10.4.2 Johnson Space Center (JSC)

Johnson Space Center

Systems Engineering Behavior and Leadership Study

by

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TABLE OF CONTENTS

ABSTRACT

This study examined the behavior traits that contributed to making six, "highly regarded" practicing Systems Engineers (SE) successful at Johnson Space Center (JSC). Data gathering in this study was the initial step in designing a comprehensive strategy to develop SE talent at critical performance levels. The study enlisted the services of members of JSC's System Engineering Working Group (SEWG) and the NASA Engineering Management Board (EMB) members in selecting the candidates to be interviewed. One major element in selection was the stated requirement that these interviewees were the "go to" System Engineers at the Center. A JSC Organizational Development (OD) team interviewed, shadowed and observed these System Engineers for an average of 12 hours during a four month period (May – Aug) in 2008. In addition, all interviewees were asked to complete the Myers-Briggs Type Indicator (MBTI). This data was used to look for any patterns that this instrument might provide. The findings of the interviews were verified and validated at an August meeting with interviewees and SEWG members.

The SE competencies and linked behaviors derived from this study were grouped into six themes: leadership, attitudes and attributes, communication, problem solving and critical thinking, technical acumen, and systems thinking. This report outlines the competencies and associated behaviors for each theme. The study also found that of those systems engineers interviewed, eighty-three percent participated in the MBTI administration and represented five different MBTI personality types. However, when viewed using the Keirsey temperament classification from the MBTI, thirty-four percent were Intuitive-

Thinking (NTs), thirty-four percent were Sensing-Possibilities (SPs), and seventeen percent were Sensing-Judging (SJ).

INTRODUCTION

About Johnson Space Center

Johnson Space Center was established in 1961 as the Manned Spacecraft Center. In 1973, the Center was renamed in honor of the late President and Texas native, Lyndon B. Johnson. Its mission, from the early Gemini, Apollo and Skylab projects to today's Space Shuttle, International Space Station, and Constellation Programs, remains the same: to lead NASA's efforts in human space exploration.

For more than 20 years, JSC has been the home of NASA's Space Shuttle Program, conducting the longest human space flight endeavor in history.

JSC's more than 16,000 full time permanent and contract employees are committed to accomplishing these missions and getting back to the moon by 2020. Co-op students, scientists, engineers and astronauts all contribute to make JSC the agency's lead human spaceflight center. The data from this study will assist JSC in developing the talent so critical to human space travel. JSC, along with other NASA Centers, leads the world in technical knowledge unique to space travel. The challenge is to continue to develop that knowledge, and this study will do that by expanding the understanding of behavioral competencies of system engineers. The benefits will be far reaching for those interested in developing systems engineering talent.

Background

In March 2008, the Office of the Chief Engineer held a meeting with some of NASA's top Systems Engineers for the purpose of developing shared understanding and agreements regarding the practice of systems engineering across the Agency. Historically, there have been many definitions and descriptions of systems engineering used across the Agency. In fact, the actual practice of systems engineering varies across NASA. For the most however, part Systems Engineers agree that:

> *Systems engineering is the art and science of developing an operable system that can meet requirements within imposed constraints. It is holistic and integrative and incorporates and balances the contributions of structural, electrical, mechanism-design, and power engineers, plus many other disciplines, including systems safety, to produce a coherent whole that no single discipline dominates. Systems engineering is about tradeoffs and compromises, about generalists rather than specialists.*

Almost all NASA Systems Engineers also agree that systems engineering is a critical core competency in enabling the current and future success of NASA missions. This is why it is necessary for NASA to improve its development of systems engineers.

Several actions were initiated at the March 2008 meeting to begin this development process including updating the APPEL curriculum and establishing the Systems Engineering Leadership Development Program (SELDP) to enable top Systems Engineers to engage in hands on

developmental stretch assignments that would broaden and enhance their capabilities. Foundational to these development enhancements was an understanding of the systems engineering leadership behaviors that needed to be developed in order for systems engineers to go from good to great.

In order to achieve this understanding, NASA initiated a Systems Engineering Behavioral Study designed to identify the behaviors that separate superior systems engineers at NASA from the average systems engineers. This study looked at 30 "highly regarded" practicing engineers across the Agency to determine the behaviors that helped make them successful.

METHODOLOGY

The JSC Systems Engineering Working Group and Engineering Management Board members selected six "highly regarded" JSC Systems Engineers to participate in this study. One major element in selection was the stated requirement that these interviewees were the "go to" Systems Engineers at the Center. The interviewees serve in systems engineering leadership roles at both the project and program level. Two organizational development professionals, from the JSC Human Resources Development Office, interviewed, observed, and shadowed these Systems Engineers. Observation and shadowing settings included design concept reviews, multi-center review and change control boards, and project team meetings. In addition, the interviewees were administered the Myers-Briggs Type Indicator (MBTI). The interviewees were asked the same questions, with follow-up questions based on their initial answers. Appendix A contains the list of 16 interview questions. Interviews lasted from 45 minutes to 2 hours and were tape-recorded for transcription. The tapes were given to the interviewees after transcription upon their request. All interviews and observations were transcribed and analyzed using a "coding" process that grouped responses into behavioral themes. The interviewees verified and validated the findings. Due to schedule conflicts and travel schedule, not all interviewees participated in observation and MBTI. The study identified three levels of behavior, as described below.

Level	**Description**	**Example**
Top: Theme	Collection of competencies	Attitudes and Attributes
Middle: Competencies	Aggregations of related observable behaviors	Remains Inquisitive and Curious
Lowest: Actual Behaviors	Observable behaviors	When they do not know the answer, they will seek out specialists and ask the important questions.

FINDINGS

Themes

Six top themes, with associated competencies and behaviors, emerged from the study:

- Attitudes and Attributes
- Problem Solving and Critical Thinking
- Technical Acumen
- Communication
- Leadership
- Systems Thinking

Each is described in turn. The theme findings are followed by the Myers-Briggs Type Indicator findings.

- ## Attitudes and Attributes

  - *Remains Inquisitive and Curious*

    - Has a natural inquisitive and curious quality.
    - Asks difficult questions of discipline or subsystem experts regarding boundaries, conditions, assumptions to ensure continuity across all systems and to ensure the proposed solution is an integrated solution and fundamentally makes sense.
    - Asks probing questions to find weaknesses in a proposed solution.
    - Continues to ask "Why?" "Why did we decide to do it that way?" "What were the alternative solutions, and did we do trade studies that helped us determine why this was the best solution?"
    - When they do not know the answer, they will seek out the specialist and ask the important questions.

  - *Gains Respect, Credibility, and Trust*

    - Gains professional respect of others by respecting others and building positive relationships.
    - Gains credibility through a history of practical hands on experience, superior technical competence in at least one discipline, getting results, and possessing an understanding of systems and how the entire system functions as a whole.
    - Gains trust by following through on commitments and serving as an advocate for the team.

- *Remains Open-Minded and Objective*

    - Works hard to keep an open mind with few pre-conceived notions.
    - Frequently challenges recommendations and strategies for resolving program initiatives. Fairly and objectively evaluates solutions, listens to input and opinion of team members, and makes decisions based on facts and data rather than personal opinion.

- *Possesses Self-Confidence*

    - Fearlessly questions or challenges a technical assessment or proposed solution, even if those doing the assessment or proposing the solution may be more technically competent in their discipline or subsystem.
    - Confidently goes in front of a room of people who may be technically superior and says "That doesn't make sense."
    - Outspoken, not shy or timid.

- *Possesses a Positive Attitude and Dedication to Mission Success*

    - Displays a passion and love for the job through a positive attitude that manifests itself through interactions and communication with team members.
    - Enthusiastically expresses excitement about the work and the challenges of contributing to a great story.
    - Place a high value on mission success. Dedicate themselves to the success of the program, Center, and Agency. Clearly demonstrates this by putting in extra work hours to ensure the job is done.

- *Values Honesty and Trust*

    - Exemplifies honesty and trust of self and others. Sees mutual trust between team members as an essential element required to achieve success. This is evident when the systems engineer is expected to deliver on commitments and take all points of an argument forward as well as team members providing best efforts, accurate data, and recommendations.

- *Appreciates and Respects the Technical Competence of Others*

    - Recognizes limitations in discipline and subsystem knowledge. Recognizes what they know and recognizes what they do not know and are not afraid to admit what they do not know.

- Shows appreciation for the technical strength of team members and seeks guidance from specialists and subsytem experts.

- *Adapts to Change and Uncertainty*

  - Presses on with the project and ensures that the implications of changes are addressed throughout the entire system in the face of everchanging requirements.
  - Makes decisions with incomplete or imperfect data.

- *Uses Intuition*

  - Uses a certain amount of intuition and sensing when evaluating a problem or making a decision.
  - Doesn't rely solely on data. Have a "gut feeling" if the data is inconclusive.

Problem Solving & Critical Thinking

- *Identifies the Real Problem*

  - Identifies the real problem to be solved by asking questions and identifying the real requirements.
  - Drives for clear understanding of problem to be resolved by questioning and measuring a proposal against system requirements.

- *Assimilates, Analyzes, and Synthesizes Data*

  - Assimilates and distills large quantities of data and ensures all of the data is on the table to solve a problem or make a decision. Decisions made must be supported with data.
  - Possesses a very quick mind and has the ability to recall data in an instant.
  - Looks for answers that may not be readily apparent from just looking at the data alone. Doesn't rely solely on the tools outputting the data.
  - Breaks data into smaller pieces or parameters, prioritizes the parameters, then synthesizes the data to reach an answer or solution.

Technical Acumen

- *Technical Competency Development*

  - Demonstrates a clear mastery of basic engineering knowledge when engaged in conversation (to include a fairly detailed understanding of the discipline areas of expertise themselves) and branches out into multiple disciplines to obtain critical SE skill sets.

- Demonstrates knowledge and capability to understand the complexity of the system and be able to articulate the nuances.
- Is openly acknowledged and respected by peers as competent in at least one engineering discipline and demonstrates a breadth of knowledge in multiple disciplines acquired from personal inquiry of specialists and subsystem experts.

Communication

- *Identifies the Real Problem*

  - Uses standard identifiable units of speech to insure clear and effective communication of ideas, concepts, strategies, and level of trust/risk, thus ensuring consistency in questioning and challenging technical constructs.
  - Drives for clear understanding of problem to be resolved by questioning and measuring a proposal against system requirements.

- *Facilitates an Environment of Open Communication*

  - Uses selective listening to identify critical elements or parameters of the problem. Listens for information that leads to connections between system elements and information that disrupts connections.
  - Promotes the most efficient communication from a diverse team by demanding adherence to meeting agendas, assigned tasks, and focused presentations.
  - Canvases team for additional inputs at the end of discussion or just before decisions are finalized.
  - Encourages and respects the divergent opinions in order to drive convergence on decisions.
  - Facilitates critical questioning to ensure all information is on the table. Does not play the role of referee in discussion.
  - Clearly communicates requirements to external suppliers.

- *Uses Visuals to Communicate Complexity or Interconnections*

  - Uses visuals, such as venn diagrams, models, pictures, charts, metaphors, archetypes, and other relevant representations, to communicate complex problems or to display the interconnections of sub-elements.

Leadership

- *Focuses on the Greater Good*

  - Effectively listens to assessments and concerns of all team members, realizing each person on the team has a system of interest that is important

to them, but continually reminds team members of the greater goal or higher cause.
    - Establishes an overarching figure of merit or measure of goodness for the team so they understand how the designs or concepts they have come up with either do or do not add value to that measure of goodness.
    - Places high credibility, influence, and directions on uniting individual team members and the pursuit of a common goal.
    - Through discussion and debate, makes sure everyone is on the same page and the bigger picture is now being addressed.
    - Reminds people of the greater goal; understands what different individuals' agendas might be or what their different areas of expertise are. Guides the group of talented, yet individualistic people, into the goal for the common good.

- *Uses and Appreciates the Team Concept*

    - Uses the team environment and teaming strategies to accomplish mission. Establishes healthy relationships to foster team cohesion, strong mission focus, and system perspective by asking team members to give input, dissent, support for the initiative at hand. In addition, there are numerous sidebar discussions on the relevant options.
    - Understands the human element in a project is critical. Understands that team members are not always objective about decisions on the project.
    - Combines team challenges with a personal acknowledgement of individual input into the process through various forms of recognition.
    - Knows these technical experts make the difference.
    - Articulates the relevance of the team's work and its overall contribution to the success of the program and organization.

- *Leads Others Through Consensus Building*

    - Recognizes the source of good ideas is infinite and creates an innovative environment that is trusting of the decision making process. Clearly communicates drivers behind decisions.
    - Expects team to respect each other and process.
    - Knows that resolving differing opinions is important in clarifying the problem and fostering better understanding. Works hard to ensure vigorous debate is allowed.
    - Promotes a variety of responses to questions and answers in order to continue investigation and teamwork.
    - Uses the rigor of the problem to assist in defining the necessary discipline and attention to detail.
    - Gets everyone on the same page. This gives confidence that the decision or recommendation being made is the right one.
    - Makes decisions at the correct time in the process.

- **Systems Thinking**
  - *Thinks Holistically*
    - Possesses an approach that is comprehensive and intentionally does not favor any particular sub-element of a system. Looks across the entire system and facilitates trades and compromises to get a balanced design. May have to sub-optimize the piece parts of a system in order to optimize the bigger architecture.
    - Understands how all of the piece parts of a system work together to produce a desired result or behavior.
    - Zooms in and out on a system of interest, keeping the big picture in mind.
  - *Sees Interdependence of Elements*
    - Sees the trickle down effect or ripple effect of changing requirements or making changes to any element of the system.
    - Examines and explores the implications of how technical decisions being made affect the bigger system architecture.

The Future of Systems Engineering

In the interviews, two questions were asked about the future of systems engineering:

- How will the job of an SE be different 10 years from now?
- What will the future SE need to know and do differently?

The responses to these questions are summarized below:

- Do not foresee dramatic changes in the role or job of a systems engineer.
- Development of new and improved tools to do visualization, modeling, simulation, probability/statistics will help the future systems engineer.
- Due to increasing complexity of systems, the future systems engineer will have to be able to assimilate and analyze even more data.
- Future systems engineers must obtain practical hands-on experience, OJT, and be paired with a mentor who has been through it all and seen it all.

Myers-Briggs Type Indicator (MBTI) Results

The study also found that of those systems engineers interviewed, eighty-three percent participated in the MBTI administration and represented five different MBTI personality types: ESTP, ISTJ, INTP, ISTP, and ENTP. When these types were viewed using the Kersey temperament classification of MBTI, thirty-four percent were Intuitive-Thinking (NTs), thirty-four percent were Sensing-Possibilities (SPs), and seventeen percent were Sensing-Judging (SJ). The Perceiving preference is a major influencer in this group. The study population was overwhelmingly "I" versus "E" in preferences. Appendix B provides a brief description of each of the Kersey types.

As interesting as these findings are, a larger agency wide sample is necessary to show significant preferences and tendencies. A clearer understanding of these preferences and the behaviors associated with them could significantly lead to strategies leaders might incorporate to guide organization culture. Systems Engineers and other leaders might be better able to elevate the level of inclusion and innovation with this knowledge.

SUMMARY AND CONCLUSIONS

The six systems engineers studied share a number of common behavioral and leadership characteristics. Essentially, all interviewees shared a way of thinking about the problem to be solved. They are able to get a comprehensive look across the entire system and understand how all of the elements of a system work together to meet requirements. They are masters at facilitating compromises and trades in order to optimize the performance of the entire system, without favoring any sub-element of the system. They thrive on solving complex problems that require them to ask questions and assimilate, analyze, and synthesize very large quantities of data. While they are not technical experts on every sub-element of the system, they know who the experts are and will seek those experts when they have questions. Through questioning and remaining curious, they are able to increase their own technical knowledge by consulting with subsystem and discipline experts. They are confident, curious, respected, open-minded, and dedicated to accomplishing the mission. They lead the team by creating and facilitating an environment where everyone's perspective is heard and recognized. They are able to build consensus by ensuring that everyone on the team understands the problem, is encouraged to provide input to solving the problem, and understands the rationale for final decisions. They remain focused, throughout this process, on the greater goal and continually remind the team of the common goal they share.

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APPENDIX A

Interview Questions:

1) How would you describe the role of the SE?
2) On a scale of 1 to 10, how important is the SE in the success of a program or project?
3) Create, in behavioral terms, a statement that would describe you as an SE.
4) Identify the attitudes and attributes a "highly regarded" SE possesses.
5) What leadership behaviors does a "highly regarded" SE possess?
6) As an SE, what leadership abilities do you possess?
7) How are these abilities displayed?
8) On a scale from 1 to 10, how important are these abilities to mission success?
9) What general knowledge does a "highly regarded" SE possess?
10) On a scale from 1 to 10, how important is this knowledge to mission success?
11) What values drive you as a leader?
12) How are these values reflected in your attitude?
13) Describe to me what goes on in your mind when you are problem solving.
14) What do you look for in determining if someone will make a good SE?
15) How will the job of an SE be different 10 years from now?
16) What will the future SE need to know and do differently?

APPENDIX B

Kersey Types

Some of the most important recent work done in the field on Personality Typing has been done by David Keirsey, who has created the theory of temperament associated with type. In his research, he has made observations that have allowed him to combine two of the four sets of preferences, into four distinct temperament categories. Each of the sixteen personality types fits into one of these temperament categories. The titles used here for the temperament types, and the individual personality types listed within each temperament, are Keirsey's own descriptions. You'll notice that they do not match our labels for the types. Keirsey describes the SJ, SP, NT, & NF in the following manner:

SJ - "The Guardians" The SJ group's primary objective is "Security Seeking". The SJ grouping includes:

- ESTJ - "The Supervisors"
- ISTJ - "The Inspectors"
- ESFJ - "The Providers"
- ISFJ - "The Protectors"

SP - "The Artisans" The SP group's primary objective as "Sensation Seeking". The SP grouping includes:

- ESTP - "The Promoters"
- ISTP - "The Crafters"
- ESFP - "The Performers"
- ISFP - "The Composers"

NT - "The Rationals" The NT group's primary objective as "Knowledge Seeking". The NT grouping includes:

- ENTJ - "The Fieldmarshals"
- INTJ - "The Masterminds"
- ENTP - "The Inventors"
- INTP - "The Architects"

NF - "The Idealists" The NF group's primary objective as "Identity Seeking". The NF grouping includes:

- ENFJ - "The Teachers"
- INFJ - "The Counselors"
- ENFP - "The Champions"
- INFP - "The Healers"

APPENDIX C

Interview Coding

Top Theme	Response
Attitudes & Attributes	Experience is important
	having a naturally inquisitive quality
	high tolerance for ambiguity…it's an ambiguous job and you have to make, you have to create something solid out of matter that's very squishy
	I have been out'dueled by people better than me and I respect those people greatly
	if you could say…I designed the first spacecraft that landed on Neptune, there's a certain amount of immortality that goes with that
	if you're a known commodity, if folks have heard of you and they know that you're a good leader, they will sometimes take your leadership abilities just based on what they've heard about you
	pliability…you have to be adaptable to change…adaptability is maybe the best characteristic, constantly adaptable
	Project will fail if the art of SE is not practiced correctly
	start them out getting their hands dirty, with hands on the spacecraft and actually seeing how the piece parts go together
	the best SE's are the folks who are always stepping back going "Why are we doing it that way?"
	There have to be a couple people who practice SE as the cerebral art…those are the people who actually make a project work
	There is the practical or the art part of systems engineering that's more creative thought than anything else
	there will be more emphasis on practical training, on getting people practical experience, and less emphasis on getting a PhD in book smart SE
	they'll need to be able to relate what they've learned in an academic setting to the way SE is applied practically
	training should be focused more on the art of SE rather than the process of SE
	we need to get people hands-on experience
	we're all interested in somehow contributing to a story that's much bigger than any of us…and by doing so, saying that I play a part in that story
	we're trying to create things that no human has ever done before…the ultimate value is immortality
	you have to have a natural inquisitiveness about why things work successfully or why things work unsuccessfully…
	you have to constantly be looking for answers that are not readily apparent

you have to have an open mind…no preconcevied notions
No, I'd say it's an equivalent kind of a job
I believe being open-minded is a really key behavioral characteristic.
you've got to be an obviously value-added member of the team,
that the right solution trumps somebody's bias over what's the right design.
in the beginning all of us are unproven, unaccepted.
Sometimes that's hard for people to accept
a recognition of the objectivity
get a fair shake.
My opinions will be heard.
My concerns will be evaluated.
a feeling that I'm smart enough to understand your issues,
smart enough to understand the compromises
have systems,
can't give them authority to give a peer work.
characteristics are absorbable it's observable.
will mature and have the right characteristics.
it gets to be innate,
no salary difference
it'll get done.
self-satisfaction is the dominant perimeter in my success.
can't tie your personal job satisfaction to that.
end up unhappy all the time of things you can't control.
'It's the quality of the endeavor that counts and not the results'.
I don't have to second-guess myself.
second-guess yourself
your instincts as opposed to some solid factual basis.
pressure increases your ability to focus.
Pressure sometimes unnerves people
pressure as work harder, work longer, work stronger under pressure as opposed to falling apart under pressure.
back to the behavioral concept.
the way they think about problems.
the effectiveness that they have with working with their peers
willingness to adjust their characteristics to be a team player
assume do it myself than getting any help.
can begin more quickly,
Being exposed a tool doesn't mean you use the
don't see the basis for the concern.
if there were gonna be dramatic changes, it would have been in my career.
Whether you use them or not is your behavior.

That knowledge has to exist in a systems engineer.
be more of a different aspect of a person’s personality or quality.
Having good intuition,
There might be a certain art to it that is difficult to define
Sometimes it’s a gut feeling in making a decision
I guess inquisitive.
So intellect.
Intuition, I think there is a little bit of
a gut feel involved.
I think you kind of have to have a type A personality
you can’t be soft spoken
may not be effective in communicating if you’re soft spoken
A proactive attitude.
be proactive with issues and concerns.
A positive attitude is a benefit rather than a negative attitude.
have a positive attitude and have some optimism.
I think I feel comfortable being a systems engineer.
And personal aside,
I’m dedicated to my job.
I want to make sure that this is done.
You can see if someone is dedicated or just putting in the hours. I think those are things people can see.
that's kind of where you learn if there's a weakness in what you understood of somebody else, that one or two other people may have a better grasp of that or may point out something you missed
I think it tends to be get the big picture from as many people as you can, distill that in your brain, bounce it against a few more smaller groups of individuals
poking at weaknesses
pull at the underpinnings of what they're telling you and see if it makes sense
the SE is the first guy that needs to challenge you and make sure your story's gonna hold together and that you've bounced it against the other disciplines appropriately
you're looking at asking basic questions as it relates to boundary, conditions, assumptions…
you're interrogating those basic boundary conditions and basic assumptions to make sure there's continuity across all systems, even though you're not a systems expert
you're looking for someone that's going to challenge you and maybe not adversarial in the sense of you taking it personally, but you're a little bit afraid to go in front of that person and be wrong
someone you have enough respect for that you're gonna make sure all your I's are dotted…

It's gotta be someone you highly respect…

You've got to be seen as being very confident and not afraid to question people that are, in fact technically, superior

…at the same time you've got to stand in front of a room ful of people that, technically may be your superiors, and go "that stinks…that doesn't smell right..you guys have lost the forest through the trees…it just doesn't make sense at the most fundamenta

be confident and not be insecure about going in and saying, 'what, this doesn't make sense.'

in that natural skepticism or natural curiosity about why it is

good judgement about who they trust and who they don't trust

integrity and honesty

if you promise the team that you'll go follow up and you'll integrate something and you'll make it happen, you have to do those things or they won't trust you to do that…and they won't bring you their problem the next time and then the SE&I function break

if they don't think that you can do anything for them, they won't come to you

you want to show them that you're gonna tell them the truth, you're gonna be honest

They're gonna continually bring you their problems, even if you kind of take it out of their hide in some meeting because they know you're gonna be effective for them

I think I am kind of hard on the technical guys sometimes but I do think that they know and I will demonstrate to them that I will be their advocate

you can't be shy

so it's probably just as much about being able to get in there and deal with the problems head on

If you can be competent and respected in your own discipline, you probably have all of the engineering tools you need to be competent and respected across the discipline

you can't do the systems engineering job if you don't have the confidence, the ability to not be popular

you're trying to challenge the fundamental premises on which they're building

you've got to be willing to be unpopular

you've got to be willing to ask questions and not be afraid to ask questions

attitude should be excited about what you're doing and excited about your mission and, of course, working at NASA that's easy.

They're excited about what they're doing.

They love their job and really it doesn't matter if it's system engineering or what

have some excitement about what you're doing and come across that way.

your attitude toward your job, they tend to…it's infectious as far as helping you and it excites other people

	You have to have sort of a ‘self starter’ type. You can’t be someone that has to be directed every step of the way to be an effective systems engineer.
	You’ve got to be hungry to go dig in to find things, to go ask the questions, to be curious about systems.
	And if you’re not curious…it’s a good attribute for a systems engineer
	So you have to be hungry and curious and want to get more information.
	So you certainly have to be someone that’s excited about your job and excited about your mission of your organization.
	I hate to toot my own horn
	I love my job I love doing systems engineering I love doing it with this organization
	I’ve got a bunch of really good people
	You will get on my bad side if you half-assed it.
	Honesty, integrity.
	My tendency is to trust people to do the right thing. But once you give me reason not to, it is real hard to get it back
	Once someone’s been dishonest to me, I will not trust them.
	And I hate that. I don’t like that. And I don’t want people around me that I can’t trust because it’s so important
	I know Mike doesn’t like the current systems engineering handbook and he’s trying to put together kind of the art of systems engineering. That’s a great goal and I’ve been kind of thinking about that.
Communication	be able to explain why certain decisions are being made
	I'm a visual leader. I like to communicate with more than just words. I think pictures and examples, metaphors, archetypes, all those are important in explaining why you've made a decision
	it's a network diagram…I'm constantly using Venn circles to explain to people how systems work with a Venn diagram…people get it right away
	process a lot of information and be able to convey it to people in a way that they can understand why certain decisions are made
	when they make a decision they can explain why they made it and everyone falls behind them
	you have to be able to communicate the answer
	you have to be able to explain why, in a big systems perspective, this is the best thing to do
	you always have to work with somebody else.
	You don’t usually do systems engineering in your own blue sky.
	you’ll cause perturbations.
	needs to be a very good relationship.
	needs to be viewed as an unbiased recommendation.
	a compromise, it’ll be in the nature of the best for the big picture.
	very seldom a one-person job.
	was respect.

has to be professional respect

can’t be any berating of people or bullying or whatever.

a belief that the technical strength of others is appreciated in the process.

all part of the same organization, the same community

the help me out ploy.

more genuine you are, the better you are.

get along with people,

the mutual respect

You can’t do your job if people aren’t willing to work with you.

working across systems and you’re gonna be dealing with so many different people.

communicate to all sorts of different people.

so many people you have to communicate to,

different types of people you’re gonna have to communicate to.

listen to everything that’s being said,

leading to, around communication. But patient, is maybe part of that too

There are all sorts of different types of people and you have to be able to communicate with them all and to listen to them all.

You have to make sure that everyone’s on the same page and working as a team.

make them understand what some of the implications were of implementing this different design.

Make them understand your concerns

Everyone has to understand what’s going on.

You have to help educate everybody

I control the meeting to the aspect of making sure all the data is on the table,

Make sure it’s all on the table.

likely that every individual is different.

Mentoring, I think too.

It’s very difficult for one person to do everything.

I think it's listening and communicating and having the tolerance to do that many times

come up with some overarching figure of merit or measure of goodness that you can give them so they they can understand how the work or designs or concepts that they have come up with either do or don't add value to those figures of merit or measures of

yes, that's a very nice concept you have. Unfortunately, there's not enough money to do that. You're significantly contributing to us exceeding the money we have available. Please try again

willingness to listen

look for more of a consensus discussion kind of person

brings up issues and lets the manager know when he needs to make a decision.

	Make sure that those issues are communicated
	it's our responsibility to make sure it's communicated
	check off through all of those things and assign actions
	formal process for closing those so it doesn't get lost in the shuffle.
	I was trying to keep from getting attitudes confused with personalities.
	You can't have someone that's a systems engineer that doesn't have really good communication skills.
	You've got to be able to communicate, both technically and personally, with a wide variety of people
	So you've got to be able to talk to those guys.
	You've got to have good communication skills that's written and oral.
	And you absolutely have to have communication skills.
	I kind of think I do fairly well on communications. I think I've got a pretty good grasp of a lot of different technical disciplines and understanding.
	One of the things I think I do quite well is taking a complex problem and getting the essence out of th
Future	the tools that you have to do visualization of how things interact will be better
	The tools will be better
	Leadership0 years is gonna make any difference at all.
	Leadership0 years is not very long in terms of where we are today.
	don't see that dramatic change.
	Well, I think in Leadership0 years, the job of a systems engineer can be modified given the technologies, the implementation of technology, how they work.
	Give him somebody who's been through it all and seen it all and help develop that young system engineer.
	there are many tools and analyst techniques that have been developed…they tend to give you insights much earlier in the program than we have had before..we are starting to learn the behavior of what our designs are likely to be much earlier in the design
	tools that can do statistics, probability and risk early in the design process
	there are probably tools and skills needed to deal with that
Leadership	gregarious and outgoing…I found it easy to have people get in line behind me and follow me
	if you're a known commodity, if folks have heard of you and they know that you're a good leader, they will sometimes take your leadership abilities just based on what they've heard about you
	the ultimate payback is when the mission succeeds
	when they make a decision they can explain why they made it and everyone falls behind them
	you have to be able to have people support you in that position
	you have to have people rally around the direction that you think is right
	it's a shared responsibility.
	I don't really see a higher hierarchy there.

ability to lead the team.
ability to organize a group,
effectively use that group
leadership to have people participate
leadership that you generally don’t boss them.
not generally your employees.
generally peers.
It’s a peer leadership relationship.
aren’t hierarchical.
same organizational position
not a hierarchical relationship there.
a peer leadership situation.
person that’s trying to lead the team has to demonstrate that respect.
leader of that group needs to tap that expertise
can’t do it themselves.
higher cause
I don’t know how you would say respect is less important than being a leader, having respect.
don’t see a hierarchical arrangement there either.
highest standard would be credibility.
credibility on the individual.
credibility it’s # Leadershipon my list.
a set of responsibilities that are not the same as the organization
I don’t think my responsibility stops at doing whatever job I’ve been given.
also part of the management team for the next higher level. In this case it’s the directorate. I think that part of my job is seeding that management team with my experience, my ideas, my ability to think through issues
I owe the next level up
put it on the table.
put out a quality product,
before I act
But anybody can have a good idea.
how smart you have to work,
encumbered to stay with the bureaucracy of age.
There was no time for the bureaucracy
Leadership0 years is too short.
haven’t even finished building the space station yet.
is looking at the big picture across systems
having enough intuition in order to address concerns,
I would say it’s a 9
Leadership abilities
it’s important to be a people person.
making sure we all function together as a team and being as efficient as

we can
get all these people together
You certainly don’t help the third party if you just say, no.
make sure everyone’s on the same page
I try to let the team decide and make the decision as a team.
helping, educating, so that we’re all on the same page as a team, so that everyone can come to the same conclusion.
“I don’t want to be the one that makes the decision if somebody over here disagrees with it because they still don’t understand why the decision is being made.
So you try to make the team as global,
as a team make the decision
that also takes time to do that too.
That’s really the one thing that I really control.
Other than that, I try to let everyone come to the conclusions that, and with the data, make the decision.
So I think people know me more as, I come in a room and get everything on the table and let’s make a conclusion together as a team before we recommend something or before we go forward with some decision
I think when you get to points like that, situations like that, then you just document that you have a difference of opinion.
I’m gonna say as it applies to mission success, I would say a 9
Making sure everyone’s on the same page, I think can help conclusively give you confidence that the decision recommendation that’s being made is the right one.
I think bringing them forward, the differing opinions, is important because maybe, just maybe, there was an aspect that, at your level, you just didn’t understand.
A certain dedication is important to ensuring a successful project or mission.
I’m gonna do is make sure that we are addressing all the right aspects of it,
I think I’ve seen other leaders do, in meetings that I’ve been in, in the past.
I think for me, that second aspect is more learned and the first part’s more just me.
it's sort of continually reminding people of the greater goal; understanding what different people's agendas might be or what their different areas of expertise might be but still guiding the group of talented, yet individualistic people, into the goal fo
you certainly have to be tolerant with the views and the priorities that individual systems experts have…you have to be sensitive to their concerns, sensitive to what they think is important…but you have to be firm in communicating that while you understa
It's to trust his experts, maybe get independent assessments of them, but they're really not to override them on their technical disciplines

support of the work and the decisions the team has come up with take ownership of what the team does…it's your responsibility with the, would be, leadership, a responsibility of running the team..its support and ownership
consider everbody's input
I tend to bring them down gently if it's not the right answer for the larger question that's being asked…perhaps offer a suggestion or redirection you don't really just say, no, that's the wrong answer, you go away and I'll find someone that gives the right answer
build consensus fairly effectively that way..I think that's important…it's not necessary but I think it's important that you do get agreement from everyone that the bigger picture that we're going after is now being addressed in the right way
Everybody doesn't have to be happy but I prefer that they are
show appreciation…I think I tend to let the team know very clearly that this is their work that's responsible for our success
it's simply verbal, just civil behavior, even in very long, very tiring meetings or get-togethers or debates or technical assessments…showing respect and gratitude verbally…appreciation awards…making sure that appreciation back to the home organizations g
so you can either make a job out of this for people or make it something that's challenging and enjoyable and make people feel that they're part of the process and not just a cog in the machine
I think almost everybody is dedicated to the success of the agency and the success of the role it plays in what the country does…so it's really the success of the program, success of the agency is realy how I look at it
We need to fix the problems and redesign the hardware to meet the mission goals we set forward for Constellation
look for more of a consensus discussion kind of person
I would not pretend that I'm superior, from an engineering perspective, discipline perspective, any of these guys that I take to task at a meeting, but they can be very discipline-focused
you've got all of these technical experts at your disposal, so you've got to know how to use them and you've got to know what you do know and what you don't know
teaming…being able to work in a team environment
lead by example, in terms of how you integrate the systems in the decision making process, making sure all the right disciplines are there
you kind of have to get it through trial and error and asking questions and not being afraid to say…I don't understand how my TV works…
you have to figure out how to supplement your own knowledge deficits you have someone you can go to and go,"This happened today and that doesn't make sense to me."
sometimes you're gonna ask them hard questions and it's not gonna be pretty and you don't feel bad, personally, against them and they shouldn't hold that personally against you.

	the systems engineer is the guy that has to be someone that's kind of a jack-of-all-trades, my mind adds value to the meeting products that we deliver, getting ready for the mission. To be a good leader, you need to set the example, set the tone I'm not afraid to make a decision. Another way to get on my bad side is to agree with me all the time. I want people to think about what they think they should recommend I like pushback If you're talking about my office, my system mission is to provide the SNL function to the Shuttle program, for me their in the 8 or 9. You've got to understand people because you're dealing with people. And the people skills, in my mind, are as important as the engineering skills because if you can't deal with people, you can't do your job. I've always…I've never taken credit for anything that I didn't do. I've always been honest with people and you have to be. Making a commitment and sticking to the commitment is quite important to me. If you're not as good as your word, then I'm not sure w I'm for the greater good as opposed to what's best for me. People are more committed to the greater good than they are to themselves That's the way I am. I value those things and I expect people to be that way as well. I want to trust people. We're kind of in a bubble because we have people that are trustworthy and want to do the right thing. Like I said, thankfully, I haven't run into that, although I've seen it. Yeah, it's the distraction and you don't need that. If a decision doesn't have to be made, sometimes it's better to think about it for maybe a few days or maybe a week. Because a lot of times if you think about it for a few days, the fuzziness will sometimes clear up a little bit and sometimes something wi That if I don't have to make a decision and I can wait, that sometimes it's better to wait because I don't have enough information. That's kind of like when you're hiring folks, it's trying to get someone that has all these things that we talked about, skills, engineering, communication, personality You've still got to do the same basic functions no matter what the issues are and no matter what processes you put in place. For a systems engineer, it's almost like…for a painter, you either got it or you don't. You either can do systems engineering or you ought to go do something differently. Not everybody's cut out to do systems engineering and they shouldn't.
Problem Solving & Critical Thinking	being able to recall that knowledge on an instant is absolutely required

can visualize the best direction a particular decision should take
data-driven decision maker
if there's a solution that people are going down that doesn't feel right, I'll start thinking about different ways to do it
if you are making a decision, even if it's an unpopular one, and you have data to support it, it's very hard to refute that that's a logical decision
if your decisions are data-driven and you can show that you've concatenated all of the right data together…it's easy to make a very effective argument that you've made a valid decision
it's a network diagram…I'm constantly using Venn circles to explain to people how systems work with a Venn diagram…people get it right away
they have to be really quick on their feet and really quick with their mind to be able to assimilate lots of data
visualize the problem
we make decisions based on data and facts and knowing how things operate best
you have to be able to assimilate a whole lot of data very quickly
you have to have a very quick mind
you have to support your decision with data
It's a systems engineering problem.
Then there's another level.
I think that behaviorally, you must keep your mind open.
You can't prejudge an answer.
you can be smart enough to prejudge the answer potentially.
How will they interact with the vehicle?
You do it with somebody else's hardware, somebody else's software, somebody else's…there are others out there.
a systems engineer needs a lot of information from the things,
there needs to be an obvious objectivity.
doesn't favor one approach or one system or one concept over another.
systems engineers work in teams.
making sure that the system is optimized, not the subsystem.
can't be any personal issues.
don't get to the vehicle level.
don't get to the integrated system level.
separate the variables
hard to solve a mixed up problem.
It's related, sounds related, but it's not.
So I think sorting the variables is the first thing you do.
dealing with the pieces of the problem
a lot of any decision has to have a data acquisition phase where you're gathering information,
begin to gather data,

to get all the pertinent information.
trying to be thorough.
it's part of the data acquisition process.
sort the variables and weed 'em out.
you have to shave the information based on where it comes from.
time is a secondary variable.
how quick you have to focus to make decisions,
how much check and balance you can have.
trying to resolve a problem
making sure that all the right validations and verifications are performed
you know when you fly
don't have a failure or something because you didn't properly verify
certainly like to make decisions based on data.
address any questions that might come up,
And take personal opinion out of the equation
Then bring it back up from there,
cost and schedule,
try to help everyone understand the convergent issues
so that as a team, they can all see that and all come to the same conclusions.
And everyone has seen the data and all come to the same conclusion.
And you move forward to the next board or to the next manager that may be making the real decision.
kind of understand what's important and what's not important, what's missing to what's needed to be included.
need to make sure or try to make sure that I understand all that.
understand the most important parameters of that problem.
how do I attack,
It's a multi parameter problem.
have to try and understand which problem is most important so you can tackle the problem most efficiently and make sure that you have the right priority in resources to go look at those particular parameters.
can't solve the problem in a meeting, one meeting.
draw up a little bit of a plan for dealing with the problem.
Assign tasks to people to go work certain aspects of that problem,
I try and draw the most important aspects of that problem and make sure we're adjusting all the important ones that are missing.
Then once that's done, then you can move on to the 'ok, what's the plan?'
Fix this or adjust the problem. So that's working the resources, the schedules, to work the aspects of the problem, to solve the problem.
you're trying to make sure that first all the parameters are on the table, there's none missing,
start prioritizing the most important ones.
The second part of doing the priority,

look at as much information as I can or get as much informed opinion from the experts as I can

I think I tend to visualize, out of information I'm hearing, where the right answers would be leading

I think it tends to be get the big picture from as many people as you can, distill that in your brain, bounce it against a few more smaller groups of individuals

every once in a while we put study teams together and try to get more information on it and when it comes out it's just not a conclusive answer yet…when you really start getting down to saying it's time to do it and you just can't do it, then it's got to

be able to draw on cumulative knowledge they have and say that does or doesn't make sense

you're kind of looking at these issues and tearing them apart and putting them back together…in my case, I almost see it like a big filing cabinet where I've stored away everything I've heard

I've been blessed with a very good memory so I don't rely a lot on written notes

everything really that you're relying on is kind of what you can remember so you start flipping through that filing cabinet in your brain to try to tap, pull out all the pieces of data and tie them together

And you say, did you talk to so and so, did you know about this and are you aware of these other things that are going on?

You have to pull all those pieces of data, out of the filing cabinet and say, so you're telling me with these other pieces of data that you didn't see…It's like a puzzle

you get all these pieces that are kind of turning around in your brain…then you get the one piece that fits and it all kind of falls into place and you say…when I tie it with this thing, that draws me to this other conclusion…

it's either like a puzzle or a filing cabinet or something that pulls all those pieces together

it's finding the best way to do it, from multiple options

the amount of data you have to manage…so there's probably a lot that's changing in terms of the amount of data you have to manage and understand in that filing cabinet

I get inundated with data real-time. So figure out how to manage and distill all that data

it really becomes a matter of complexity of the system and the amount of data you're trying to manage in your decision making process

I'd rather have more data to make a better decision

I think sometimes we can't call it very well and it winds up clouding up the decision

so that's part of the SE process where I was trying to put a filter on what's coming out because there was so much data

The tools are really supposed to help the system engineer get information that allows him to make a decision.

	he has to look at the total system and make trades.
	Where I think a lot of folks get hung up is, they let the tools drive them as opposed to…the tools are just supposed to be something you use.
	it's a thought process
	The systems mentality needs to be also permeated down into the different elements.
	can save you a heck of a lot of money
	train the people to think from a systems
	So you add maybe a value to the meeting by a broader perspective, if that's required in the meeting.
	I do try to make sure that I've got all the information I need before I make that decision
	And that has been a learning process over my caree
	I want to hear the data and I want to hear a lot of different sides of the story but I'm not one to go wait for very long.
	I like to argue
	I like people that think on their own
	The first thing is make sure I really understand what the real problem is because some people will bring you what they perceive a problem to be and that's really not the problem. Sometimes you have to dig a little deeper to find out what the real problem
	So my first inclination is to first try to understand what is it I'm trying to solve and what decisions do I need
	So understanding the issue. It could be a technical issue. It could be a political issue. It could be a personnel issue.
	do I have all the data to go make a decision or do I need to go collect some more data
	Then a lot of times, if they're really too gray, I'll put it off until I get some more data or at least think about it for a little bit longer.
	Don't make a decision too quick.
	They go through that process, do these guys fit into the office, are they substarters, do they have good engineering backgrounds, do they have good people skills, do they have good communications skills?
	The key is to be able to assign them to positions that are jobs that make them successful and they get good success ratings because they're in something that they're capable of doing.
Systems Thinking	…if the person answers anything but they're all important, they all have to work together to make it work, they probably don't have the aptitude to be a systems engineer
	…it turns out that if I just add a coulbe kilograms…the whole trick down effect of it
	big picture thinker
	conductor of the orchestra - SE keeps all of the piece parts playing the same tune

how broad is their focus…if they really love GN&C systems and they want to be the world's expert in GN&C, that's great….but that person is never going to be a systems engineer

I have to see the lander as a piece part in the whole system that will take us back to the moon

I may have to suboptimize my piece part in order to optimize the bigger architecture

I see things as a network diagram where everything is connected to everything else and there's inputs and outputs going between every one of the piece parts

I think you've made this big categorization of a group of people who essentially share a way of thinking, in common

it's a way of thinking

not an expert in any of the particular piece parts

SE is applied at many different levels…spacecraft level…mission design level…administrative level

see how all of the pieces fit together at the top level, the pieces are missions and politics and budget…

sees a project or a spacecraft as a big interconnected series of piece parts

step back and look at the big picture

they have to have the right mindset to think of problems in an SE sort of way

they think they have a better way of doing it because they're thinking a little bit at a level above anyone else

understands how all the interconnections work

understands how everything fits together

you have to be able to make lots and lots of connections to understand how the data interconnects with one another

you have to have seen examples of how systems actually work…see how their little subsystem fits into the bigger subsystem

you have to quickly be able to assimilate all those puts and takes to understand how the whole system works together

zoom lens..you have to be able to zoom in on the piece of interest that you're looking at…but you have to quickly zoom out…

Then you put all those together.

There's a systems engineering component that says, all of that working together has to be a comm system.

So I don't believe systems engineering infers by its name, a level.

a way of thinking,

a comprehensiveness

they're dependent jobs.

There's a lot of ways you can do it.

when you finally get to the systems level, that's a detriment.

the longer you can keep an open mind and fairly and objectively evaluate

	the alternate ways to accomplish the function, the better you are.
	And usually it's more subtle.
	I think it's a little bit more subtle.
	as a systems engineer points upward and reports out and tries to seek the agreement of management of essentially optimizing a system,
	compromising compromises to get the best overall system.
	In an integrated design,
	best system level answer,
	expected to have an optimum system kind of an answer
	an optimum system approach
	thinking cross system, across components, or across subsystems is a characteristic
	learned or whether it's the way you think.
	I see parallel paths.
	I don't see that as an either/or.
	still a subsystem systems engineering job.
	You need very good people at all levels.
	A good systems engineer on a comm system is worth just as much and should be paid just as much as a good systems engineer at the vehicle level.
	that's a Leadership0.
	without that degree of integration, you'll have a hodge-podge.
	the systems engineering job is extremely important.
	it may not be the right answer at the integrated level.
	every idea is not accepted,
	don't think it will be redefined at all.
	that we have a lot different tools
	We do a lot more integrated analysis
	Integrated analysis,
	a design aspect or a development of a project…
	part of classical systems engineering.
	involved in the development of the vehicle.
	understand what development,
	don't at the end find that you have an issue that was hidden, in terms of meeting a certain requirement.
	there is a certain part of it that's developing a process of how systems are designed and how systems are analyzed.
	there is a certain intuition aspect as well.
	So unless that happens early and a systems engineer can do that early, it can affect the outcome of the vehicle design, which I think is a huge, huge impact.
	definitely a 9 or even a Leadership. Leadership0 of the importance to the success of a project.
	they all understand why something is or isn't in the design.

broad spectrum of expertise a systems engineer needs to have.

just something that's part of my personality
I could remember seeing a pile of Legos and having in my mind ok, I'm wanna build this, whatever it is, and try to figure out what's the best way to do it first, before I start putting it together.

Yeah, I had a vision first. I think it's been part of me for as long as I can remember.

I think just the general job, I don't know if it would really change too much. I think there is so much under the brown envelope of systems engineering.

understanding the behavior of the entire system…to understand, really, what the high level goals of that system are and to understand what the most efficient ways to get there might be

to get where you want to go, you really have to orchestrate the trades and the compromises that have to be made among all of those systems

come up with some overarching figure of merit or measure of goodness that you can give them so they they can understand how the work or designs or concepts that they have come up with either do or don't add value to those figures of merit or measures of

It's to understand how the implications of technical decisions that are made at the systems level really are affecting the architectural systems or whatever level of abstraction you're taking this to and affecting the overall figures of merit, the overall

a discipline that, from the beginning has a bigger picture and sort of an understanding of the integrated problem…from the beginning tends to be a better set of qualifications than a very narrow technical discipline

form their own understanding of what they've heard and come up with a little more than just a summation of the numbers, a better intellectualization about it

people that understand how a group of systems interact with each other and how that feeds up to the whole architectural or larger level of vehicle integration..it's a way of seeing the effects of one system on another in a complex way early in the design

it's an integration role

be able to talk all of them in transit, between them, and understand what they're saying so that you're able to pick out how the pieces play together

as a function of the complexity of the project, the SE function becomes more and more important

He would look at the problem..You were looking at it in a very stovepipe kind of fashion typically, and he's looking at how it touches everyone adjacent to you and how it affects ops and how it affects safety and how it affects the other engineering disci

…at the same time you've got to stand in front of a room ful of people that, technically may be your superiors, and go "that stinks…that doesn't smell right..you guys have lost the forest through the trees…it just doesn't make sense at the most fundamenta

	you can have somebody who has the fundamentals, technically…be a good systems engineer if they can see across the disciplines and utilize things on your team in an efficient way
	…can you help us integrate with these people
	Well, then it's obvious, 11.
	but each of the elements have to have their own systems engineering organization.
	what am I affecting by doing it this way?
	that if you're doing it that way, I've got an affect over here.
	give and take on getting the right design
	Of course, we look at it from a perspective of 'does it affect our interface documentation?
	Does it affect any of our products that we're responsible for producing?
	Whether you give me too much detail or not enough, you won't get on my bad side either way
	And then what are the impacts if I make this decision down the road?
	Yeah, that's the impact…if I make this decision, what does that affect down the road? That in itself, what are my other alternatives.
	It's the lesser of the bad impacts.
	So you go look at alternatives and say, what can I do?
	The same type of decisions are still gonna have to be made.
	And he was a big proponent of keeping the interfaces simple. He says, if your interface is too complicated for one guy to understand, it's too complicated.
	And if it's too complicated for one guy to know all of that interface, then you've done a bad design job
	I always remember what George Lowe said. Keep the interfaces simple.
	So you can have as complicated a system as you want to, it's got to interface _____. You've just got to keep the interface simple.
Technical Acumen	if you get a group of folks from the outside…and they say, "This is an excellent design solution. We can't find anything wrong with it…that's the ultimate payback
	it's definitely technical excellence
	read about how successful projects were engineered..do a lot of reading on the Apollo program to understand how people pull these off
	strive for a solution that under any scrutiny will be judged to be technically excellent
	I don't think systems engineering infers a level
	I think it's a job,
	acceptance through competent performance.
	has demonstrated a competence that has respect of the other people.
	need that credibility.
	credibility with the people you're dealing with,
	by having directly interfaced, by reputation.
	larger scope than their particular area.

	it doesn’t work in the systems engineering world.
	a compromise based on its overarching requirements
	have to get to competence.
	I think you have to create, through competence,
	real understanding of the technical
	an appreciation by the subsystems
	each subsystem has an optimum.
	this is the right way for me to do my job.
	believe this is the right answer.
	right subsystem.
	components and then you have subsystems,
	have vehicles.
	super competent.
	people that have those systems have that expertise.
	don’t usually have strangers get together and try to do systems engineering.
	basically system synthesis.
	aren’t the day-to-day bread and butter of the subsystem and component designers.
	confidence in any one of the systems.
	native discipline
	subtleties of a system.
	a lot of systems engineering is practice OJT-kind of practice.
	like a checklist maybe for a good engineer
	So if you had a person that did have breadth and was able to provide that function for you, that’s not a failure that you don’t go to the higher level of system.
	those that people can depend on, that comments are on target, that their recommendations are good recommendations, that their technical assessments are valid technical assessments
	don’t believe that the next level up is always going to accept or agree with my input.
	recognize that people above you have a different set of responsibilities
	recognized that as a trait was way early in my career
	had to accept the fact
	“I did my job.
	best that I could offer them.
	It’s not my fault. I did my job”.
	appropriate amount of effort,
	I didn’t slack off,
	didn’t do a shotty job,
	the product was a quality product
	can get job satisfaction out of a task or assignment.
	out of your control.take that and accept it

	put in enough forethought,
	enough strategic thinking
	I know when I'm there
	I need to be thorough,
	confidence in some
	long as you're in the general part of the bell.
	they make good systems engineers.
	create simulations
	So I think the tools have changed
	I don't think the job has changed at all.
	I think that we're moving forward on the tools
	Communication hours, we can run thousands of cases now.
	The accuracy is better,
	things like that that make us smarter than our initial job,
	engineering process really has the potential of being a lot better and a lot faster
	believer in good training
	best education you can.
	depend on OJT as to whether they use those ideas or not
	education is good.
	except for the tools,
	I think that the OJT is the only real test of effectiveness.
	If you can do that in a shorter time frame, that's valuable.
	It's going to put tools in their box that they will or won't use and whether they use them or not is whether they're good systems engineers or not.
	On-the-job training eventually exposes it to them.
	real benefit of that, at least post graduate, is to expose people to all the ideas.
	sending somebody to school to make him a systems engineer is a little overstatement.
	the concept of educating people to become systems engineers
	help define where to go to solve some of those concerns and issues.
	looking at the requirements, developmental requirements, the verification of those requirements.
	looking at the requirements and verification aspect, I think it's also looking across the different systems making sure the requirements are probably designed to describe what the intent is in order of what the vehicle is supposed to perform to.
	reducing risk and going into certification,
	analysis and testing that need to occur in order to meet those requirements.
	there's a certain understanding that a systems engineer has to know.
	learned throughout development, the professional development of a systems engineer.

	there’s some general knowledge that needs to exist, of the systems themselves
	lot of that can be performed over professional development.
	learn a little bit more about a certain thing.
	There’s a certain knowledge and capability that a person has to have in order to understand the complexity and be able to iterate the complexity.
	Maybe grounded in realism though.
	conclusion that is the most efficient conclusion regardless of opinions.
	constraint that you just may not have any
	sometimes you have constraints.
	I think you have to have knowledge of the systems you’re looking at.
	I think it’s important that you have the right background and understanding of all the systems in that functional area.
	“Certify that someone had the good knowledge and general engineering across different types of engineering.”
	So either you learn in becoming a systems engineer through years of being a systems engineer.
	So I think having that knowledge is really important, making sure all the appropriate things are done in a project.
	work it sufficiently whether it’s weekly or daily, to meet the right schedule that you need to fix the problem.
	draw it in steps.
	probably comes with professional development and a little bit of learning that you gain through work, through previous work
	So more, it’s products that help assist the system engineer in doing the day-to-day job, not necessarily changing their knowledge or whatever. It’s their ability to communicate or to integrate how things are pulled together.
	So I think the working tools can really influence what a systems engineer, or how a systems engineer works in Leadership0 years.
	And I think it can be difficult for one person to really, to have that knowledge coming into systems engineering.
	I think somebody who’s been a systems engineer for Communication0 years, could finally get to a point in having their development of being a systems engineer.
	Yeah, I think maybe. In some aspects, we’re already doing it where there’s training classes that help break some of that developed expertise down to entry level systems engineers, to help get that knowledge.
	a fairly detailed understanding of the discipline areas of expertise themselves. There's no way a systems engineer or a systems architect is going to have the depth of knowledge or experience of any of the technical experts he has working for him
	you have to have the fundamentals of all systems
	have a basic understanding of how all the systems work and work together
	they have to demonstrate the basic knowledge of all systems at some level

	you've got to be a sound engineer. You have to have basis engineering skills. You have to demonstrate it in your discipline and then you can branch out from there If you can be competent and respected in your own discipline, you probably have all of the engineering tools you need to be competent and respected across the discipline
	knowledge, across all the engineering items, looking at it from the whole system and not just a particular view someone who's able to look across the entire system of whatever you're systems engineer to
	All those tools kind of help you know when you've got a decision to make, for one thing, but also to keep track of decisions you've made and configuration of what you've got.
	The tools are there to help people do their job better.
	And also put the tools in place sets up the processes that allows that to occur. Most schools are pretty good at this. When you go into any engineering school, you're last two years you're specializing in whatever field you decided to go in. The first two years, most engineering schools, almost all engineers take the same breadth of stuff. I mean, mechanical engineers get an electrical engineering course and all engineers get electrical engineering. And all engineers get a statics course or a Once you get out of college, you're definitely not out of school So as subjects come up, you go to the library and you get something and you go study it. You get a little bit more background. First job that I had, they kept talking statistical processing. I told them I had no idea what that meant. So I went and I got a book, two or three books, and I started reading and studying and then I knew So you get kind of a basis for theory and the academia. Then you go make some judgement on the implementation of it. It's 8 or 9, maybe Leadership0 I mean, you've got to have some background and general knowledge on just engineering principles and physics. You've got to have more knowledge than just that There's no way I could do everybody's job and I have to trust these people to do their job. In my dealings with them, if I can't trust them just on simple stuff, how can I trust them on the stuff that's really important? It's vital. You've still got to go do those basic functions the same