on Asperger Syndrome, because, there appears to be evidence supporting a relationship between type **INTP** and Asperger's. This does not mean that if an individual has a MBTI of INTP that he or she will necessarily have Asperger's, even though there is a strong possibility that if someone has Asperger's he or she is more likely to have an MBTI of INTP. (Moss, 2012)



It has been observed that among health physicists, there is a larger percentage of those who have MBTI profiles in which the the **N** – or intuitive preference for taking in information is coupled with the **T** – thinking preference for making decisions. Although there are sure to be **F**eelers among those in the field of health physics, there are likely to be fewer of them who make decisions based on feeling rather than thinking.

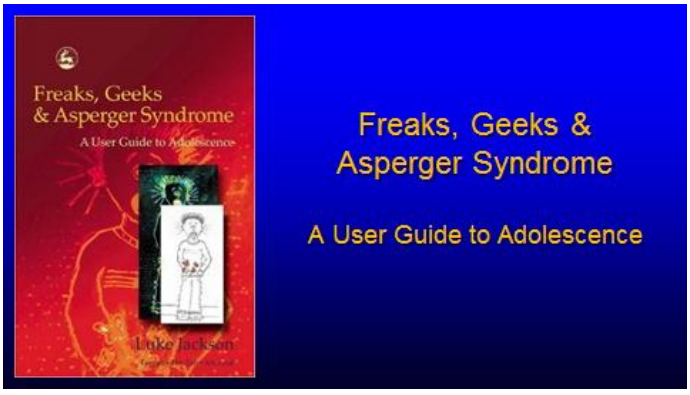
ISTJ	ISFJ	INFJ	**INTJ**
ISTP	ISFP	INFP	**INTP**
ESTP	ESFP	ENFP	**ENTP**
ESTJ	ESFJ	ENFJ	**ENTJ**

Two fourteen year-old boys are shown in the inset. Sam Hancock is now a medical physicist. Luke Jackson is the author of at least three books about Asperger's. Both have Asperger Syndrome.

Sam Hancock was a first wave baby boomer, who was born in Phoenix , Arizona, because that was where his military father was stationed at the time of his birth. Before the sixth grade, Sam had attended 7 different schools. Sam was a quiet and obedient child, who spent a great deal of time day dreaming in class because he was easily distracted and found it to be stressful and confusing to process verbal instruction. He was remarkably intelligent, however, and loved to read, which is how he learned. In fact, he often found sitting in class to be an excruciating experience, and in college attended his undergraduate, graduate, and medical school classes only because he was required to do so.

Luke Jackson was born in England in 1988. Luke is one of seven children raised by a single mother. Luke, at the ripe age of 14 wrote a book, entitled, Freaks, Geeks, & Asperger Syndrome A User Guide to Adolescence, about what it is like to have Asperger Syndrome. (Jackson, 2002)

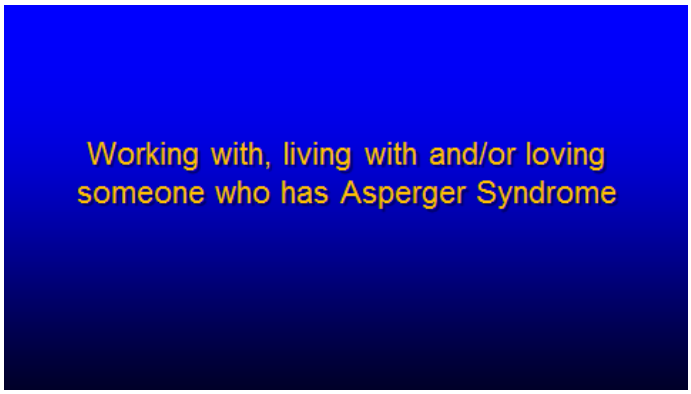
Here are two quotes from Luke's book:



"I suppose I am very pedantic and speak slowly and monotonously. My sisters often tell me stuff like this! I am told that I have a problem with communication because I do not know when I am boring someone."

"The very heart of AS is that we are not able to decipher other people's thoughts, feelings and motivations – we can't put ourselves in their shoes."

One of the Radiation Oncologists who worked with Sam Hancock once said that he learned very early in their working relationship, that if he asked Sam a question, he should be prepared to stand and listen to the answer for a very long time, because Sam always made it worth his while.



When Sam told his wife that they would be speaking for two hours, she knew immediately that regardless of how she might feel about it, getting to speak about something in which he has a special interest would be heaven for him.

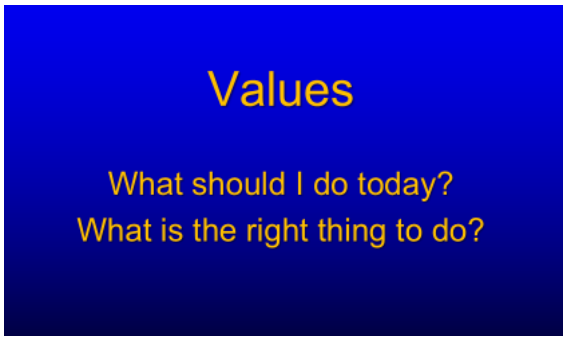
In the world of people who are i**N**tuitive **T**hinkers (NT's), and particularly in the world of the higher than average percentage of health physicists whose MBTI is INTP's, it is good to have a friend or companion who understands. Sam Hancock married a neurotypical person who is a trained listener, and that is a good quality for the spouse of a person who has Asperger Syndrome

Strategies
Sam Hancock, PhD

Physicist's Primary Role – Assure Quality

You need to have some basis for deciding what you should do at any given time. You need to be purpose driven. When I walk in the door of the cancer center every day, my purpose is to contribute to quality of care.

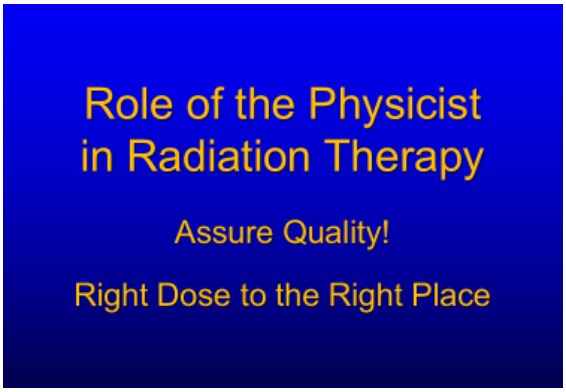
Ok! That sounds simple. Provide quality of care! But still, that leads to the question, "How do I do that?" How do I know what's the right thing to do now, next, today? The answer to that comes down to a question of values. Not moral values, but ethical values. By values, I mean how do you rank the various choices of what to do today?



In health care, the ultimate value is the quality of care of the patient. But what do we mean by "quality"?

W. Edwards Deming (Deming, 1982) taught us that quality means consistently providing the customer with what he needs, but not necessarily what he thinks he wants.

The role of the physicist in radiation therapy is to assure quality for the patient. The necessary condition for quality of care is to give the right dose to the right place – every time. We rely on the radiation oncologist to tell us what the right dose is, and what the right place is. Our responsibility is to assure that the patient receives that.



This is a broader responsibility than most people in radiation therapy grant to the physicist. And therein lies some of the challenges. I'm going to talk about some of those challenges and share the strategies that I have found to be effective in meeting the challenges.

Quality Assurance

I'll divide the topic of quality assurance into two categories: Facilities and Processes. Let's start with Facilities.

Facilities

QC of Equipment Performance is a necessary, but not sufficient, component of quality assurance.

Strategy: Tools – Not Rules

Let's consider first, the strategy: "Tools – Not rules!"

AAPM Task Group Reports are guidelines. They're not a recipe for assuring quality. The members of the task groups, astute as they are, cannot envision every possible combination, or application, of current technologies, much less the technologies that have not been developed. You have to exercise professional judgment. Your responsibility is to determine what must be done to ensure that anything that could go wrong doesn't adversely quality of care.

Radiation therapy technologies continue to become increasingly complex. We must have efficient ways to test this complex equipment, and that requires good tools. Not the tools of yesterday, but the tools of today that match the complexity of today's treatment technologies.

Health care costs are growing at an unsustainable rate, and physics staffing is expensive. If you can increase efficiency and avoid adding an additional physicist by spending $150,000 on good physics tools, then you could save about a million dollars over the seven year life of the equipment. This can be a compelling justification for a generous budget for physics tools.

Strategy: Delegate!

Now, let's consider the Delegate strategy

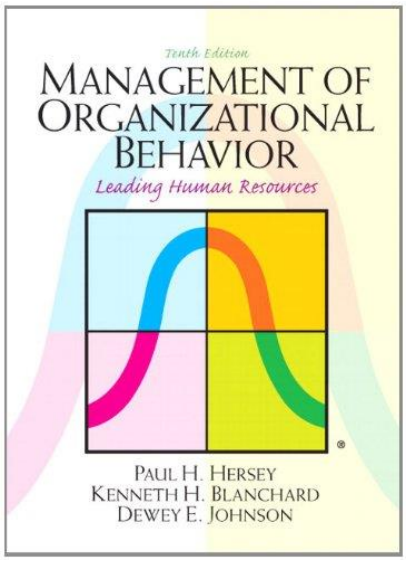
Put extra time into developing simple and efficient QA processes. And then delegate responsibility for the QA task to the lowest level employee capable of performing the task reliably. My rule of thumb is, if you can't get the right result by doing the procedure wrong, then you can delegate it.

The role of the physicist is to provide oversight and perform a timely review of the results and take corrective action. The physicist is responsible for quality assurance, but he doesn't have to personally perform the QA tasks.

Delegation is the right thing to do, because it lowers cost by shifting duties to lower paid staff.

Delegation increases the value of the delegate employees by giving them higher-level tasks to perform. It increases the value of the physicist by freeing him to focus on those problems for which he is uniquely suited and qualified.

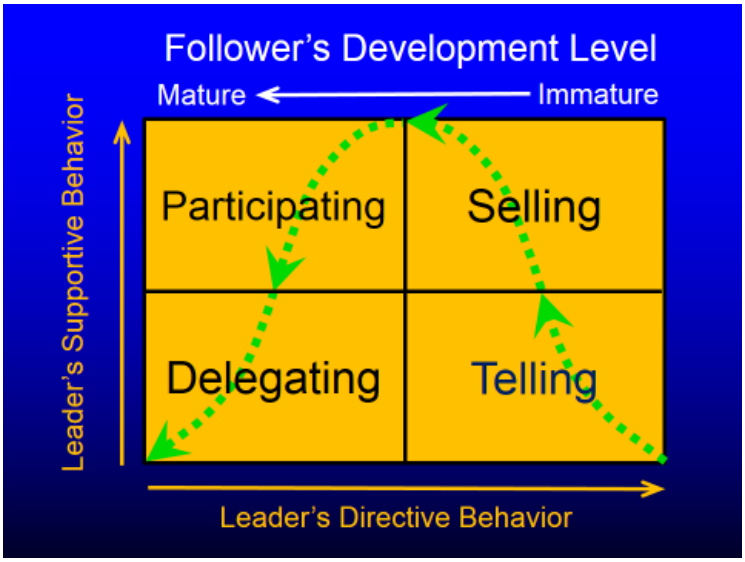
Situational Leadership – A model for effective delegation



Now, as you know, delegation involves managing people. In case you haven't recognized it, most of us didn't go into physics because of our aptitude for understanding interpersonal relationships. We have to work at it, and most of us work best with a simple model. Situational Leadership (Paul H. Hersey, 2012) is a model for effective delegation that has worked quite well for me for about 30 years

Situational Leadership is based on a simple model that was devised by Hersey and Blanchard. That model has developed into a large body of work, like in the 10th Edition of "Management of Organizational Behavior." Unless you are pursuing a Masters of Business Administration, I don't think you need everything in this book. But an understanding of the basic model has helped me many times over the years.

The concept and application of Situational Leadership can be illustrated with one figure. The horizontal axis is the leaders' directive behavior. The vertical axis is the leader's supportive behavior.



In this model, the leader's directive behavior depends on the follower's development level with respect to the particular task or responsibility to be assigned. As you can see at the top of the figure, the leader's directive behavior is in inverse proportion to the follower's maturity with respect to the specific task or responsibility.

For simplicity, the graph is divided into four quadrants, each representing a leader's mode of supervision. For a follower starting out with a new task assignment, we start in the lower right quadrant with the telling mode. We tell him simply what to do, how to do it, and when to do it.

As he demonstrates ability and willingness to do the task as assigned, follow the curve toward the upper right quadrant – the selling mode. We start reducing the directive behavior and increase the supportive behavior. In this mode, we start explaining why we do things the way we do. My most frequent error is to start out at selling, and the follower doesn't yet have a foundation to understand the reasons until he has experienced the performance of the task.

As the follower begins to gain understanding, we follow the curve to the upper left quadrant -- the participating mode -- continuing to decrease the directive behavior. In the participating mode, we take opportunities to ask the follower how he would propose to deal with a particular existent situation. That gives the leader the opportunity to test the follower's understanding and give him redirection where needed.

As the follower demonstrates an increasing grasp of the task or responsibility, we move toward the lower left quadrant – the delegating mode -- in which we assign primary responsibility to the follower

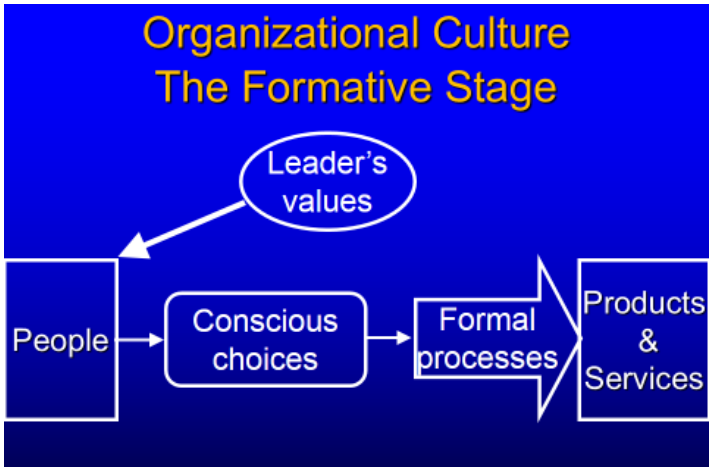
but continue to monitor his performance. As he continues to demonstrate competence and maturity in the independent performance of the task or responsibility, we reach the ultimate goal of delegation.

Processes

Let's consider now the topic of Processes.

QC of equipment performance is not enough if people are not following effective processes.

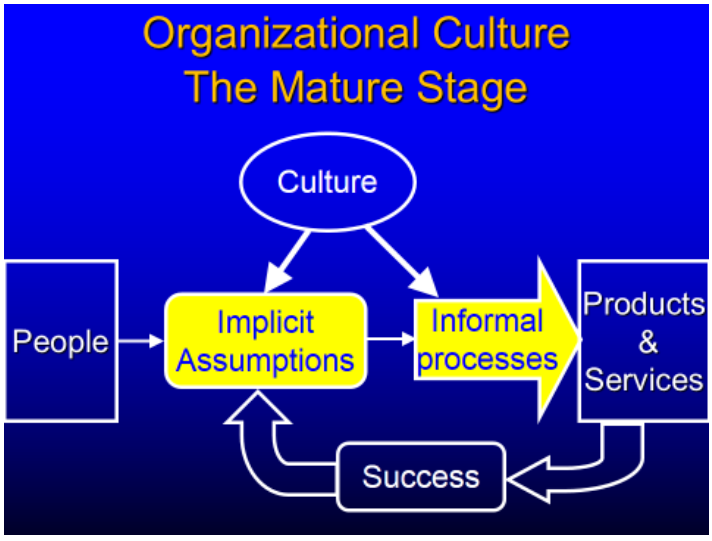
Assuring quality in radiation therapy requires a culture of process improvement. All the industrial engineering approaches to quality, like TQM, CQI, Lean, Six Sigma, and Lean Sigma, all started with W. Edwards Deming, the father of modern quality assurance who developed Total Quality Management. (Deming, 1982)



For Total Quality Management to work in radiation therapy, it can't be something that the Quality Management Department does. Or something that hospital management does. It must be a part of the culture of the organization, including the radiation therapy staff.

Let me explain what I mean by the culture of an organization.

A cohesive culture starts with a leader's ethical values. In the formative stage, people make conscious choices based on the leader's values. These choices lead to formal processes for the products and services of the organization.

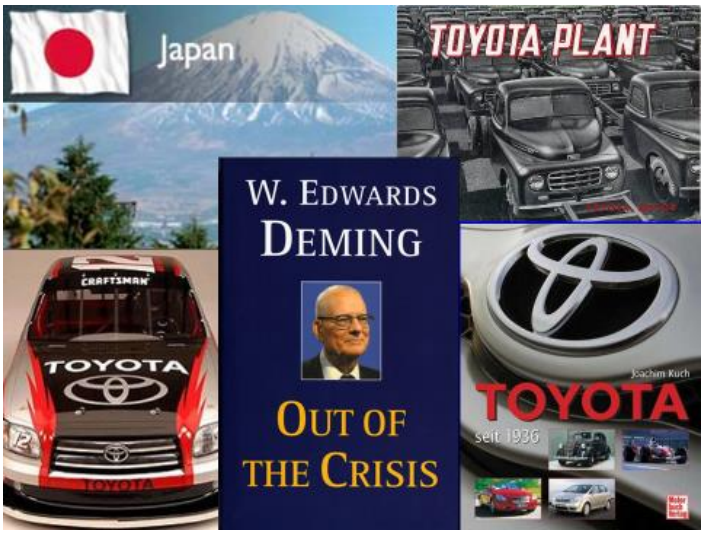


And then, if the people in the organization experience success, they feel encouraged to continue along that path. Over time decisions begin to be made based on implicit assumptions rather than conscious choices, and informal processes develop that are implicitly based on the leader's values.

And now we reach the mature stage where people can work autonomously while the leader goes fishing.

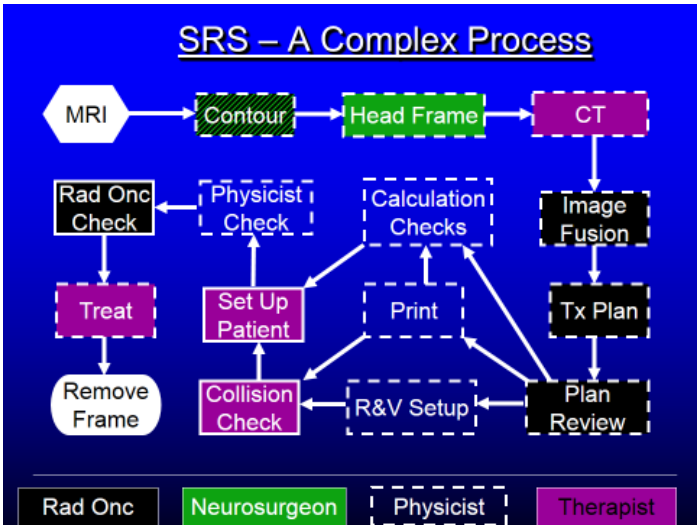
The combination of those implicit assumptions and informal processes is what I mean by culture. When you hear someone say, "I don't know about where you came from, but that's not the way we do things around here," it's all about the culture. Once established, an organization's culture tends to be self-perpetuating. And a culture is very hard to change.

Total Quality Management



Dr. W. Edwards Deming was an American physicist who developed Total Quality Management prior to World War II as a means of continuously improving quality while simultaneously reducing cost. After the war, General Douglas MacArthur, who was the U.S. commander of post-war Japan, invited Dr. Deming to introduce Japanese industrial leaders to Total Quality Management. Japan went on to become a global leader in many industries through the persistent application of Total Quality Management, while U.S. industries didn't begin to adopt TQM until the 1980's. Now, Total Quality Management has been widely adopted in U.S. health care, where it is known as CQI, or Continuing Quality Improvement.

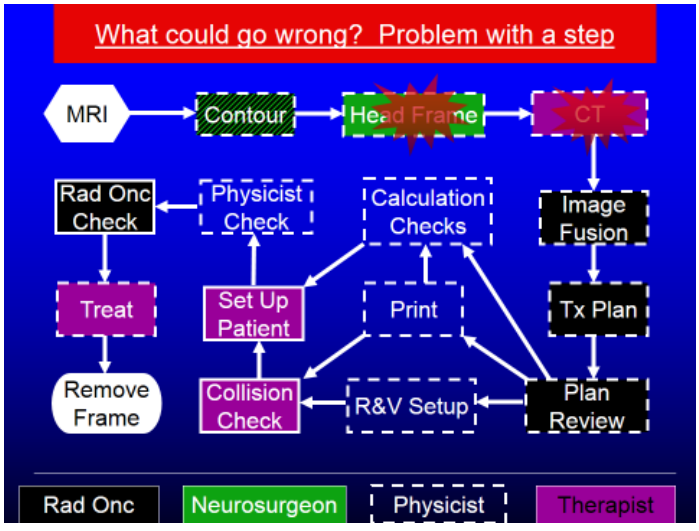
AAPM Task Group 100 has drafted a lengthy report that will set the standard for process improvement in radiation therapy. This report will represent a major paradigm shift for the physics of radiation therapy. The time has come for us to prepare ourselves for this paradigm shift and adopt a process-oriented focus.

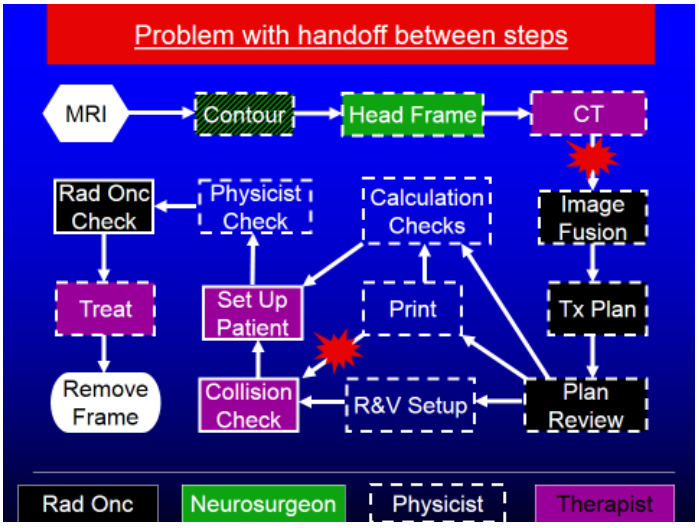


Here is a process flow chart for frame-based stereotactic radiosurgery to illustrate how processes in health care often involve many sequential and concurrent steps.

Consider the nature of errors in a process. We could have a problem with a step, such as placement of the head frame, or performance of the CT.

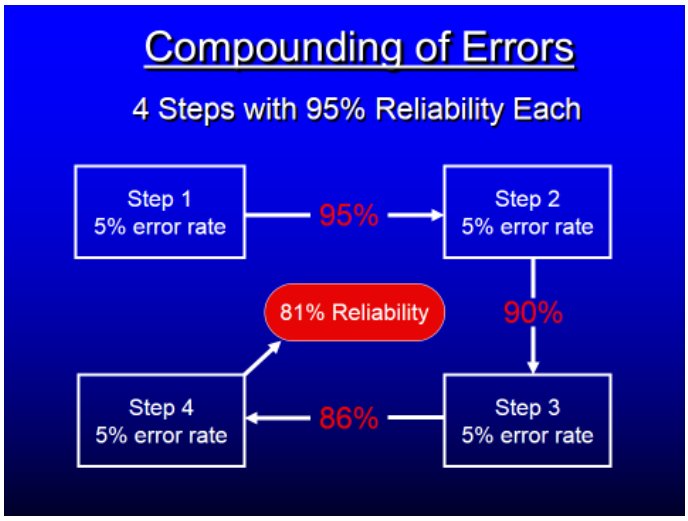
We could have a problem with a handoff between steps, such as getting the CT scan to the planning system, or getting the plan printout to the therapist for the operational check.





Compounding of Errors

To appreciate the importance of process improvement, one must understand compounding of errors in a multi-step process. Let's look at a process with four steps, each of which has a 95% rate of reliability.



The first step results in 95 % reliability.

The second step brings the combined reliability for the two step down to 90%.

The third step brings it down to 86%.

And the fourth step results in a combined error rate of only 81%.

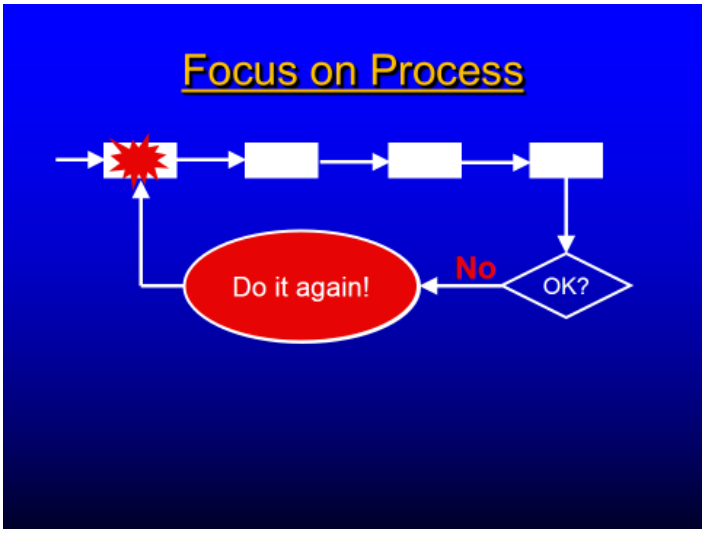
So with a multi-step process, a low rate of error per step can still result in a high rate of error for the process, because of compounding of errors.

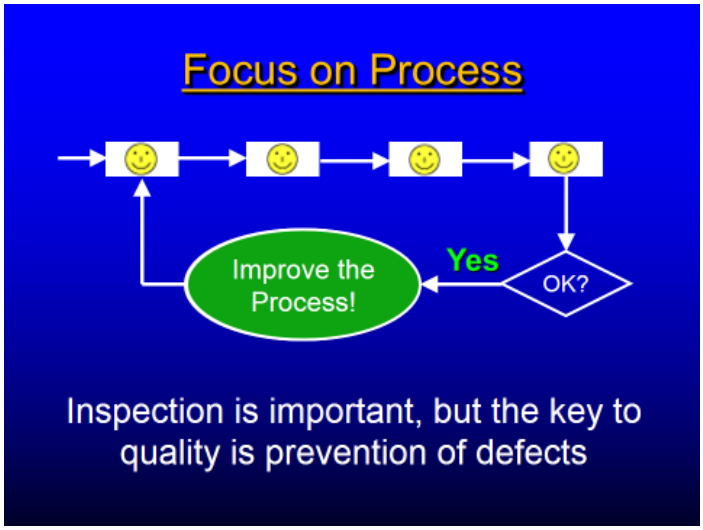
Focus on the Process

With TQM, the focus is on the process. When there is a defect in the end product, you have to go back and do it again, starting with the step where the error occurred.

But then, you have to work on improving the process and eliminating the cause of the error.

So, inspection is important, but the key to quality is prevention of defects.





Provide Leadership

Deming taught that TQM cannot be successful without leadership to create a culture of cooperation, collaboration, and teamwork. He said the leadership must be provided with a constancy of purpose. That means persistently and consistently.

In radiation therapy, the physicist shares responsibility for the leadership that's required for assurance of quality. He shouldn't wait for someone to tell him to do it. He should take the initiative. But success requires everyone's buy-in, and anyone can provide leadership, even without authority.

Drive out Fear

You have to drive out fear.

You want to work on improving the process. But when you try to give the appropriate feedback, fear can get in the way. You may hear, "It's not my fault! Or "Don't blame me. I'm just the messenger."

- Always attack the problem and not the person

- And don't shoot the messenger!

Don't Shoot the Messenger

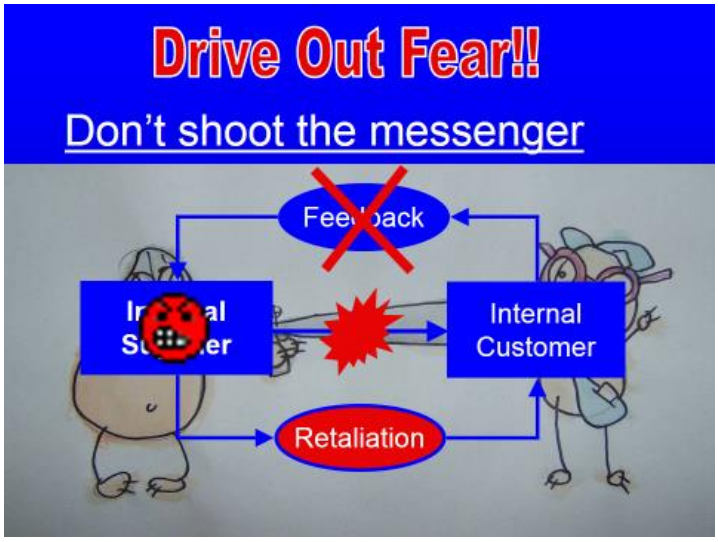
Here's what happens when you shoot the messenger.

You're not meeting the needs of an internal customer – another employee.

The employee gives you appropriate feedback.

You get angry and retaliate.

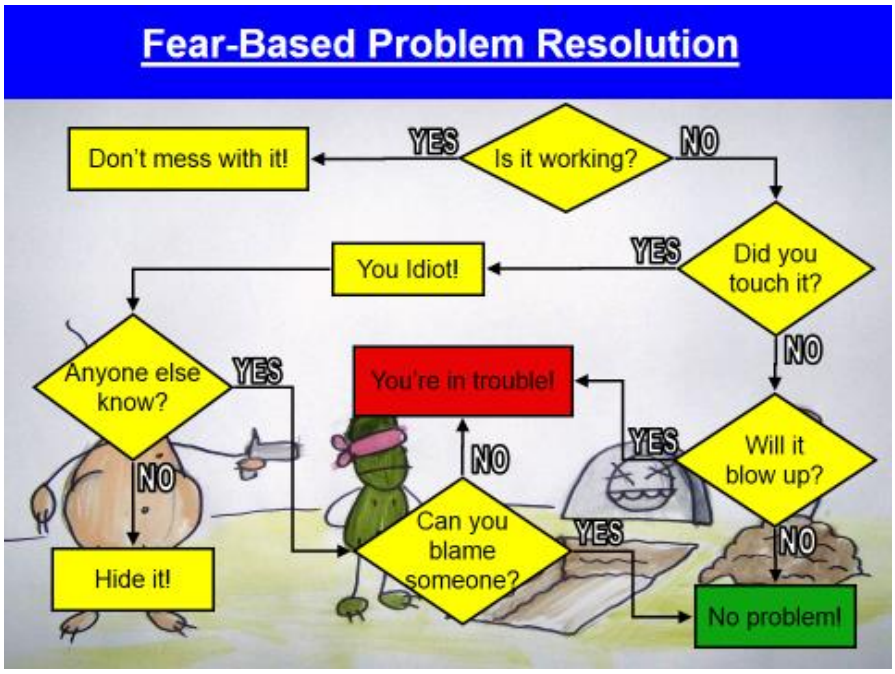
The feedback stops, and the opportunities for improvement end.



Fear-based Problem Resolution

Here is an example of fear-based problem resolution that typically exists in a culture of fear and blame.

The problem-solving approach that I call "blamestorming" is what develops when appropriate leadership is not provided to drive out fear.



Strategy: Create a Culture of Total Quality Management

You have to provide leadership to **promote a**

Encourage teamwork. No one wins unless the whole team is successful.

Encourage behavior that lifts others up; behavior that enhances morale; behavior that inspires others to do their best.

Discourage behavior that pulls others down.

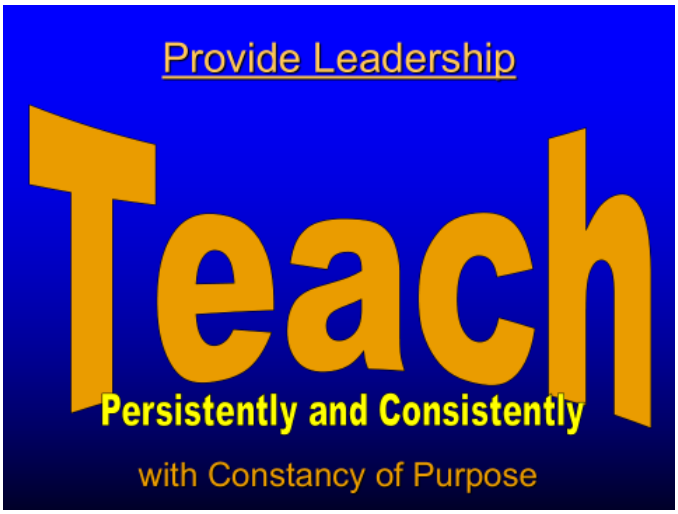
of blame, gossip, innuendo, sarcasm, or rudeness.

Discourage internal competition. Internal competition is a deterrent to helping others

culture of cooperation.

No one can do his best if he fears being the target

succeed. An employee's performance evaluation should depend on behavior that enhances the performance of the whole team, and not just the individual's competence.



Teach

One of the roles of the physicist is teaching. You have to teach – with a constancy of purpose, and that means Persistently and Consistently.

Follow the Process

Teach them to follow the process. You can't tell if the process needs to be improved if it's not being followed.

Don't bypass the system

If the system is not working, don't bypass it, fix it.

Give feedback

They can't expect to get what they need if they don't communicate.

Solicit feedback

If you're not meeting your customer's needs, you're wasting your time.

Attack the problem, not the person

When there's a problem, say "Let's work together on this problem." Or "I need your help with this problem."

Root Cause Analysis

How do you get started creating a culture of TQM?

Provide the staff with a simple formula that can be used for process improvement. This is a procedure for root cause analysis.

1. Assemble a representative group and ask the question, "What is the problem?" Or "What happened?" At this stage you're just trying to get all the facts before moving on to problem solving.
2. If there was an error, ask, "What do we need to do to fix the immediate problem?" The error may have already been corrected at the time of the root cause analysis,
3. Ask, "What circumstances contributed to the problem?" These are the root causes. It's important here to not assign blame.
4. Ask, "What can we do to avoid the problem in the future?" Consider changes in processes or environment. Do this as a group and try to arrive at a consensus.
5. Lead the group to a consensus, which becomes the implementation plan.
6. Decide a follow up date to evaluate how the changes are working.
7. Document for review by the CQI Committee.

When you embark on building a culture of TQM, if the staff are accustomed to a culture of fear and blame, it would be wise to perform root cause analyses with the entire staff together. This can be inefficient, but if you meet with multiple groups, each group may fear that the other groups are blame-storming, i.e. looking for a scapegoat. It's better if everyone is hearing what everyone else has to say

about the problem. In the beginning, this process may be tedious. One problem is that each person is afraid to reveal information about what happened. If he reveals how he was involved with the incident, he may fear that someone will take that opportunity to scapegoat him. Or, if he reveals another's involvement in the incident, he may fear retaliation. With persistence, though, each individual in the team eventually begins to implicitly take a root cause analysis approach to problem resolution. When that happens, the group has developed a culture of TQM, and problem solving becomes efficient and almost effortless.

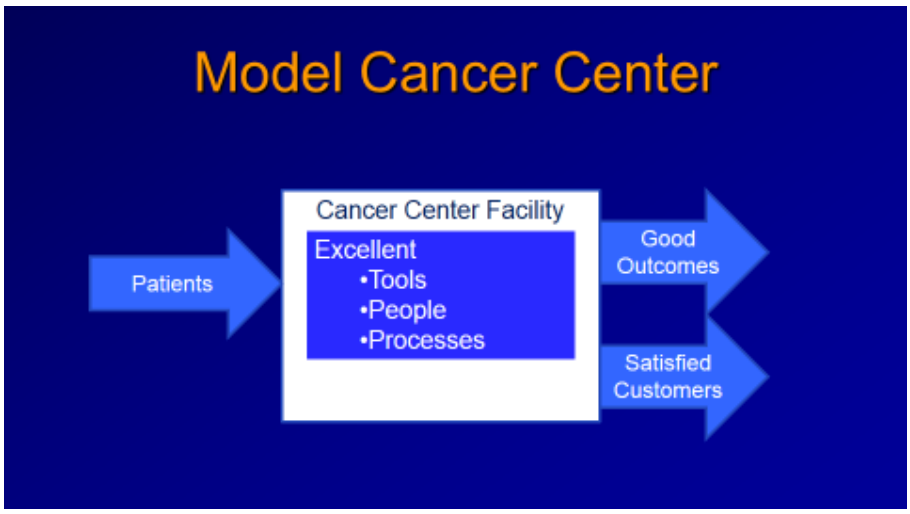
Quality improvement is a journey – not a destination. It never ends.

Once your team has developed a culture of TQM, the journey is not over. They are then ready for other more proactive approaches to process improvement, such as Failure Modes and Effects Analysis (FMEA) and Error and Near Miss Reporting Systems.

These are possible next steps on the journey that are beyond the scope of this presentation.

<u>Experience Design</u>

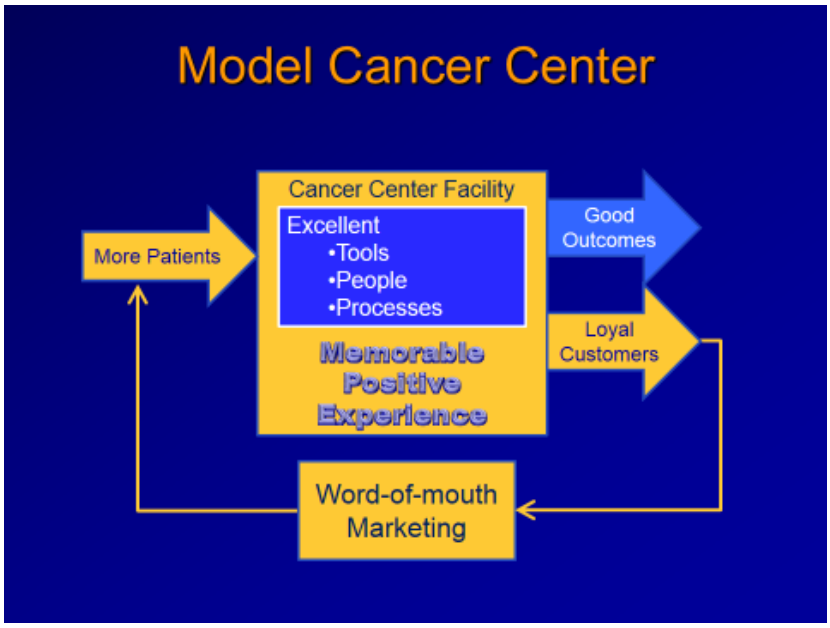
What about the experience? The patient may get the right dose to the right place and have a good outcome, but hate the experience. The quality of the experience should be included in our measure of quality of care.



Let's look at what goes into a model cancer center.

Patients come to a cancer center. If it has excellent tools, excellent people, and excellent processes, they achieve good outcomes, and they have satisfied customers. This is a necessary, but not sufficient, condition for a successful cancer center. How are you going to attract more patients who can benefit from these good outcomes?

If you can provide the patients a memorable positive experience, then the satisfied customers become loyal customers with stories to tell. They provide word-of-mouth marketing. And that leads more patients to come there for their cancer care.



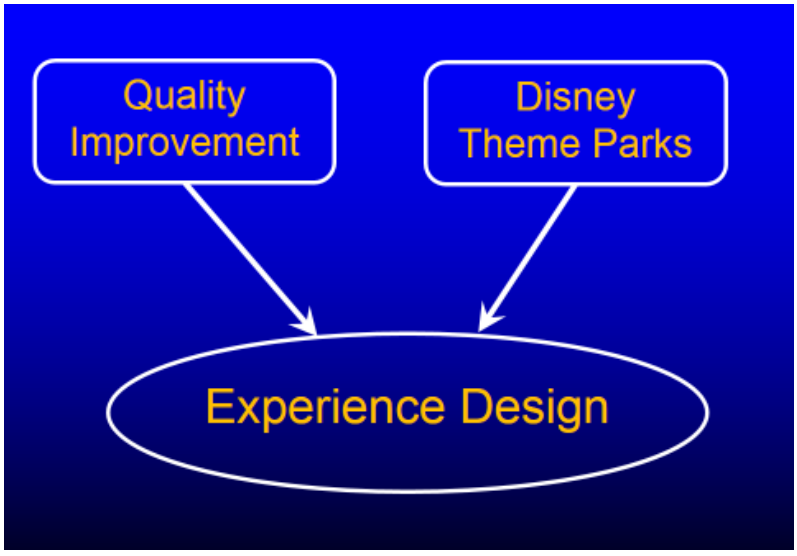
This is a model for a successful cancer center.

This brings us to the strategy of Experience Design.

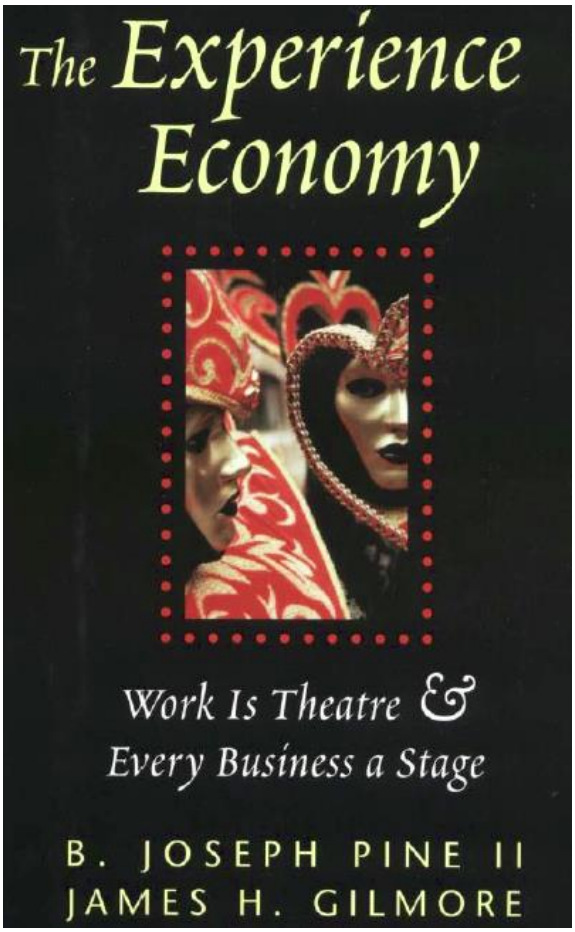
Strategy: Experience Design

The physicist has an opportunity to influence experience design through the quality improvement program. It's the right thing to do for the patient. It's also the smart thing to do, because Experience Design is a way for the cancer center to differentiate itself in a competitive market. Do you like getting paid? Help your employer be more successful by providing the customers with a positive memorable experience.

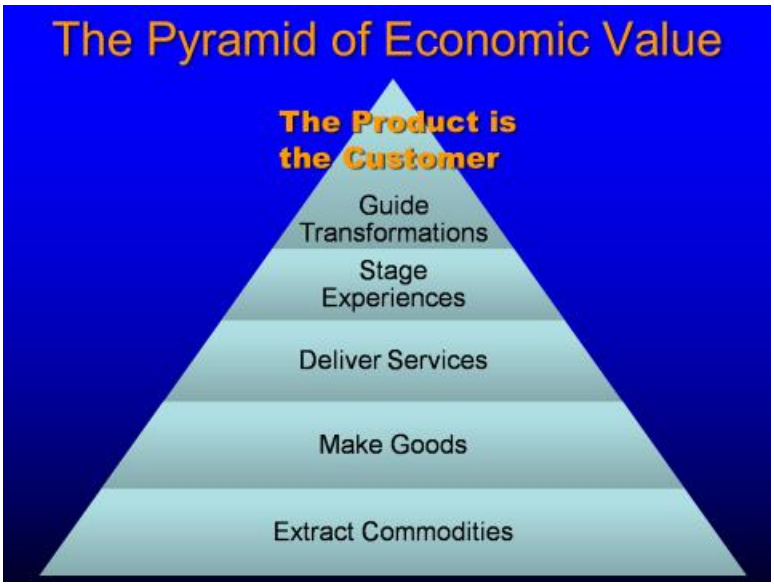
Although I initially saw experience design as an extension of quality improvement, it's actually a convergence of quality improvement and an approach that derives from things like Disney theme parks.



The application of Experience Design to any business has been described by Pine and Gilmore in their book "The Experience Economy – Work is Theatre & Every Business a Stage." (Pine, 1999)



Pine and Gilmore describe the progression of economic value as a pyramid, progressing from extracting commodities, through making goods, delivering services, staging experiences, to guiding a transformation.



At the pinnacle, if the experience leaves the customer somehow transformed to a better state, then the product is not just the experience. The product is the customer.

Some desirable transformations in oncology might be making the patient well, reducing their pain, acceptance of their new status as a cancer survivor, or maybe just helping them adjust their hopes to match their new reality.

Mr. Cellophane

In the movie musical "Chicago (Marshall, 2002)," John C. Reilly sang,

> *Mr. Cellophane*
> *Should have been my name*
> *You can look right through me*
> *Walk right by me*
> *And never know I'm there.*

So much of what the physicist does is transparent. He's Mr. Cellophane.

How can you influence the processes that people follow?

How can you influence the culture?

If they don't even know you're there?

You have to somehow make yourself visible.

The Opportunity, Influence, Impact Cycle is an effective strategy for gaining influence.

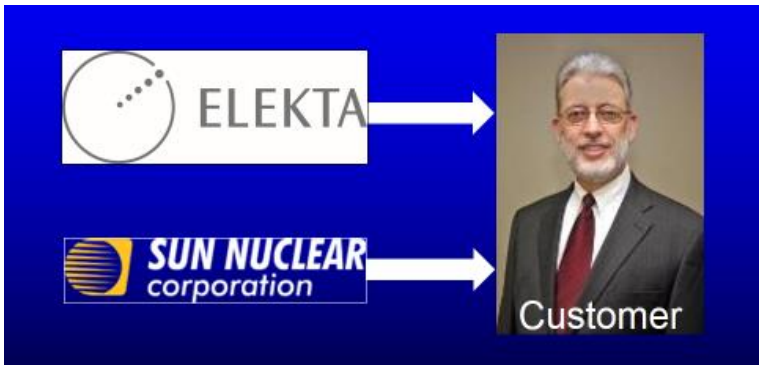
Strategy: Opportunity, Influence, Impact Cycle

Take advantage of every opportunity to have influence. If you have a positive impact, you'll be offered more opportunities. The more you practice this, the more influential you'll become.

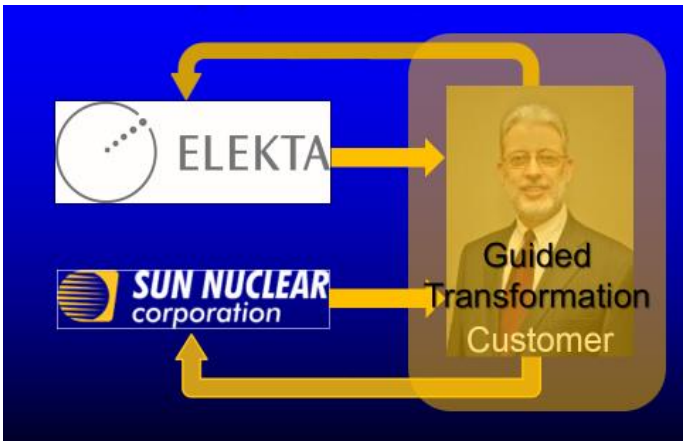
Add this to your lexicon: "I need opportunities for awareness and influence." You can't use the Opportunity, Influence, Impact Cycle if you're not aware of the opportunities. Information often flows through the Administrative Director and doesn't get shared with the physicist. Management needs to be repeatedly reminded that you can't do your job without opportunities for awareness and influence.

Strategy: Customer-Supplier Relationship

I use the Opportunity, Influence, Impact cycle to gain influence with my product suppliers. Deming said that you should have a relationship with your suppliers to help them better meet your needs. They should be part of your quality improvement system. This can best be done if you select a few preferred suppliers that support a culture of quality improvement.



My main suppliers happen to be Elekta for treatment equipment, and Sun Nuclear for physics tools. I want them to provide me with a guided transformation. But that's not going to happen if I'm Mr. Cellophane.



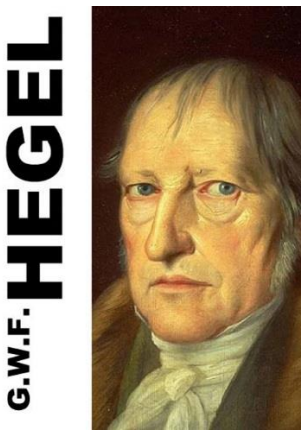
So, I'm assertive about giving them the feedback that they need so that they will know how to immerse me in a memorable positive experience. Or even better, a guided transformation that makes me somehow better as a medical physicist. The value that I receive is not in the tools that they deliver. The value is in what I am able to do with those tools. The product is not just the tools. The product is the customer.

Your suppliers are in the business of supplying their customers' needs, but in practice they fall short to some degree. If you want them to meet your expectations, you need to close the loop and let them know how they have missed the mark. My mantra with my suppliers is, "Let me help you help me!" They like to hear that.

So that's the strategy of the customer-supplier relationship.

Strategy: Be a Champ, not a Chump

This strategy of helping your supplier may seem to go against the paradigm of competitive individualism that dominates American culture. But if you take a broad perspective, you'll see that helping your suppliers, and helping others in your professional and personal community, is really a smart thing to do. It can contribute to a greater sense of happiness and lead to greater long-term success.



Philosophers through the ages have debated our essential interdependence with others in our community, from John Donne, who said "No man is an island," to Albert Einstein, who said ". . . almost the whole of our actions and desires are bound up with the existence of other human beings."

The 19th century German philosopher G.W.F. Hegel seemed to have the right idea when he concluded that individual freedom is of greatest value when communally guided. And ethical life consists in integrating ourselves into the right kinds of community, because we need the collective knowledge and wisdom of the community to help us know the potential consequences of our choices. (McCumber, 2011)

Darwin once wrote that a tribe with many people acting like givers, who "were always ready to aid one another, and to sacrifice themselves for the common good, would be victorious over most other tribes; and this would be natural selection." (Grant, 2013)

Since Darwin, the relative success and natural selection of Givers *vs.* Takers, or Cooperators *vs.* Defectors have been thoroughly studied. The fields of hedonistic psychology (Dunn, Gilbert, & Wilson, 2011), organizational psychology (Grant, 2013), and mathematical biology (Nowak & Highfield, 2011) provide some interesting results.

Hedonic Psychology

First, let's look at what the science of hedonic psychology tells us about what makes people happy. Dunn, Gilbert, and Wilson (Dunn, Gilbert, & Wilson, 2011), from the Universities of British Columbia, Virginia, and Harvard, reviewed the scientific literature on how people predict the hedonic consequences of future events. That is, what they think will make them happy. They found that the things that actually make you happy are usually not the things that you think will make you happy. Here are some of the things that they found.

- People gain more happiness from buying experiences than from buying things.
- People gain more happiness from buying something for others than from buying something for themselves.
- Almost anything we do to improve our connections with others tends to improve our happiness.

Do you want to be happy? You can increase your sense of happiness through helping others in the medical physics community by sharing your knowledge, and thereby improving your connections with others in your community.

Organizational Psychology

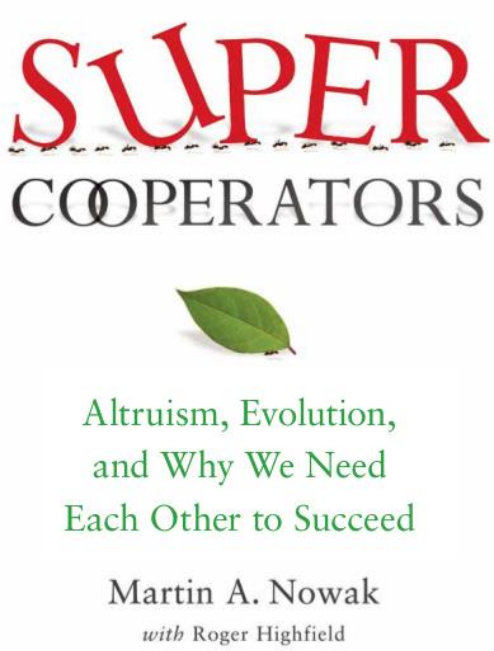
In the field of organizational psychology, the reciprocity styles of individuals are divided between Givers, Takers, and Matchers. Adam Grant (Grant, 2013) describes research that explains how Givers are more successful than either Takers or Matchers in the long run.

For example, new medical students were tested for reciprocity styles and their grade performance was ranked at the end of each year. After one year, Takers were the top students, and Givers were at the bottom. But after the second year and beyond, the top students were Givers, and the bottom students were also Givers. Studies show that this pattern holds through all professions. The Chumps are the altruistic Givers who keep getting taken by the Takers. The Champs are the smart Givers who learn to recognize the Takers and adjust their reciprocity style accordingly. And over the long haul, the Takers fall behind all but the Chumps that are their victims.

Do you want to be more successful? Be a Giver. It may not be good for a 100-yard dash, but it's a good strategy for a marathon. But be a Champ, not a Chump. The challenge is learning to recognize the Takers and adjusting your reciprocity style when you recognize a Taker. Also, there are effective strategies for effecting what Adam Grant calls the Scrooge Shift, in which takers in a group are influenced to change their reciprocity style to become Givers. For more about Give and Take, see Appendix A.

Mathematical Biology

Martin A. Nowak, a mathematical biologist, describes how mathematical modeling of the evolution of populations can explain how altruism arose in our otherwise competitive world (Nowak & Highfield, 2011). Natural selection picks the individuals that are best suited to a given environment, but cooperation, says Nowak, is the master architect of evolution. Evolution is as much about survival of the fittest group as it is about survival of the fittest individual. Nowak found that evolution of groups of cooperators could occur under conditions that are increasingly more prevalent in today's modern highly connected world. These conditions include:



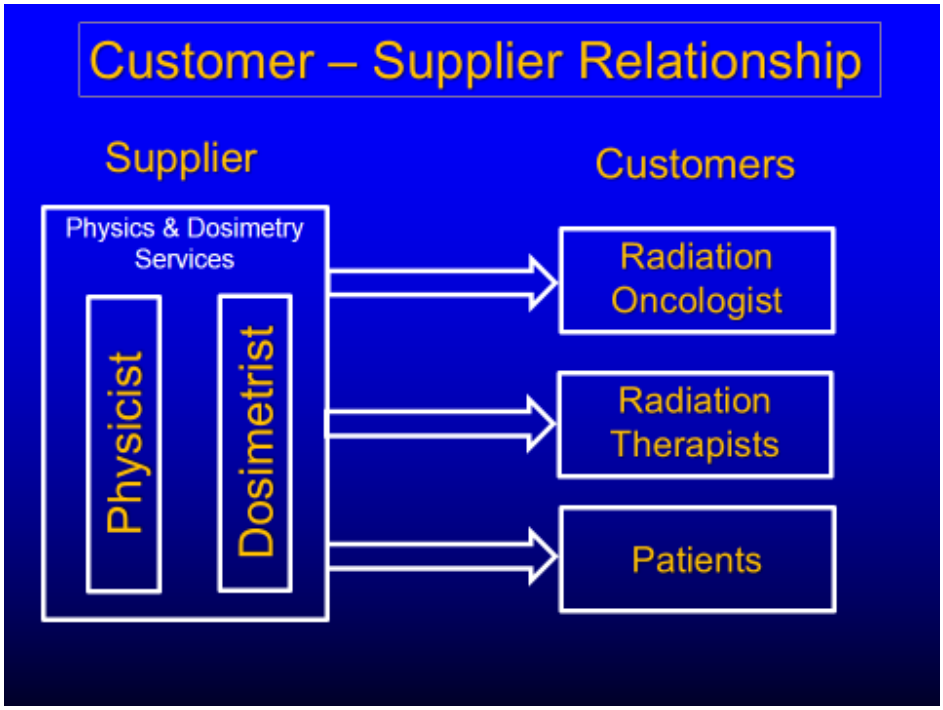
- Opportunities for repetitive interactions
- Knowledge of reputations
- Formation of symbiotic clusters of cooperators
- Competition that leads to natural selection of groups.

Do you want your professional community to be more successful? Be a Giver, and promote a culture of mutual cooperation. For more on this topic, see Appendix B.

Strategies for Effective Reporting Relationships

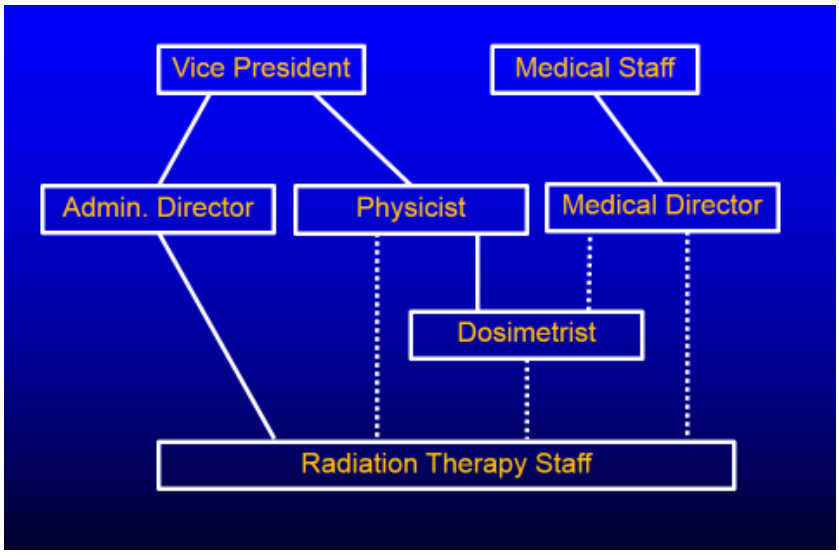
Now let's talk about strategies for achieving effective reporting relationships in the organizations where we work. I'm still learning that this topic is not as simple as one might think.

One way of looking at reporting relationships for physicists and dosimetrists is in a customer-supplier model. In the model shown here, the physicist and dosimetrist are the suppliers of Physics and Dosimetry Services. Their customers are the radiation oncologist, radiation therapists, and the patients. I intentionally put the Dosimetrist at the front counter of Physics and Dosimetry, with the Physicist in the back, because that usually facilitates a more efficient flow of information..



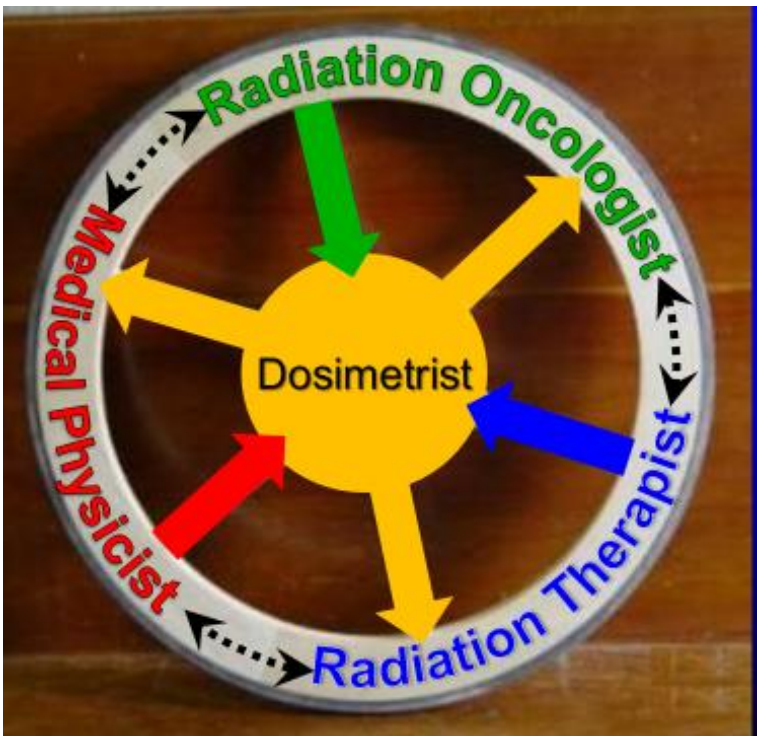
Here's another chart that illustrates the common flow of information in a radiation therapy department. This structure is like a wagon wheel, with the Dosimetrist at the hub.

In this model, the Radiation Oncologist, Radiation Therapist, and Medical Physicist are arranged around the rim of the wheel. The communication between each of the three groups is often difficult,



as represented by the dotted arrows. In my view, the Dosimetrist is frequently at the hub of communications. Each of the groups communicates frequently through the Dosimetrist for matters regarding the formation and execution of the plan of treatment. And the Dosimetrist is often better suited to communicate information to each of the groups on the rim of the wheel.

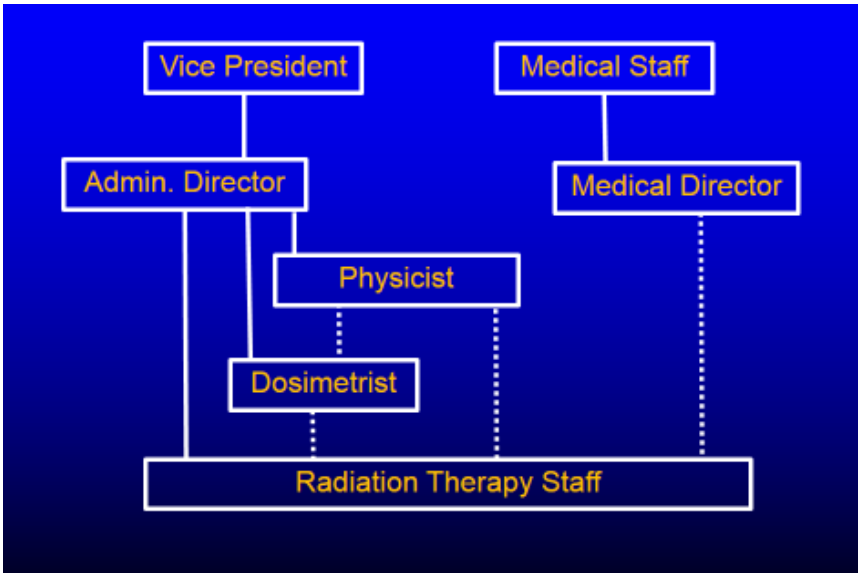
The organizational structure illustrated here is one recommended by the American College of Radiology. This structure shows recognition of the overlapping responsibilities of the Administrative Director, Physicist, and Medical Director, who have unique and overlapping responsibilities for different facets of the same organization. The dashed lines represent indirect, or secondary, authority. The advantage of this structure is that it gives the physicist authority to exercise his professional judgment without authoritative interference by an administrative director who lacks understanding of the depth and breadth of the physicist's knowledge and responsibilities.



The disadvantage, though, is that it puts the physicist in the management chain and requires a lot of time spent on management activities. However, an offsetting advantage of the time spent in management meetings is the

opportunities for awareness and influence that it provides

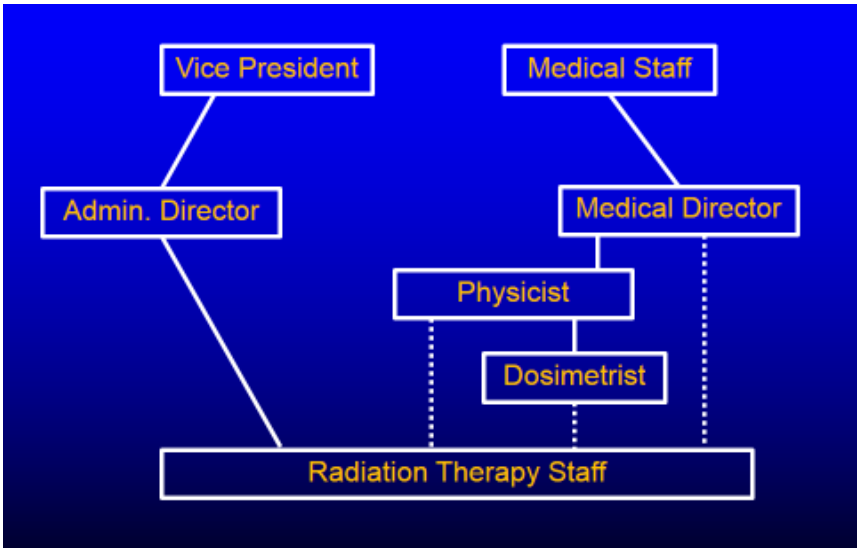
The American College of Radiology also recommends that the physicist report to the medical director



of Radiation Therapy. With some employment arrangements, this can be a good reporting relationship.

One of the problems with this, though, is that the physicist is not connected to the hospital organization through either the administrative chain or the medical staff. So there may be fewer opportunities for awareness and influence.

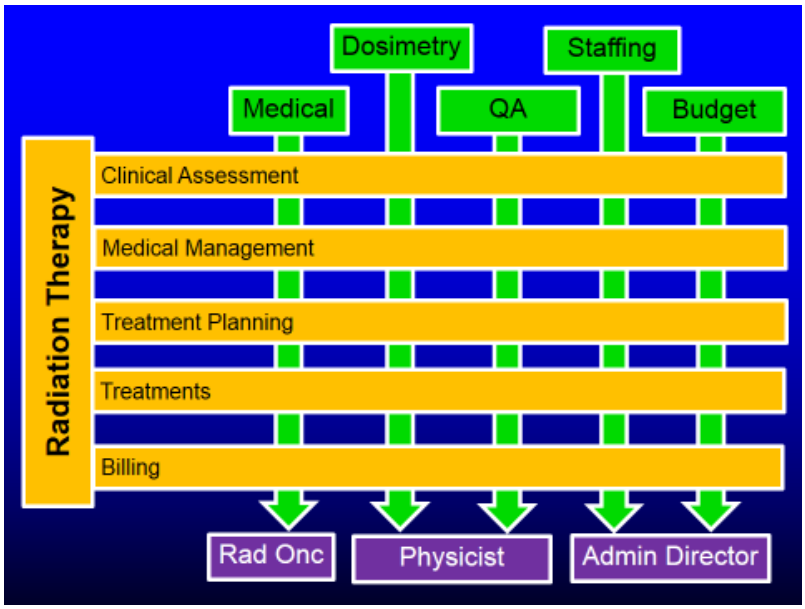
Physics professional standards have long recommended against an organizational chart like the one shown here, in which the physicist reports to the administrative director. This relationship can be problematic if the administrative director sees the physicist as a subordinate.



My experience, though, has been that this can work very well if the Administration Director sees his role as one of managing resources to empower people to do their best, and he understands and respects the depth and breadth of the physicist's professional and technical responsibility.

How this works can be best understood from the perspective of a matrix management model.

Matrix reporting is an organizational scheme that was introduced in the 1970s. In matrix management, you have a straight-line boss, who is the person who prepares your performance review and decides on your raise; and a dotted-line boss, who may also assign you work but has less control over your review. Matrix reporting systems are designed to keep people working together in teams that best utilize their core competence, while avoiding people working at cross-purposes. This allows an organization to meet their needs in terms both of functional coordination and product focus.



Matrix reporting is not widely understood, because it does not easily lend itself to a visual diagram. One way to visualize how matrix reporting works is the diagram here, in which the product focus is Radiation Therapy Services. Some of the functional activities involved are shown in the horizontal bands in which multiple people are involved. The matrix of responsibilities for different aspects of each of these functional bands are

- Medical, for which the Radiation Oncologist has primary responsibility
- Dosimetry, and QA, for which the Physicist has primary responsibility,
- And Staffing and Budget, for which the Administrative Director has primary responsibilities.

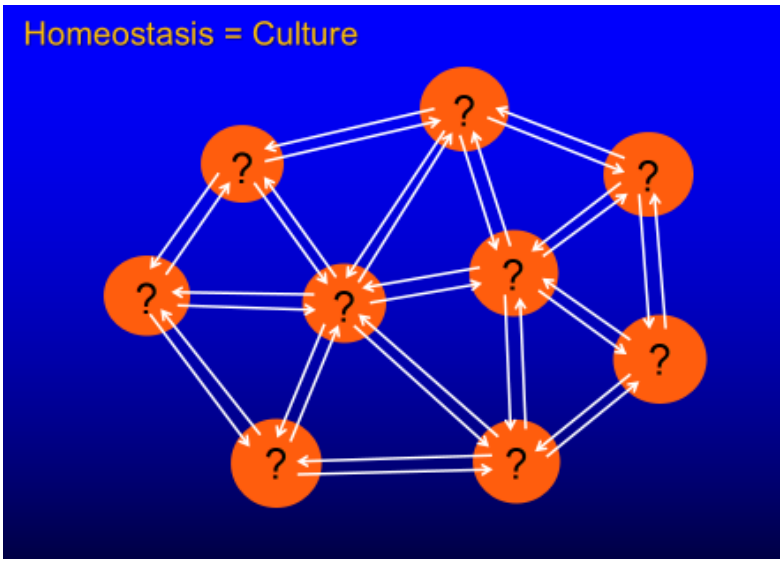
Of course, there are other activities and responsibilities, but these primary responsibilities can be used to illustrate the concept. Accountability for the service line and keeping people focused on strategic goals falls on the Administrative Director. It's important for matrix managers to make sure that people understand the reasoning behind matrix reporting and choose their behaviors accordingly. In matrix reporting, the formal structure becomes less important to getting things done, so managers need to focus on the soft structure of relationships within groups, networks, and teams that are needed to get things done.

Systems Theory

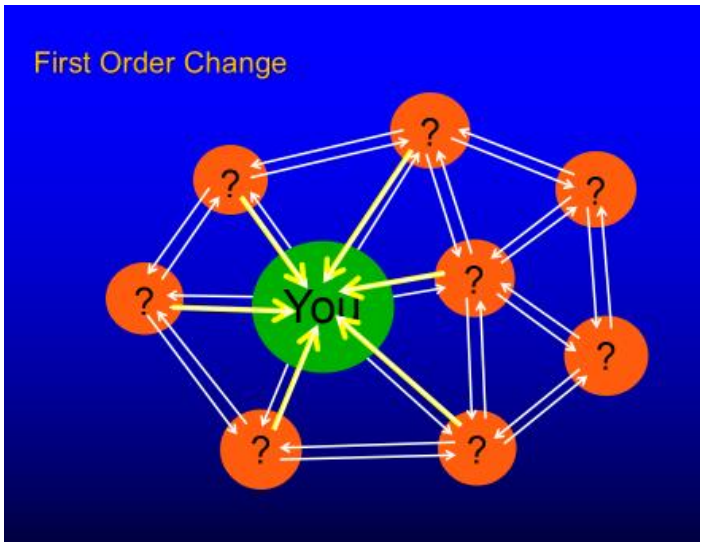
Quality control checks of equipment performance is not enough to assure quality if people are not following effective processes. So, one of the perennial challenges for a physicist in radiation therapy is answering the question, "how do you influence the staff if you're not their boss?"

I didn't go into physics because of my strong aptitude with interpersonal relationships. In fact, I married a psychotherapist to help me with that. When I was helping her write papers for her master's degree in Marriage and Family Therapy, I learned about Systems Theory, and I have found it to be helpful in understanding how to influence people within a group. Systems theory is a model of the behavior of individuals in a group.

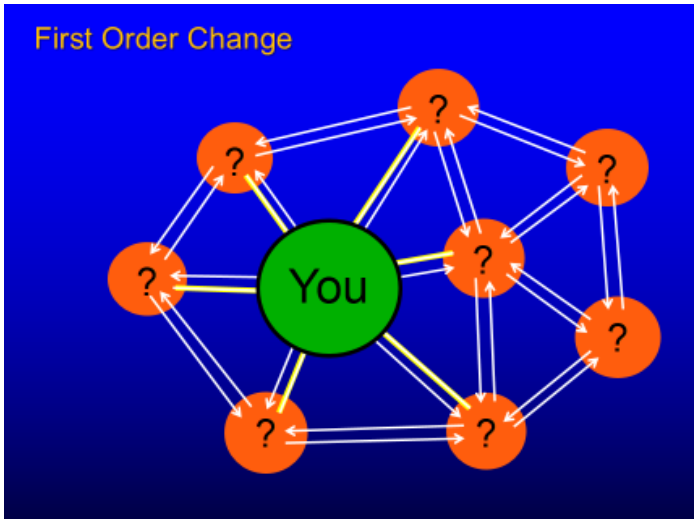
In this model, the thoughts and motives of the individuals are not characterized. Instead, the interaction between individuals is characterized by negative feedback loops. We know that negative feedback loops act to resist change. So, in systems theory, the behaviors that provide negative feedback lead to a group homeostasis, which is the culture of the group. And we already know that a culture is difficult to change.



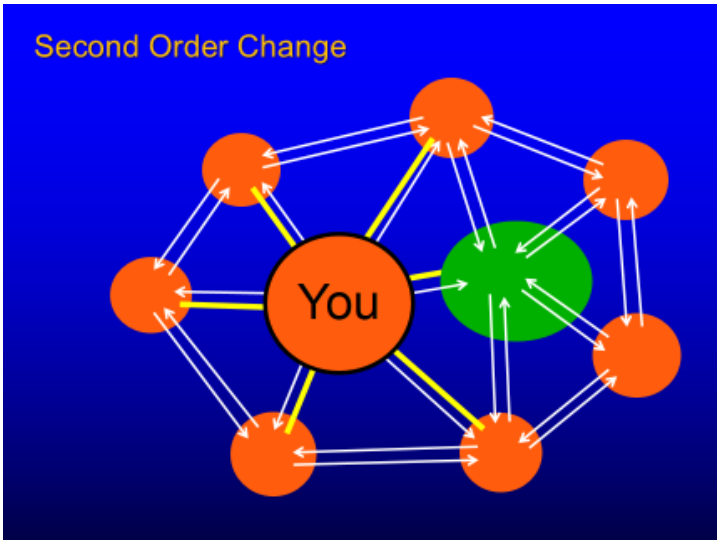
Let's consider what happens with a first order change. If you, the physicist, decides to expand your role to include influence over processes, the feedback from the group will push back against the change. And this pushback can be quite malicious.



If you are determined and persistent, and you develop a thick skin, the group will eventually adjust to your change. But it can take a very long time.

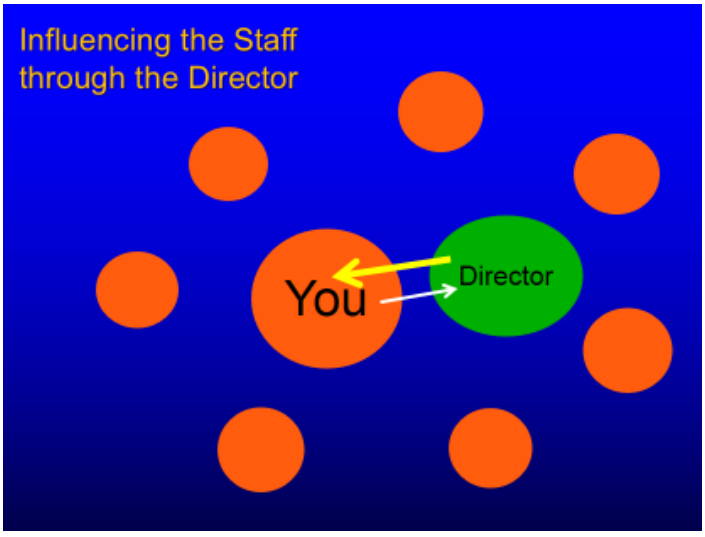


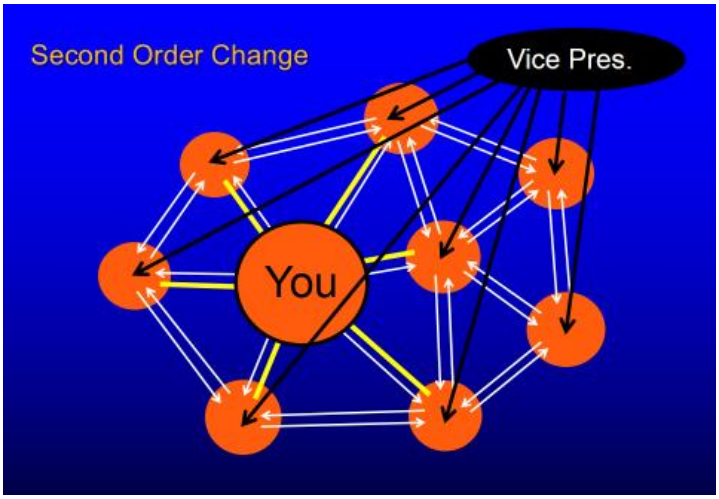
Sometimes, a second order change is needed.



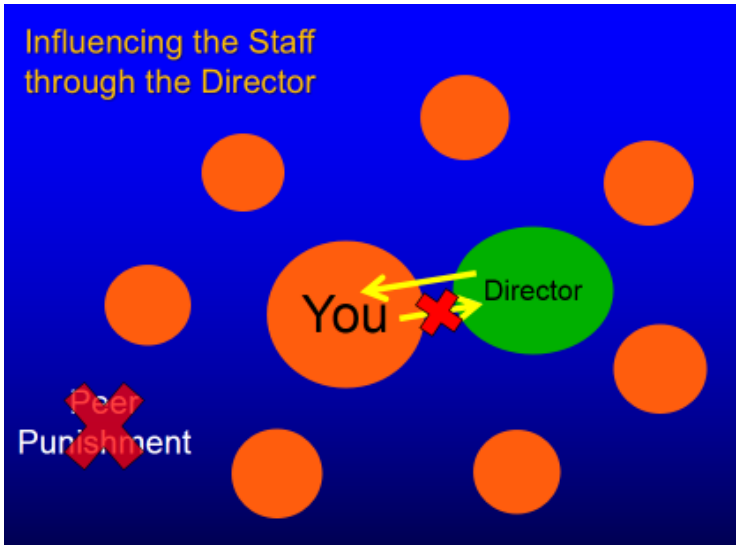
This might consist of bringing in a new person to replace a troublesome employee.

Another second order change is to elicit the support of an administrator, who is insulated from the push-back.





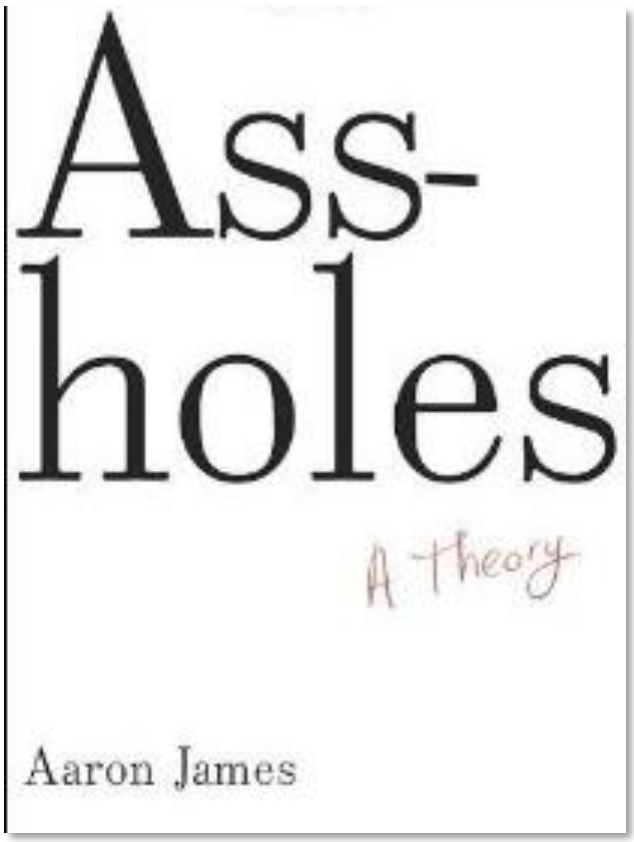
The goal should be to influence processes through the authority of the Director, who is the supervisor of the radiation therapy staff. But when you try to collaborate with the Director, he may push back with animosity



You may be compelled to retaliate, or apply what Nowak refers to as Peer Punishment. You should avoid this, because Nowak found that peer punishment will destroy any chance of evolving a group of cooperators.

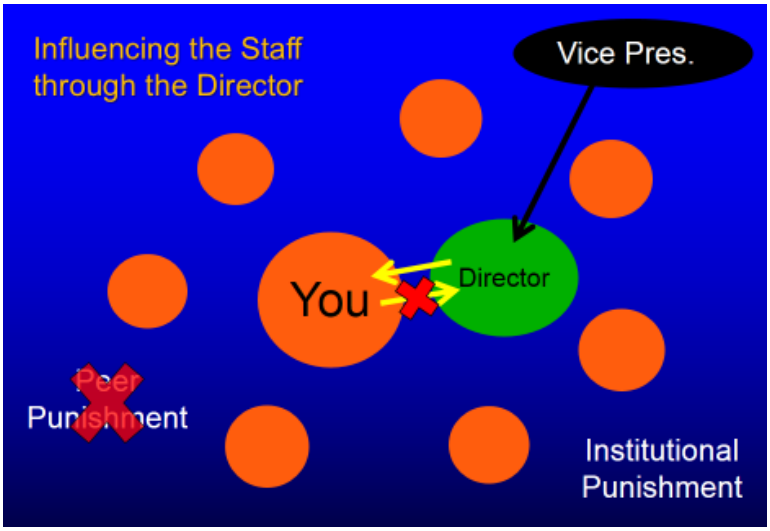
Mohandes Gandhi taught us to be the change that you want to see. This applies here. Never retaliate!

Sometimes it's practically impossible to influence a group to be cooperators if there is a powerful person like that described in the book by Aaron James (James A. , 2012). The terminology for description of this personality type has been well established in the literature. The expletive person is one who has an inherent sense of moral superiority. He thinks that everyone should show him the utmost respect and deference. But he doesn't believe that others are entitled to the same respect from him. That can lead to a culture of fear and blame, like that I portrayed earlier in the humorous flow chart. In my experience, the following approach can be effective in neutralizing the negative influence of such a spoiler. In Systems Theory, it's called a second order change, which is one in which there is influence from outside the defined system.



Nowak refers to this as Institutional Punishment.

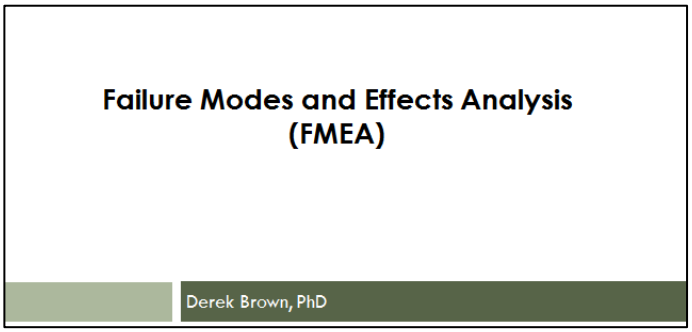
In order for this strategy to work, though, you must have influence on the administrator. You have to have credibility. You must always model good behavior and express pure motives.



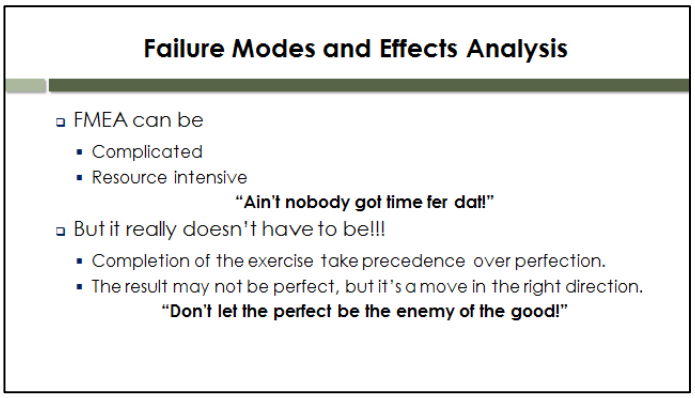
Mohandes Gandhi said, "The moment there is suspicion about a person's motive, everything he does becomes tainted."

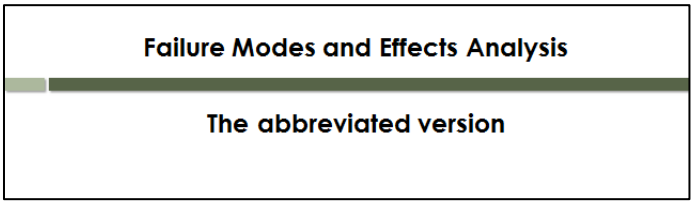
Strategy:
Failure Modes and Effects Analysys (FMEA)

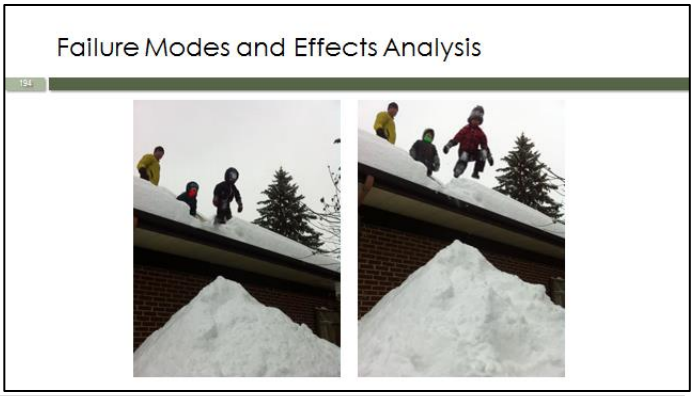
I have described methods and tools for identifying opportunities for improvement and making process improvements. Failure Modes and Effects Analysis (FMEA) is a proactive approach to process improvement. I borrow slides for this section, with permission, from Derek Brown, PhD.



There have been many excellent presentations and publications about the application of FMEA in medical physics and radiation therapy. Anyone who has paid attention will know that the FMEA process can be very complicated and very resource intensive. The prospect of performing a full-blown FMEA with the limited resources in a typical radiation therapy clinic can be very daunting. Also, if I got past my trepidation and proposed such a task in my clinic, I would be sure to hear something like, "Ain't nobody got time fer dat!" But it really doesn't have to be so complicated and resource intensive. Doing an abbreviated FMEA should take precedence over doing it perfectly and completely. Don't let the perfect be the enemy of the good! The result may not be perfect, but it's at least a move in the right direction.



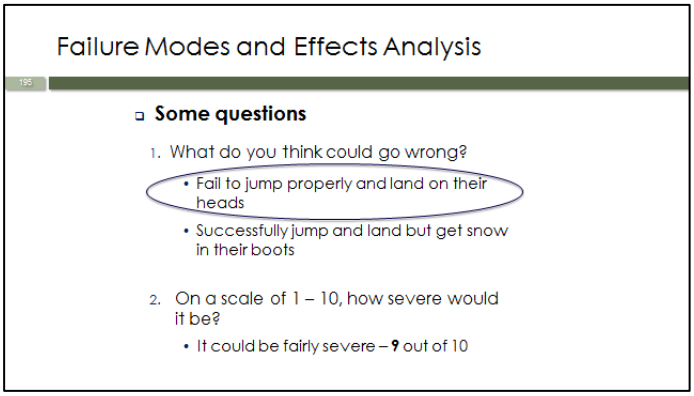




Derek Brown, author of these slides, is from Canada where there is a LOT of snow. Here is a picture of his kids ski jumping off the roof. Let's do an exercise of FMEA of this process.

The first step in the process is to ask the question, "What do you think could go wrong?" Some possible responses might be:

1. Fail to jump properly and land on their heads.
2. Successfully jump and land but get snow in their boots.

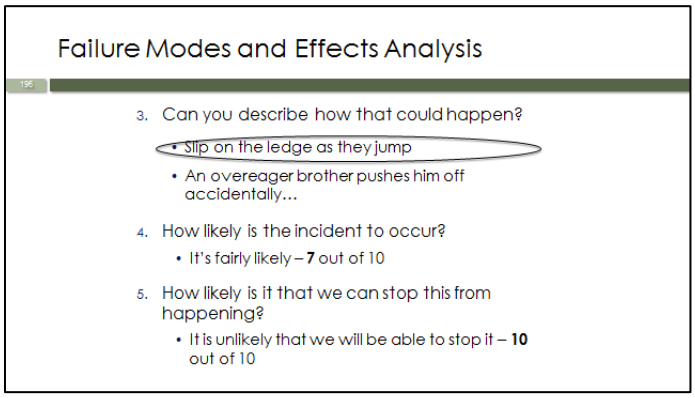


Now we want to focus first on the failure with the most severe consequences. That would the first involving landing on their heads.

The second step is to ask, "On a scale of 1-10, how severe would it be? This is an approximate, relative scale in which higher numbers are more severe. Let's assign a severity of 9 to landing on their heads.

The third step in the FMEA is to describe how the failure could happen. Some possibilities are:

1. Slip on the ledge as they jump.
2. An overeager brother pushes him off accidently.

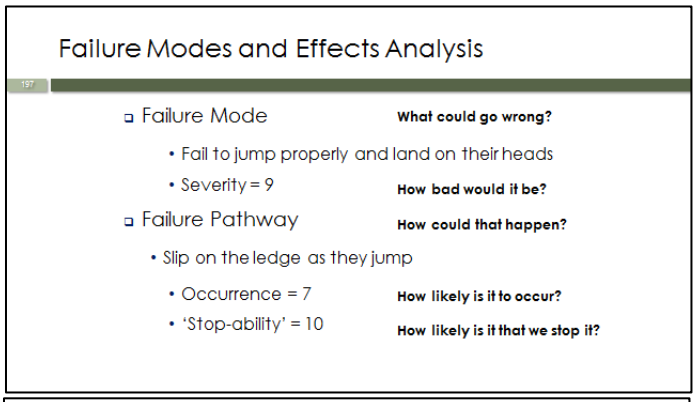


Let's say that the first mechanism of failure is the more likely and focus on that one first.

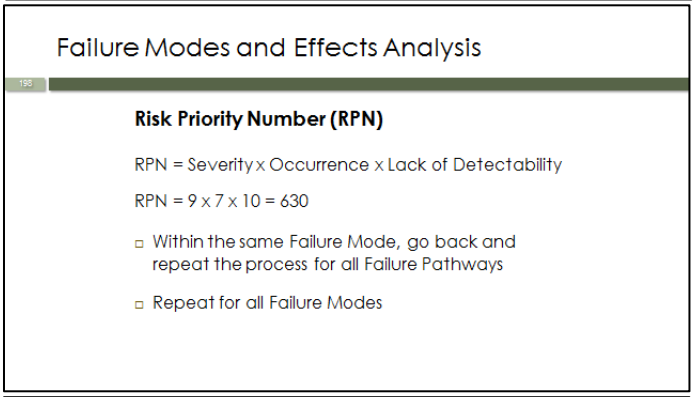
The fourth step in the FMEA is to estimate how likely the incident is to occur. A value of 7 suggests that is fairly likely.

The last step is to ask how likely is it that we can stop this from happening. In this case, once the child is in motion, it's extremely unlikely that we will be able to detect it and stop it before it becomes a problem, so we assign a value of 10 out of 10.

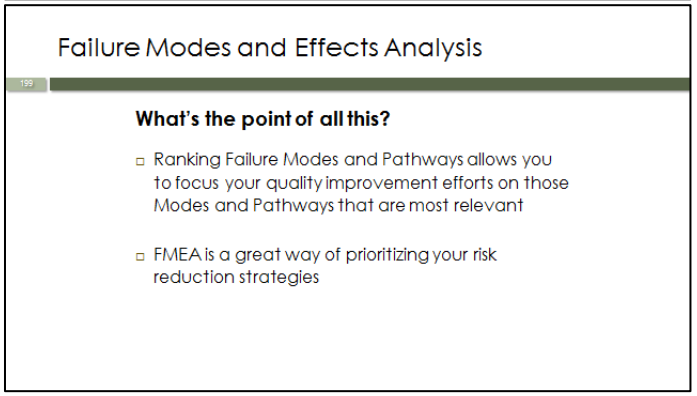
We have come up with three rankings. The first question, "What could go wrong," gave us our failure modes. We ranked one of those, "Fail to jump properly and land on their heads," by asking how bad would it be, and that give us a severity ranking. We asked how that could happen and that gave us the failure pathways. For one of the failure pathways, "slip on the ledge as they jump," we obtained a ranking of likelyhood of occurrence by asking how likely is it to occur, and a preventability ranking by asking how likely is it that we can detect it and stop it before it leads to a failure.



Now we can take the three rankings and multiply them together to obtain the Risk Priority Number (RPN). Next, we would go back and do all the same thing with all the failure pathways for this failure mode. Then we would do the same with each of the failure modes, and we would end up with a relatively long list of Risk Priority Numbers that relate to failure modes and pathways.



So what's the point of all this? Ranking the failure modes and pathways by RPN value allows you to focus your quality improvement efforts on those modes and pathways that are most relevant. It's a great way, as a group, of prioritizing your risk reduction strategies to make best use of your limited resources.



Although FMEA is relatively new to medical physics as a formal model, but medical physicists have been using this approach to safety and quality for a long time. In my personal experience, it's second nature when implementing a new modality or procedure to think about what could go wrong and what to do to ensure that it doesn't lead to serious consequences.

FMEA potentially allows you to identify issues before they occur in the clinic, and so it is most useful when used prospectively. Through ranking of RPN values, it allows you to focus your quality improvement efforts on the modes and pathways that are most relevant.

FMEA does not have to be used prospectively. It is also useful as an ongoing QA tool. I find that I do this intuitively with established processes, constantly thinking about what could go wrong and how serious the consequences might be. Root Cause Analysis is a good tool for determining changes to make when things go wrong. Incident Learning Systems allow one to identify opportunities for improvement from both errors and "near misses." FMEA can be used to help identify and prioritize opportunities for improvement in ongoing processes, and an FMEA mindset can lead to intuitive recognition of those opportunities without the formal process.

The slide shows a table from AAPM TG 100 that is a tool for estimating ranking for FMEA.

Failure Modes and Effects Analysis

Quality and Safety Improvement!

Failure Modes and Effects Analysis

1. Potentially allows you to identify issues before they occur in the clinic
   - FMEA is most useful when used prospectively
2. It allows you to prioritize your QA efforts and interventions
   - FMEA allows you to focus your quality improvement efforts

Failure Modes and Effects Analysis

3. Doesn't have to be used prospectively – It is a great ongoing QA tool
   - FMEA can also be used on a process that already exists, and can be easily updated when processes change

On a Scale From 1 – 10…

Rank	Occurrence (O)		Severity (S)		Detectability (D)
	Qualitative	Frequency	Qualitative	Categorization	Estimated Probability of failure going undetected in %
1	Failure unlikely	1/10,000	No effect		0.01
2		2/10,000	Inconvenience	Inconvenience	0.2
3	Relatively few failures	5/10,000			0.5
4		1/1,000	Minor dosimetric error	Suboptimal plan or treatment	1.0
5		<0.2%	Limited toxicity or tumor underdose	Wrong dose, dose distribution, location or volume	2.0
6	Occasional failures	<0.5%			5.0
7		<1%	Potentially serious toxicity or tumor underdose		10
8	Repeated failures	<2%			
9		<5%	Possible very serious toxicity or tumor underdose	Very wrong dose, dose distribution, location or volume	20
10	Failures inevitable	>5%	Catastrophic		>20

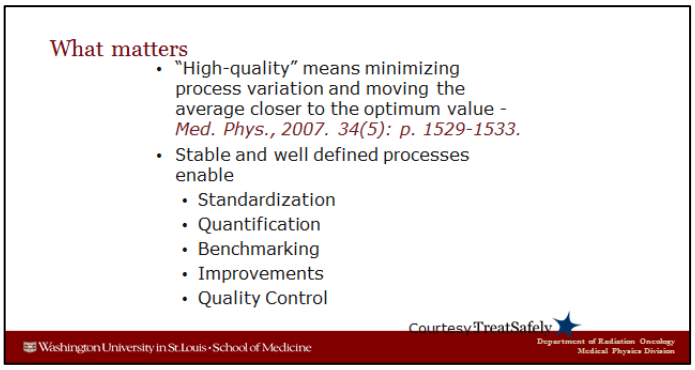
AAPM – TG 100

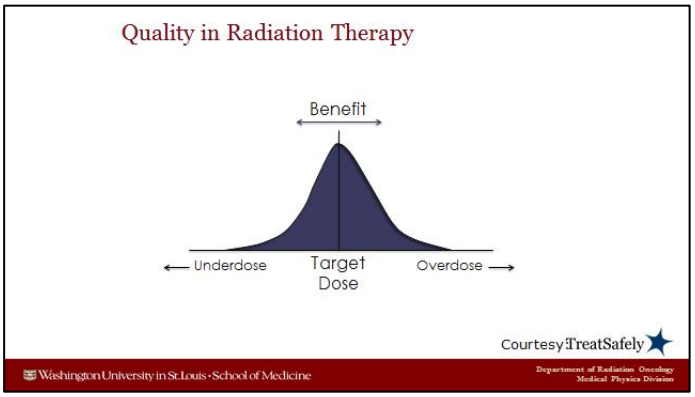
Strategy: Finding Opportunities for Improvement with Incident Learning Systems

Once you attain a culture of quality improvement, once you have learned methods of process improvement such as RCA and FMEA, you need a way to identify opportunities for improvement. A good way of doing that is with an Incident Learning System (ILS). . I borrow slides for this section, with permission, from Sasa Mutic, PhD, at Washington University.

W. Edwards Deming taught us that the essential fundamental principle in Total Quality Management is to reduce variability and move the average closer to the optimum value. To do that, we have to have stable and well-defined processes. These enable

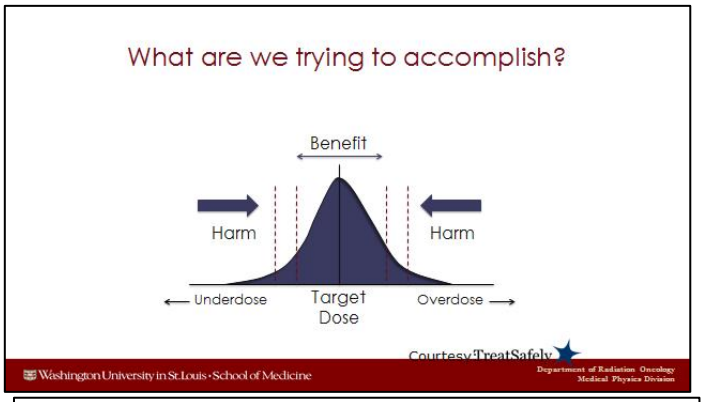
- Standardization
- Quantification
- Benchmarking
- Improvements
- Quality Control



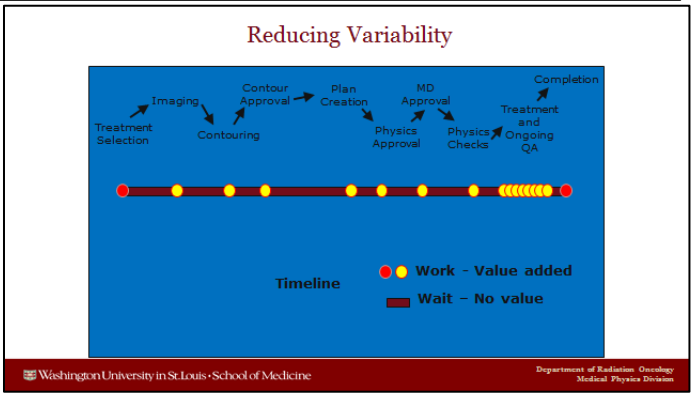


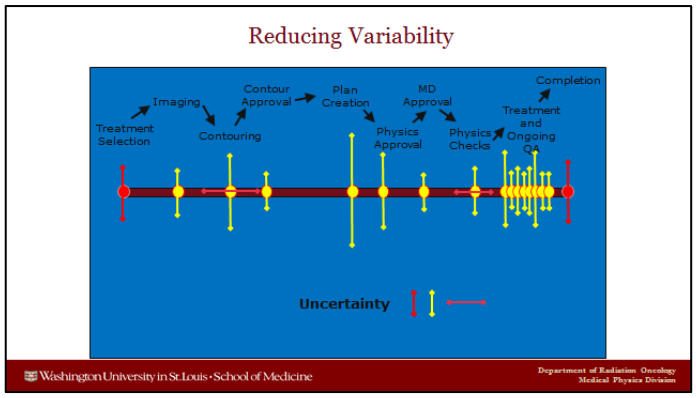
The variability in target dose in radiation therapy can be represented approximately by a normal distribution as shown in the figure. The central part of the distribution provides benefit to the patient, but the tails represent underdose or overdose. In general, the strategy for pursuing quality through process improvement is to reduce spread of the frequency distribution, bringing the underdoses and overdoses into the range of benefit.

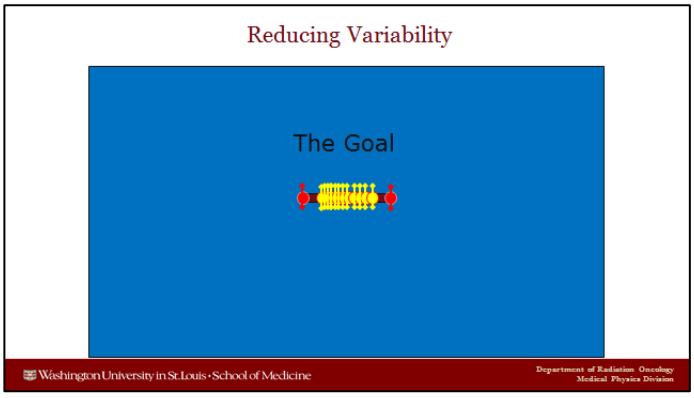
These representations of a normal frequency distribution represent only one dependent variable that affects quality. There are many variables, though, that contribute to quality.

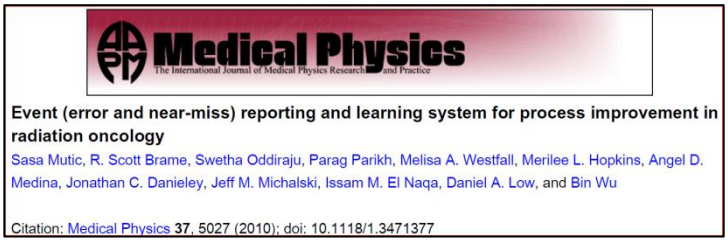


The first figure entitled Reducing Variability shows a timeline of the many steps leading to radiation treatment and through the course of treatment. This is a simplified value stream map that shows value-added time, represented by the yellow circles, and the intervening non-value-added time. In general, to improve the quality of the patient's experience it is desirable to reduce or eliminate the non-value-added wait times. The next figure illustrates that there can be variability in each step as well as in the time between value-added steps. The goal is to reduce variability in each step and in the time required between steps.



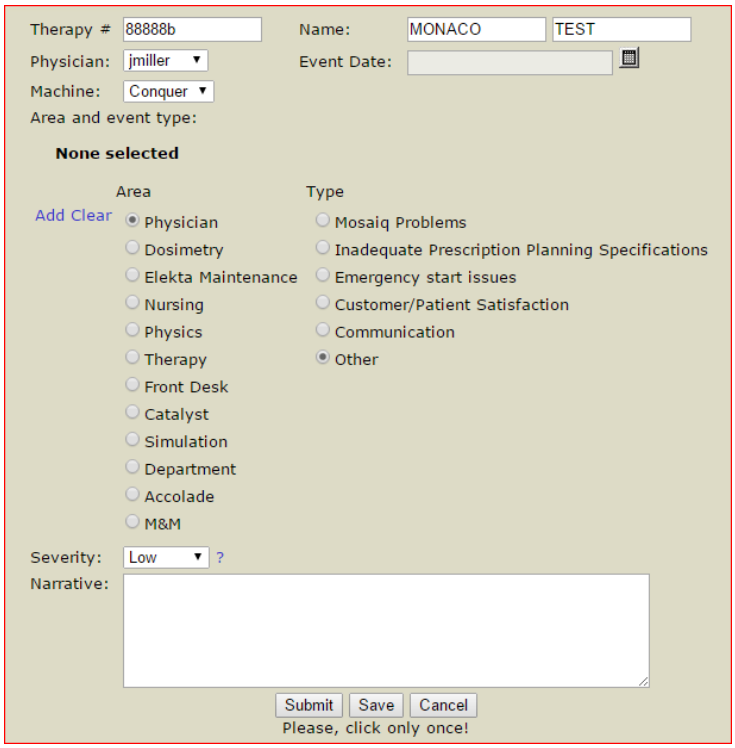


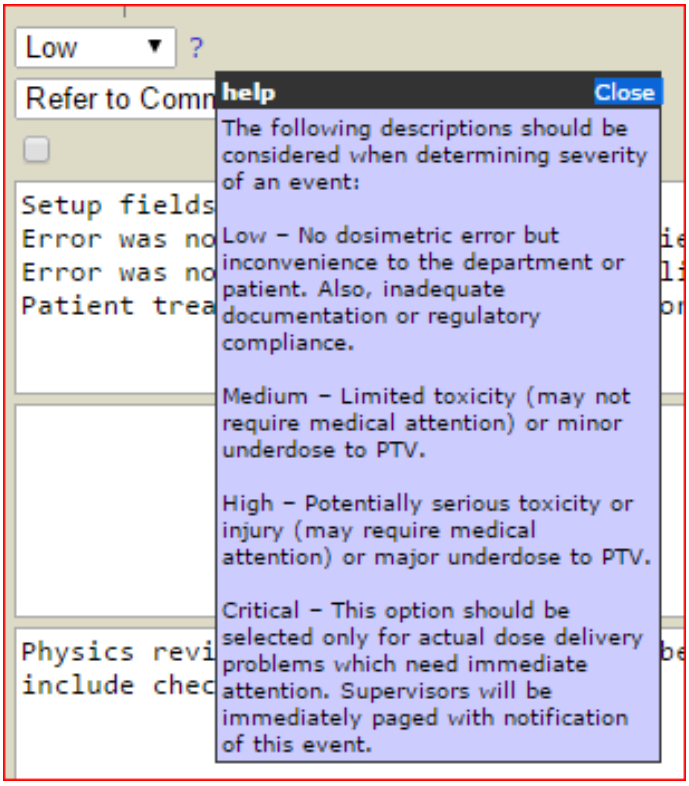




We are in the early stages of implementing an ILS developed and in use at Washington University (WU). The ILS was described in Medical Physics in 2010.

One of the key features of the WU ILS is that an incident can be reported very quickly. This is accomplished through context sensitive menus and pull-down options. The initial report screen is shown here. When the reporter enters the patient ID number, the software queries the MOSAIQ EMR for the patient's name and physician. The date defaults to the current date, but a retrospective date can be entered. The Area is selected by mouse click, and that opens the context sensitive list of event Types.



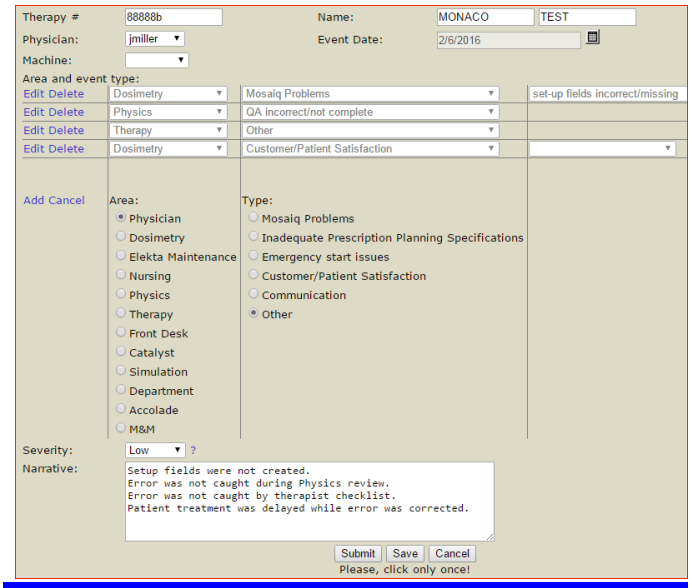


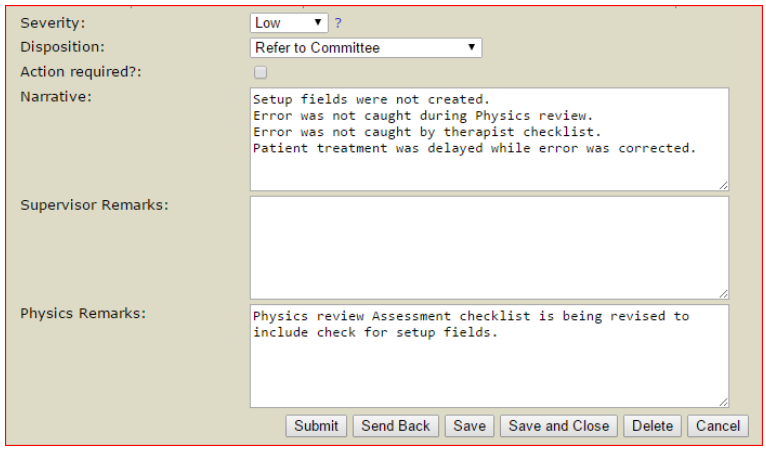
The pull-down menu of Severity allows the reporter to select Low, Medium, High, and Critical. Clicking the "?" opens a list of definitions. The reporter chooses the choice that seems appropriate. This can be changed later by a supervisor or physicist.

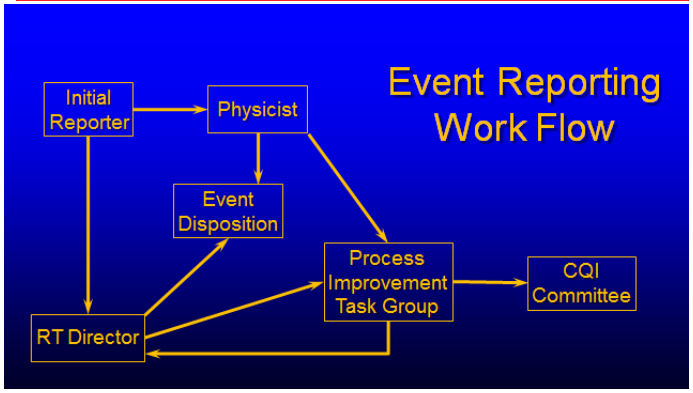
As shown in the next reporting screen, multiple areas and types of incident can be selected. A free-form field is available for the reporter's Narrative. It is not necessary at this point to include all the details, which can be added later. The reporter can save the report to be completed later.

When the Submit button is clicked, the report becomes available to supervisors and physicists. The system is configured to automatically email a notice to the physicist and relevant supervisor.

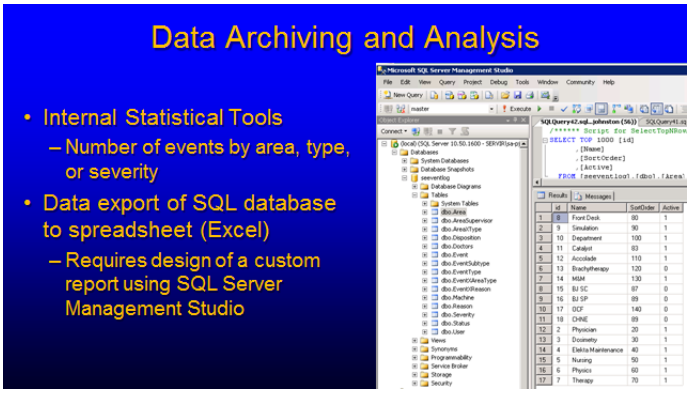
The physicist or supervisor has a field for remarks where they can note investigational results and description of any process improvement. The Disposition pull-down menu includes "Problem Resolved." Any corrective action or process improvement that might require assignment to a team indicates selection of "Refer to Committee."







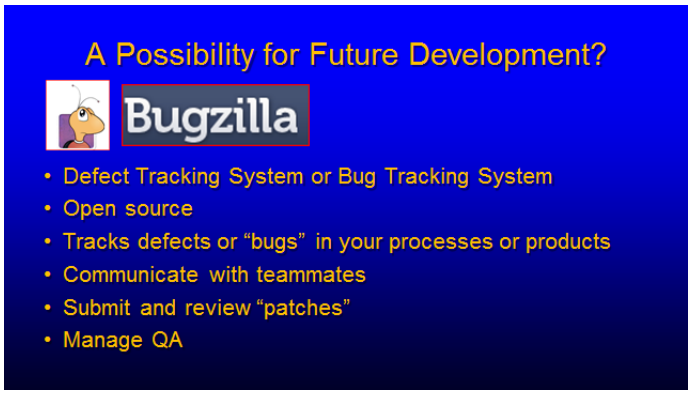
The event reporting work flow is shown in the figure. If the "Refer to Committee" disposition is selected by either the RT Director or the physicist, it is reviewed by the Process Improvement Task Group, consisting of RT Director, Physicist, Dosimetrist, and Lead Therapist. A summary report of any process improvements is reported to the CQI Committee.



The ILS system provides rudimentary reporting tools, including number of events by area, type, and severity. Data export from the SQL database to a spreadsheet requires design of a custom report using SQL Server Management Studio. This tool is also required for configuring the system for Areas and Types of events to accommodate the specific evolving needs of the individual clinic. IT support with familiarity with SQL databases is essential.

A weakness of this ILS system is the lack of easy analysis and reporting functionality. When the Task Group meets to consider opportunities for improvement, the hope is that there will have been many events reported. If there are recurring problems of a similar nature, the frequency of occurrence makes that a good opportunity for improvement. A means of mining the data by adding categories and sorting would make this task more efficient than the current manual method.

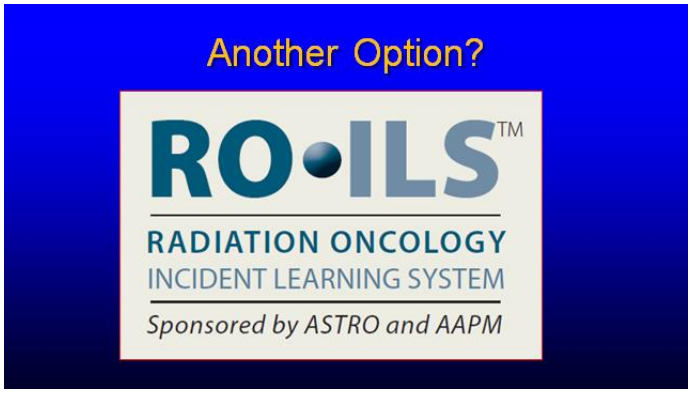
A possibility for creating an Incident Learning System with more reporting and analysis functionality is to use one of the many bug tracking systems that are commonly used in IT for reporting and tracking bugs, or defects. The process is the same as in an ILS, which is used for reporting and tracking defects in human processes rather than software processes. The most widely used bug tracking system is Bugzilla. It is open source software that is reported to be designed to



- Track bugs, or defects
- Communicate with teammates
- Allow submission and review of "patches," or process changes
- Manage QA

It can be customized with the types of defects to be reported and tracked. It will run on Linux, Windows, or Apple.

Another option for an ILS is the "Radiation Oncology Incident Learning System (RO-ILS)" sponsored by ASTRO and AAPM. I have no experience with this system. It appears to be intended for reported safety defects to a nationwide database. This is a worthy endeavor, in my opinion. However, I think that it would not provide the same benefits of ease of reporting to track opportunities for process improvements of all types, not just safety defects.



Strategy: Be the Town Marshal

For the next strategy, I want you to consider two medical physicist archetypes from 20th century American mythology.

The Lone Ranger

The fictional Lone Ranger was a wealthy former Texas Ranger, who swore to fight injustice. He, and his partner Tonto, would roam the territory looking for trouble in the land.

When they would find trouble, they would do some surveillance in town to get to the bottom of the problem. The Lone Ranger had the uncanny ability to appear at just the right time to thwart the troublemakers. Then he would ride away on his silver steed to leave the townspeople to mismanage their affairs in the same way that led to their previous problems. The Lone Ranger is a great American mythological hero who did as much good as he could under difficult circumstances.

This is the archetype that is emulated by many consultant physicists. They do the best that they can under difficult circumstances, but it's not enough for achieving total quality.

Marshal Dillon

The fictional Marshal Dillon was the resident lawman in Dodge City, Kansas. He was portrayed in Gunsmoke, the longest running prime-time television show in history, with 635 episodes from 1955 to 1975. Marshal Matt Dillon was played by 6 foot, 7 inch James Arness.

Marshall Dillon lived and worked in the town of Dodge City. He kept his finger on the pulse of the town, and he could spot trouble coming before it became a problem.

When trouble became a problem, he didn't need to magically appear. He was already there.

This is the archetype for the medical physicist who wants to assure total quality.

Summary

In summary, I have presented:

1. Quality of care as the greatest value for ethical decision-making.
2. The strategy of “Tools – Not rules!”
3. The strategy of delegation through the use of situational leadership
4. The strategy of process design and process improvement.
5. The strategy of creating a culture of Total Quality Management, and getting started on that journey with Root Cause Analysis.
6. The strategy of Experience Design and the value of guided transformations.
7. The strategy of the Opportunity, Influence, Impact cycle.
8. The strategy of seeking Opportunities for Awareness and Influence.
9. The strategy of customer-supplier feedback and why it’s the smart thing to do.
10. The strategy of being a Champ and not a Chump through intelligent giving
11. Strategies for effective reporting relationships using Matrix Reporting
12. Strategies for influencing behaviors in a group using Systems Theory.
13. The strategy of prospective process design with Failure Modes and Effects Analysis (FMEA).
14. The strategy of finding opportunities for improvement with an Incident Learning System.
15. The strategy of being the town Marshal, and not the Lone Ranger.

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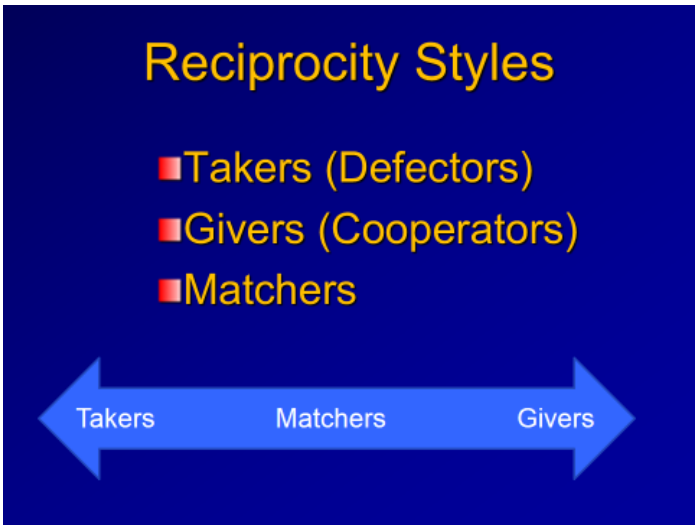
Appendix A: Organizational Psychology

Adam Grant is a Wharton Business Professor with a PhD in Organizational Psychology. In his book, "Give and Take," (Grant, 2013) he provides a perspective based on personal experience and on experimental study of humans. He also provides several individual case studies with stories of real people that illustrate his general conclusions. His findings are wholly consistent with those of Nowak in "Super Cooperators." (Nowak & Highfield, 2011)

Like all good scientists, Grant works within a model to investigate how well the model predicts the real world. In his model, he characterizes people based on their reciprocity styles as Takers, Givers, and Matchers. Takers and Givers are analogous to Defectors and Cooperators in Nowak's model.



Based on their reciprocity behavior in their relationships with others, he ranks them on a scale with Takers on one end, Givers on the other end, and Matchers in the middle.

He discovered some interesting things in his research and in the research of others. For one thing, he found that, in the long run, Givers are more successful. For example, new medical students were tested for reciprocity styles and their grade performance was ranked at the end of the first year.

The top students were the takers, who sought all the help they could get from the givers, but didn't waste their time helping other students.

Second were the Matchers, who would help other students if the other student would reciprocate.

At the bottom were the Givers, who helped everyone who asked, but didn't have enough time left for their own work.

At end of the second year, and beyond, the Givers moved to the top, the Matchers stayed at number two, Takers moved to third place and, interestingly, Givers were also at the bottom. It turns out that some Givers are Champs, and some Givers are Chumps. For the Champs, though, being a Giver is not good for a 100-yard dash, but it's valuable in a marathon. This pattern of success proves out across many different professions.

Nowak and Grant both recognize the importance of indirect reciprocity in dealing with Takers.

> We need to be able to recognize Takers in our everyday interactions. A challenge of networking lies in trying to guess the motives or intentions of a new contact, especially since Takers can be adept at posing as Givers when there's a potential return. Is the next person you meet interested in a genuine connection or merely seeking personal gains – and is there a good way to tell the difference?
>
> When we have access to reputational information, we can see how people have treated others in their networks. In today's highly connected world, these signals are easier to spot than ever before. Networks have become more transparent, providing us with new windows through which we can view other people's reputations.

Don't fall into the trap of stereotyping agreeable people as Givers, and disagreeable people as Takers. We often overlook that there are disagreeable Givers and agreeable Takers, otherwise known as "fakers."

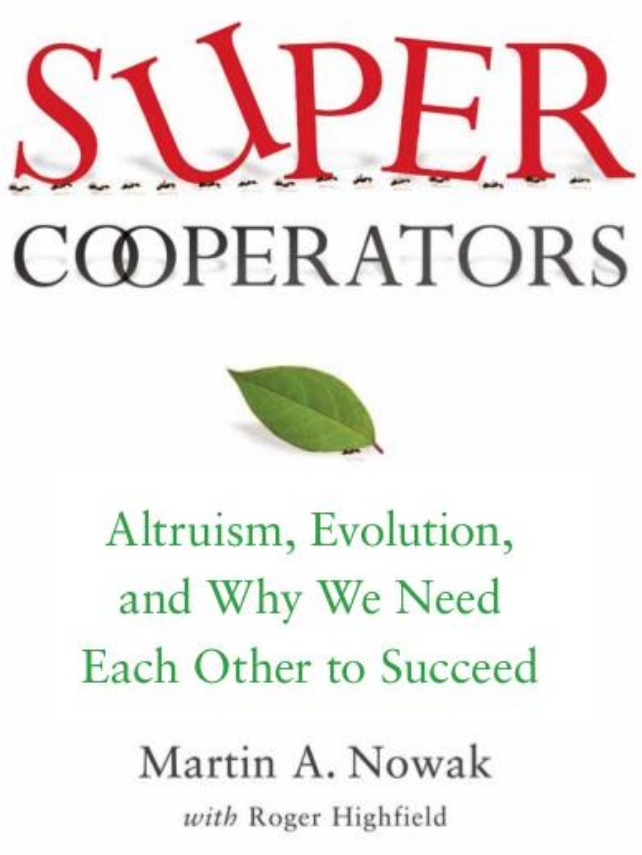
> Once successful Givers begin to spot agreeable Takers as potential fakers, they protect themselves by adjusting their behavior accordingly. They become Matchers in their exchanges with Takers. It's wise to start out as a Giver, since research shows that trust is hard to build but easy to destroy. But once a counterpart is clearly acting like a Taker, it makes sense for Givers to flex their reciprocity styles and shift to a matching strategy.
>
> According to Nowak, in "Super Cooperators," (Nowak & Highfield, 2011) an effective strategy, called "Generous Tit-For-Tat," is to never forget a good turn, but occasionally forgive a bad one. You start out cooperating and continue cooperating until your counterpart competes. When your counterpart competes, instead of always responding competitively, in Generous Tit-For-Tat, you respond competitively only two times out of three.

In group settings, Givers can make sure that they're not being exploited by getting everyone in the group to act more like Givers. Nowak calls this "The Scrooge Shift." People rarely have a single reciprocity style that they apply uniformly to every domain of their lives. If a group develops a norm of giving, members will uphold the norm and give, even if they're more inclined to be Takers or Matchers elsewhere. This reduces the risks of giving: when everyone contributes, the pie is larger, and Givers are no longer stuck contributing far more than they get.

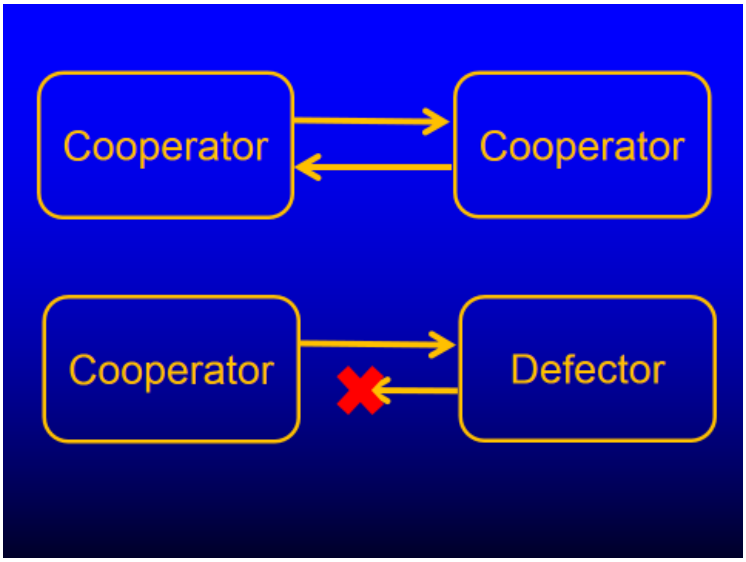
> Common ground is a major influence on giving behaviors. People are motivated to give to others when they identify as part of a common community.
>
> Being part of a group with shared interests, identities, goals, values, skills, characteristics, or experiences gives us a sense of connection and belonging. At the same time, being part of a group that is clearly distinct from other groups gives us a sense of uniqueness. The more rare a group, value, interest, skill, or experience is, the more likely it is to facilitate a bond. People are happier in groups that provide optimal distinctiveness, giving a sense of both inclusion and uniqueness. These are the groups in which we take the most pride, and feel the most cohesive and valued. These are the kind of groups that can influence someone to be a Giver.

Appendix B: Mathematical Biology

Martin A. Nowak, a native of Austria, is a mathematical biologist whose career has included stints at the Universities of Vienna, Oxford, Cambridge, Princeton, and Harvard. In his book, "Super Cooperators – Altruism, Evolution, and Why We Need Each Other to Succeed," (Nowak & Highfield, 2011) he describes his career and research in modeling the evolution of cooperation in various organisms and species. This modeling, similar to Monte Carlo modeling of radiation transport, scores the iterative application of variations of the Prisoner's Dilemma game to hypothetical populations. (Axelrod, 1984)



In this modeling, individuals are categorized as either cooperators or defectors.



In the simplest form, a cooperator extends something of value to another individual. If he receives a *quid pro quo*, the other individual is a cooperator. If the cooperator extends the value and receives nothing in return, the other individual is a defector.

In the classic Prisoner's Dilemma game, each player has two choices, namely cooperate or defect. Each must make the choice without knowing what the other will do. No matter what the other does, defection yields a higher payoff than cooperation. The dilemma is that if both defect, both do worse than if both had cooperated. (Axelrod, 1984)

Axelrod reported that, in Prisoner's Dilemma computer tournaments, the Tit-For-Tat strategy was a consistent winner over every other strategy when the competition covered many iterations. (Axelrod, 1984) The Tit-For-Tat strategy starts with being a cooperator, but switches to defector when the opponent defects. The Tit-For-Tat strategy is unforgiving of a defection. Nowak, though, found that when the interactions included a component of random errors to simulate human error, then a more forgiving strategy was the winner. He refers to that forgiving strategy as Generous Tit-For-Tat, in which the strategy is to forgive one out of three defections, and he asserts that Generous Tit-For-Tat is an effective strategy in human relationships. (Nowak & Highfield, 2011)

Nowak's research demonstrates how cooperation arose in our apparently competitive world. In evolution, mutation generates diversity. Selection, which can be either genetic or cultural, picks the individuals that are best suited to a given environment. But cooperation, says Nowak, is the master architect of evolution, which is as much about survival of the fittest group as the survival of the fittest individual.

This is not a new discovery, though, but a demonstration of multi-level selection theory proposed by Darwin, who once wrote that a tribe with many people acting like givers, who "were always ready to aid one another, and to sacrifice themselves for the common good, would be victorious over most other tribes; and this would be natural selection." (Grant, 2013)

By modeling the evolution of populations while varying the rules of interaction between individuals, Nowak discovered mechanisms that must have been at work for humans to have evolved into the Super Cooperators that they are. These mechanisms are:

- Repetition, which brings direct reciprocity into play. I'll scratch your back and you scratch mine.
- Reputation, which brings indirect reciprocity into play. I'll scratch your back, and someone will scratch mine.
- Spatial selection, which allows cooperators to prevail by forming symbiotic clusters of cooperators.
- Multilevel selection, in which selection acts not only on individuals but also on groups.

So, for human evolution, while it was important for people to not adopt a short-sided perspective in interactions with other people, it's the same characteristic that is important for success in a modern highly-connected world.