



## RESEARCH AND DEVELOPMENT IN INDUSTRY

Mr. Gerhard Neumann

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Research and Development in Industry

19 December 1962

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## RESEARCH AND DEVELOPMENT IN INDUSTRY

19 December 1962

GENERAL STOUGHTON: To discuss our subject today - "Research and Development in Industry," - we have a recognized authority here in Mr. Gerhard Neumann, the General Manager of the Flight Propulsion Division of the General Electric Company. His successes in the aircraft engine field particularly, have helped GE live up to their motto of "Progress is Our Most Important Product." Incidentally, this is an unsolicited and unpaid for plug.

It's a great pleasure to present Mr. Neumann and to welcome him back to the Industrial College. Mr. Neumann.

MR. NEUMANN: Thank you very much, General. Gentlemen:

It is indeed a pleasure to be here again. And I mean it's a real pleasure; I'm not just saying this. I talk a lot; I don't talk to groups, but I'm interested in talking to you. I'm trying to leave with you some kind of message. You'll get a lot of lectures and I know they're very interesting, but I want to give you a real message; that when you go back to your jobs in administration, combat, projects, or weapons systems, you will have another new idea of why, perhaps, things aren't as good as they ought to be. And so, I've been asked for the third time, to give you a talk on research and development in industry. I'll have to apologize to the General and to you - this is a subject here which is so large - as you can well imagine - that it's impossible to talk about it intelligently in 45 minutes, and so, I changed the subject, and I'll talk about management problems in research and development. They aren't

really different, but they really are a little more specific.

We want to learn from our problems. I learned from mine. I was in designing and engineering 15 years ago when I started with GE, and I went up through the ranks, and I know that the problems are tremendous. And the more I learn, and the more I'm wrong, and meet you and meet your associates, the more I find the less I know. So, here are real problems in R&D. I want to talk about those. I have a few flip-charts here so that you'll remember some of the words I use when I talk. Which also reminds me of the fact that I have to tell you a story, as a good speaker should do each time.

Have you heard about the two men who went into a bar, and after a few drinks one of the fellows said, "Hey let's find out where the girls are. Let's go to a house where we can find some women." The other fellow said, "Oh no; I've got more at home than I can take care of there." "Fine," said the other fellow, "Let's go to your house."

I'm telling you this because I have more problems than I can take care of at my house. I don't want to talk about your problems; I want to tell you about my problems. My problems, General Electric's problems, anyone's industry problems, and vice versa - these we want to establish right away. And this time, although the subject is the same as last time - some of you may have heard me before - I want to be more specific. Rather than give you general terms - we've got to watch out, or we've got to write specifications, or we've got to measure, or we've got to communicate, and all these things - I want to get very specific.

I'll give you today the story of one of my current problems. This morning I was

at the Pentagon and I was there yesterday. I caught hell and I paid a little back - but not really; I left a message there. This is a problem, as some of you may know - which is on one of the engines we are working on right now. I think it's an outstanding engine; it's called the "J-85 Jet Engine." It's being used in a supersonic trainer. It doesn't make any difference whether the Army has it, or the Navy has it, or the Air Force has it; it's a supersonic trainer, a twin-engined one; the trainer is very fine and the engine is also very good. But in the course of its development we had typical problems; not just General Electric. Pratt and Whitney has the same - and AVCO - and I'm sure the electronic field has similar problems. So, permit me to use this engine as an example.

I want to tell you right away that any reference to a particular individual is strictly coincidental, as it comes about; that the JE-85 could just as well be some other vehicle that the military buys - a missile, perhaps - a Skybolt or something - but, I'm sure the problems are similar. So, let me start out by giving you the first, what I call standard problems. I'll spend a few minutes talking about them.

These are the basic things you do. Whatever you do, be it in our industry or your work, you've got to define the job. We're not doing a good job doing this, which I'll talk about a little later.

We have to organize a team or something. But we've got to organize. We try to get a team; we don't always succeed. Then, we have to get the work done anyhow, and we like to get it done right. And, if possible, right the first time. That's our slogan; do it right the first time. Of course, that is one of our real problems around here. Then, we have measuring; the measuring of profits or the lack there-

of. You've got to measure how you really do it. And finally, you've got to communicate the status. This is nothing new, but I want to tell you on the example I mentioned before this really is a problem. I was at the Pentagon yesterday and had to talk to some Generals and Admirals, and with some other civilians. Why do we have to say "Gentlemen, we didn't understand it," or, "You didn't get it right," etc. It's because some of the things weren't done right. Partially it's our fault and partially not our fault. But, as I said before, it can be anything we're working on, or that you're working on.

We've got to define the job. It is very, very difficult to define ahead of time what you really want. Because, it's rarely the case that what you want on a certain date is what you want five years hence. Once we recognize this and once we apologize, then already some reasons or excuses will show up as to why things aren't as good as they could be. Let's take the JE-85. This engine was defined to operate a missile - the Quail. It's a GAM 72; it's a decoy missile carried in the bomb bay of a B-52; there are several of them in there. At a certain altitude they're released; they start automatically; they're programmed. They fly in formation with the B-52 bombers carrying hydrogen warheads, and they have gadgets in them to deceive enemy radar, infra-red etc., to make them think they are B-52s. In other words, to divert anti-aircraft fire into various missiles.

That thing was to be powered by the JE-85 engine. It's a little jet engine; a real good one. So, it should last only five hours. The specification, I think, calls for a five-hour length. It might be 15 hours; I don't know; it was done before my time - before I was there. It had no controls for a pilot to operate because it was

pre-set. Anyway, the definition was quite simple as to what it should do. So, we developed this engine, but we made some mistakes in the process. Some people were too optimistic. In order to be competitive they quoted something that perhaps they shouldn't have quoted. I'm sure they quoted too few dollars, too quick a time, too light a weight, and too low fuel consumption. This is typical. This caused part of our problem. Who gets the contract? There is something wrong. You fellows have to help us. And we have to help you to straighten this out; I'm serious about it. Because, we all get into traps. We quote things that we are egged on to quote. We are forced to quote, in order to get business, some things you really have very little chance of making. I won't say no chance because that would be dishonest, but if there is a chance you say, "There is a possibility."

This is where we are jointly in trouble - industry and the military. I'm real serious about it. This defining a job is a very difficult thing to do. Well, to make a long story short, this engine, after it was half developed, someone saw it was real light - an airplane company, of course - and they said, "Hey! It's a good engine for a new trainer. Immediately the specifications were not formally changed, but there was a lot of talk - "Why don't you do this?" And we said, "Oh, sure; it's no trouble at all." Make an engine out of it which will last not five hours, but 150 hours, or maybe 500. And control it. Don't let it have just one speed as a missile does - obviously, a pilot has to pull the throttle back in order to come in for a landing, and give it full throttle to take off again.

So, this engine changed from a little engine which was a missile engine, to a supersonic fighter engine, a supersonic trainer engine, or supersonic something

else, with altogether different type characteristics. And you can well imagine what the parts were like because of higher temperatures, higher pressures, different landings, etc., which had to be different. We, we were deep in trouble, and people forgot about the change in definition. They said, "Gee, didn't you guys quote here - a few years ago I remember that at that time I was just a Colonel and I remember you people coming in and telling us it would weigh so much and cost so much, and look what the bill is now." And anything I say, such as, "Sir, please remember that in the meantime that thing has changed from five hours to 150 hours or five hours, and is heavier," has been forgotten.

So, when you grow up to be Generals and leading people in your commands, please remember this. When you hear somebody catching hell in a military industry, let's be sure that you really know what the definition of the job was. Let's assume we do this well. We've got to do better. Then, we must organize a team; we've got to get it done. And now, this is an interesting thing, because the military, in one year gets very interested in the contractor's management team. How do you organize that? Again, I wish I had time; I could talk to you for hours on some very interesting experiences.

I was a designer, as I told you before, a member of a strictly functional team; just designing. I was told don't worry about what it costs; don't worry about delivery - you just design it right. That's a good way of doing it - maybe. And then I was on a team which decided that it didn't work at all, so we change the whole damn thing and made a project team out of it - strictly a project. Now, before you design, sir, you'd better see how much it costs, how long it will take to do it, etc., and suddenly

it becomes a very interesting job all around, but there are no more specialists. And if you have five engines to develop you need five different projects. Then you find out you really don't have enough good people. There are plenty of bodies - and warm bodies most of the time - but they're not good enough. You don't have good enough electronics people, turbine designers - the really experienced type - and you can't afford to staff five complete projects. I don't mean money-wise; there just aren't enough good people.

Furthermore, if you have a strictly project system, the experience gained on project A is very difficult to apply to projects B, C, D and E, because they have a so-called NIH, which you, of course, don't have. NIH means "not invented here." It means anything which this guy does isn't good. We don't do that; we do it differently. And so, you wind up with five completely different types of engine, five different principles in design, five different stress levels, five different materials; the cost is high, the research is duplicated or triplicated, and this doesn't work either.

So, right now, the job which I've found best (- and it may not last forever - is to have a project manager system; like you have a weapons system project officer. I think we're developing into it, the military and us, into a system of one real good top man as project officer or project manager. He has a small team with him, expert on aerodynamics, expert on materials, expert in cost, expert in quality control - about a total of 15 people. This project manager is given authority to cut the cost of the project.

Well, I don't know what you have gotten out of it, except that I hope you'll re-

member that just going on the project system alone is not necessarily the answer. Going functional alone is not the answer. Some happy medium - depending on the number of projects you have - is the best, in my opinion, and I believe you'll find it best in fitting it to your work too; a project manager with a stronger group, and then a team which gets a start on the functional side - manufacturing, engineering, purchasing, quality control, finance, etc.

Now let's say we've organized a fine group of people. We get it done right. We have to get it done right. And here again is a constant sweat between doing it on time and doing it right, but taking longer. Or, doing it right and making the thing heavier. Or doing it right, somehow. But you'll find this unbridgable conflict again, between the engineers who are told, "Doggone it, you do it right or I'll fire you," and this poor devil down there says "In order to do it right I just can't live up to the final commitment because my part has to be very heavy, and by the time you have all the parts together the thing comes out too heavy." And this takes judgment by the project manager. Or, if necessary, by the department General Manager.

He'll say, "Yes, I know; if you put two and two and two together, this is six, but good judgment shows that you are too conservative, and not everything will go wrong, so we say two plus two plus two, is five." This is what you've got to do. You've got to use your judgment finally. In the final analysis it comes out to a few good key people who have to personally review the work and not delegate it. They can delegate the proposals, they can delegate some of the work, but you can't abdicate. And this is my final message to you, which I'll bring up again later, what

can you do to help. It's to take a personal interest. This is the main message I want to leave with you today; I'll use it a few times. You must take a personal interest wherever time permits and wherever you can.

Now, I'm with General Electric and I'm proud of it. General Electric is a hell of a good company. This is no commercial, this is just a fact; it's a good company. We are large, as you well know; we employ more engineers than any other company in the United States. In my division alone I have 2,100 engineers - maybe 1,000 too many to do the job right; this is possible. I'm serious; we may have way too many people, but the way people work, with the slowness and everything, to try to speed up it just requires that many more people to do the job.

So, General Electric, which is involved in electronics, television, toasters, electric blankets, jet engines, submarines, etc., found out that the best way to do it is to decentralize. Each department is its own business. Well, we made the mistake, I believe, of going to a principle of total delegation. You delegate at as low a level as possible. Let the lowest man do the work. But gentlemen, this is the trouble. If you just sit there and delegate and delegate, and don't go down and measure personally as a General does on the front every so often, visiting the troops, but without announcing ahead of time that he is coming for a visit - just walk in there at night and see the guard asleep, or find some things in either good or bad shape - if you don't do these things, you're in trouble. That is delegation.

Well, the thing to do here is - and I'm in the measuring part here - you can't do it all yourself; you've got to let some of your people do it, but you've got to review it. You've got to go in there and see to it that the most experienced people

take the time to review it, give it a judgment factor, and say "Okay," and sign it off. So, my point here is, to get it done right. You must get it done by your people. You can't do it yourself. But you must, yourself, or you must have a trusted man in your organization who will go down and specifically check and get a brief review, and say "I can calculate these things; I hope you did this right; I assume everything you did is right, but darn it, it doesn't look right." Give it your judgment.

The problem we have is that all the good people get paid more and more, and finally become General Managers. I thought I was a good engineer and I'm now a General Manager. All of a sudden you're taken out of this fine job of designing and reviewing, and that's a real problem.

So, my message here is, you have to get it done and as well as possible, and you have to use a judgment factor. If you are conservative you don't get a product. You don't get into trouble; that's a sure thing, but you don't have a product which is attractive either; a plane that will fly, or a missile which will go as far as you want. You must take risks, but the risk-taking, I think, is the responsibility of the guy on top, or the man below him. We must take risks - we managers. You must take the risks, and you can only take a risk if you take your own experience, get a presentation, judge it, and say, "Okay, fellows; good luck; that sounds right." You can't recalculate. You've got to use your judgment and get into it personally. You have to say, "Wait a minute; let's see how you do that." Well, I hope I've gotten a little bit in this area over to you.

Then comes the measuring of progress. You must go down and measure your-

self. If I wait until I get all the reports from my people, I'll tell you that nine out of ten times they are good. They'll tell you everything is fine; this was done and this was done. They don't hide that it was not done. Or, they'll tell you "We passed such and such a test," but they won't tell you voluntarily that they should have passed twice as much at that time. In other words, you don't get all the facts. It's a fact. And I probably don't give my boss all the facts either. I try to give him all the facts. I try to give him what he should know - where I'm good and where I'm not good. But as a human being, you are somewhat defensive and you think, "By golly I do it right," even though I do it wrong, and the boss doesn't get the message. The only way for you to get it is to go down and measure.

Now, there are systems like Kirch. You all know Kirch. It's pretty good. We have now developed what we believe is better, and that is PAR - performance appraisal review. Once a month I get a folder consisting of no more than eight pages. Now, many of my friends here may say, "Let's get a copy of it," but they won't. This is my own management control report. I want to be completely honest. I want to have the most horrible things in there. If someone else reads it they will pick it out of context and they'll make us look like a bunch of skunks. This has to be real honest. And I make the gentleman sign it, to the effect that he has read every line of it; not that he glanced at it, but that he read every line and is in agreement with it. I get his signature on it. It will show one chart, for example; on finance, how much you have spent against a commitment; it's just a curve. You don't have to read the figures; you see it.

The second chart shows progress - the first chart too, if you want. As a mat-

ter of fact, I have it the other way around - first, progress against schedule. Are you on December the 19th where you are supposed to be, or how much are you off? It's not a bunch of writing; just a bar chart. This takes judgment, of course. Some people will say, "Well, I'm nearly complete, but there is one item short." Well, this item short, of course, determines the cycle. So, where are you against where you're supposed to be? How much money have you spent against what you're supposed to have spent? And then, the list of critical items. Another page shows what is anticipated to be critical.

Well, clearly again, you depend on your people. If they don't write what they expect, if they don't know about it, you won't get it. But, at least this is one report I get once a month. I measure, and then I call in the various people right down the line; sometimes the guy in the shop. They'll come shaking in the office and we'll say "Relax; here's a cup of coffee. Sit down first." Then I'll say, "Now, you tell me. You tell me." In the meantime the boss takes over and says, "Let me tell you what the trouble really is." I'll say, "Never mind; you shut up, boy." What is going on and how is it going on? Why didn't we know. And don't give him hell, because, if things don't go right it's usually management's fault that some systems don't work.

Again, at some time I'd like to talk with you - if I'm ever invited again - about measuring. Measuring in industry is a real complex thing. It is essential. Now, you couldn't do without measuring; you wouldn't know where you are. And if you later catch hell from the military for poor performance you need your own measurements because the measurements given to you are usually not the same. They think

we have the same facts, but the facts are altogether different. And it turns out that we, they, or none of us, have measured correctly. So, measuring is important. And then, of course, there is the thing I'm now doing with the Pentagon; I'm communicating. I'm telling them why things are not the way they're supposed to be; why we fell short; why we make mistakes. This doesn't interest anyone very much, but they've got to know that you know what went wrong, and then why things should be different. Because, based upon communications, decisions are made, such as to cancel Skybolt or not cancel it. Do we send it down the drain or not? To cancel an airplane program or not, or to delay it? These are always a matter of someone having measured what he thinks is critical, and then communicate this in honest words describing the situation.

And you will find, if you haven't found already, that it's always a difficult thing to communicate exactly. Now, you hear me talk today - and I talk fast, since I'm trying to get my message across in a few minutes. But if someone asks, "What did Neumann talk about?", I'm sure that even though you're very alert here you will misinterpret some things. It may not be your fault; maybe I don't say them properly. But here we're both intelligent and already there may be errors in communication. As you can well imagine, if a thing comes up from a Captain in Florida at MacDill Air Force Base or somewhere, up through the Major, through the Colonel, some civilian, up through some General; the General calls me in and I get information up the line, how great the chance is for a total miscommunication.

And many decisions which either of us are making, will be making, or have made, I'm sure we're wrong on. And they may be wrong because of a mere lack of proper

communication. We must find out what the problem is, and it's surprising how little it may take to fix it. But, somewhere along the line you've got to set a deadline. You say, "If that darn thing doesn't fly, we're going to cancel the works." It's difficult for a man to make such a decision, but before he does, I hope he has time enough to take a personal interest before he cancels anything, and says "Let me call in some other people and take another reading." Because, when you read your report and see what is being said, it may be one thing. The words may be right, but the intonation, or inflection, or other things may be different and make all the difference.

Let me give you an example. I know the old former <sup>German</sup> Defense Minister Strauss. He's a very intelligent, very aggressive - a very unpleasant, but a very, very good man to have on your team when you fight a war, or when you really want to get something done. He's out now, so I can talk about him. I went over there with an associate of mine. We are licensed in Germany to build our J-79 jet engine for the F-104 Star Fighter. It's a NATO fighter. NATO builds 1,000 F-104 Star Fighters, and there are engines built in Germany, in Belgium and in Italy.

Now, we were in a session with the Minister - and I speak Germany fluently - and I listened while my associate who only speaks English, talked with him. And in an unrelated matter the question came about, "I understand, Mr. Strauss," said my associate, "that the Germans are going to do such and such." It was stated so as to evoke an answer. The Minister said, "Oh yeah?" And after the meeting, the man told me the Minister said yes. So, you see how it was misinterpreted. Now, in German the yes is Ja - J-a - as you know, and the same word is not yeah or yes,

it is Ja. And he put a question mark after it. Oh, yeah - is that so? It isn't so at all; he didn't want to talk about it. Oh yeah? And the man came out and said "Okay, let's do that, that, that and that." This one little inflection - little intonation - in communication can make all the difference between what we would have done if I'd been present and said, "Wait a minute, he didn't say yes, he said yeah?" In other words, he said no, and I checked back and sure enough, he said "Hell no, we're not going to do that."

Now, remember this. You may do the same thing to your boss, and you may get it from your people. You've got to get in personally, when you can - your time is limited, I know - and see what the connotation is.

Well, I have another 15 minutes, and I want to talk about today's specials. The last time I was here there was a gentleman who had a real good question to answer. He asked about incentive contracts. I couldn't give an answer. He asked me, "Mr. Newmann, how can we give you a greater incentive to do better work in development?" It was a good question, but I just couldn't answer it. I mumbled something up here that was unsatisfactory to both of us. In the meantime, we still haven't found a good answer, but now it's a normal thing to spend 12 months in development into a thing that incentive contracts in development are essential.

When you have cost-plus-fixed-fee, together with cost a fee is paid on top of it, it's not good enough. I know it was mis-used; mis-used by us; mis-used by others - not purposely; we didn't try to milk the government - but the incentive is gone. There really is no incentive to do it better. Why? You have a guy tell you he needs 20 more engineers. He cries and you take a mop and remove all the tears

from the floor. You hire 20 engineers and he has 20 more; he builds himself a little empire. The 20 engineers needs assistants - draftsmen and secretaries - and more furniture - and soon you have the story of Parkinson's Law.

Well, we can't see how this happens unless you watch closely. Therefore, you have got to have an incentive. Well, the military has cooked up - I don't know which service - some pretty attractive-sounding incentives. Let's agree and judge; you should do it for this job. If you do better we'll give you something more of the same. If you do worse, you split some of the profits. Now, the problem again is, are the specifications clear? What are you supposed to do? Because, the moment someone changes, you say yes, no, or better, because you made a change - you wanted a change - and now the whole thing has to be renegotiated.

We do this with all good intent. I know some of my friends know how we sit together and scratch our heads and say, "Gee, how can we get a better incentive contract?" Well, you're working on it now. You're working now under a directive from General Schriever or somebody, I believe, on a reliable building cost to give us an incentive to produce a more reliable product. I think this is right. I'm completely in support of it. Some of my people are not, but I am. And in the matters of my own little bailiwick I think it's a good idea that we in industry are held responsible for the design and building of a more reliable product. And the reliability clause is now going into new contracts.

Of course, there is a problem. If you design something and it isn't maintained by the military personnel, properly; if you have a bunch of recruits who hate being in the Army or Navy or elsewhere, who are wondering how they can get out, they

may decide that the more things they foul up the easier it will be to get out, and it becomes difficult to hold the contractor responsible for a reliable product. Or, take airplanes, for example. If they're flown under adverse conditions, with a lot of dirt and corrosion of parts, and if they are abused or mistreated, it's very difficult to blame the contractor.

But, I am pretty high up in the organization now and I can speak with some authority. We in General Electric - and I personally, am very much behind the incentive; a condition with the contractor that by golly, you must pay a penalty for an unreliable product. But gentlemen, when you're involved in the work, think about it and include an incentive also, or reward, for exceptionally good work. You will discover, and I'm very serious - and also bitter about it - that you get pushed down by some very good government employees who try to do their job and get the contract down in price. That's what they're hired for and they do a good job. I recognize that they've got to do this. But you come to a point where you may go too far. Perhaps you won't be administering some of these things, but the people who work for you may. You should think about this. You can't just continuously push and push and push.

You see, the better a job we do in cutting costs - and we get a profit as a percentage of the cost, the law is a return to the company. You need some profit or return in order to exist. You need a profit to show the shareholders why they've invested their money in the jet engine business and not in sewing machines or kitchen stoves. They have to have some incentive or some return. And so, the more we do and the better we do it, the lower is the cost to the government, which is

fine, and the lower is the profit.

Now, this doesn't make real sense. But when you later come to the reliability clause and say, if it doesn't work right - which you can measure - we will take some of the profit away from you - that's one thing. But you've got to reward the contractor for some very, very good work - exceptional work, teamwork, good administration - and say, "Okay, good for you; I'll give you 2%, 3%, 1% or 1/2% in profit, as a reward for good performance."

So, I hope I've gotten this across to you. I've done my job for General Electric if I've gotten this point across to you that an incentive is fine, but it has got to be administered. You have to personally take an interest. Go down - if you see the General Electric man coming, or the Pratt & Whitney man, or the AVCO man, and ask the man, "Were you fair to this outfit or were you not?" You may have to overrule them a bit, and you may have to say that before you settle with them, "Let me review once more what you did. How did you really perform?" Take a personal interest in them, and you'll find industry working with you hand and glove, and anxious to do work with you and for you.

But if they're continuously pushed; they catch hell for bad things, but no reward for good ones; if this is real outstanding work and this becomes standard then, for the next time around, so that you can never improve it anymore, then I think we are heading mutually for trouble. Incentive contracts are fine. There is a clause in the contracts now, and I'm with it, my company is with it, but let's be fair about it, where you have an opportunity, I would appreciate your being fair. And the only way you can be fair is to take a personal interest in the summary before you

sign off and before you beat the poor guy down. Say, "Let's take another look at this. Is it really necessary to do this? Should we let him get away with 8% which makes for him the difference between going or not."

"Panic" due to poor performance. As I told you before, about this JE-85, we had trouble this past summer. It turned out that the JE-85 installed in the Northrop supersonic trainer, now being supplied to the Air Force, and perhaps later to the Navy, perhaps to the Army; destined for MAP countries - Far East countries - this thing suddenly developed what seemed to be a real problem. There was then panic. If there were no girls here I would say it hit the fan this time.

I got a call from General Bradley; I got a call from General Garrity; my boss, the Chairman of the Board, Mr. Cordiner. Mr. Cordiner got a letter from the General: "Dear Mr. Cordiner: This darn outfit in Massachusetts, etc., etc., they're the lousiest bunch of guys, etc." Well, what happened here? I was totally unaware of it. I had no communication. A real panic developed and it is only now subsiding. We found out there were a few things which went wrong. There was poor performance of the aircraft in the field. It flies beautifully, but it took too many manhours to maintain. And so, someone went up to the Generals there and said, "This is just impossible; we planned altogether differently. We are using twice as many manhours, we don't have enough people, and we don't have enough money." And they were ready to seriously curtail the T-38 trainer program.

Now, that would have been a terrible thing, because people were just not properly informed. Panics due to poor performance have happened. You have to take a personal interest and ask some of your own people are the figures you've given me here

right? Are the figures the fault of the manufacturer, of the engine-maker, the airplane-maker; are they the fault of the training command; are they the fault of the supply command; or what are they? And, never mind whose fault it is, "What can we do about it?" But, we found that indeed there were real problems caused by the engine not doing as well as possible; the airplane wasn't as good as anticipated; the training command completely having dropped the ball too by not having provided adequate manpower to staff a supersonic twin-engine aircraft - compared to the old T-33 which was a single-engine subsonic aircraft - we were all involved in it.

However, all hands got together, we made peace, and the darn thing is flying beautifully now, and I'm sure within another four to six months that thing will do better than it ever would have before. Don't let's panic and write a bunch of letters to the Chairman of the company. This really fouls up the works. I spend more time talking and explaining to the Chairman of the Board why the engine doesn't do what it's supposed to, or what makes the airplane fly, and this time I could use in fixing the engine. But, of course, once they get a letter they've got to write back again. And before they write back, of course, they tell their executives and their executives start checking. Here I've spent two months chasing around, just answering a couple of letters because of the Chairman up there.

So, it is necessary for you people to go down and spot things before you sign. What I do when I've written a nasty letter, is put it in the mail basket and let it sit for a couple of days. It never fails that I don't take the letter out a couple of days later and change it. Things then look different. Of course, I'm hot-headed, but time changes me, and I'm sure you are the same way. Don't just fire of a letter.

Take a look at today's specialist. It might be due to poor performance. If this happens to you, as it happens to me nearly every day, let's take a personal interest and get some of the other men in and say, "You tell me the story of what is really happening." I'm sure you'll get a different picture.

Finally, who gets the contract. Well, based upon good or poor performance - based upon his performance up here and how well he did - someone is supposed to get a contract. Let's take the TFX, a sore point from General Electric's point of view. I'm not complaining - really, I'm not - but I want to tell you what has happened. And, there is a Congressional Committee working on it; not because of us, but because Boeing at Seattle is unhappy that Convair at San Diego got the contract for the TFX. You all know the TFX, a big, new airplane with swept wings - movable wings - and supposed to do all kinds of things, which we hope it will. Perhaps by the time it comes about we will have some good tests.

Boeing is unhappy because Convair got the contract. They got their Senator into the act, and the Senator - who is a very nice person, I'm sure - is fighting in the Senate. And Mr. Russell, the Chairman of the Armed Services Committee - in Georgia - just made an announcement that he'll investigate the thing beginning next January. And we're really starting to get politics into it. So, the question is, "Who will get the contract?" Is the actual technical performance the reason you gave the fellow the contract, and not performance, or are politics mixed in?

Now, it may be perfectly all right to mix politics with it if that is allowable. It may be very well possible that they might say "Why should General Electric get another engine contract; they've got so much to do? Look at those poor fellows

in the other company haven't much to do." So, this may be a very valid reason. But don't let's hide this under some cover and say, "Well, technically that thing was superior, or not superior." I'm interested in it because we developed and proposed an engine. We spent a lot of company money on it, and some government money - an engine for this TFX. So did Pratt-Whitney, and so did Allison. So did Rolls Royce and others. Immediately a lot of people were eliminated, but Pratt-Whitney and General Electric remained.

There were six aircraft people who fought to get the TFX airplane. They had to select an engine. Four out of the six selected the General Electric engine. One of them said "Either one will do." And one of them selected another engine; not because of technical superiority, but merely because he thought they were going to get the contract anyway. It's a fact; four of the six clearly stated they wanted the General Electric engine. One of them said that either one would do. And one of them selected the other engine. We were eliminated long before the TFX decision was made in April of this past year. We were eliminated from it and I think I have a beef coming, which I really do.

Now, there is no use complaining to you gentlemen, because I'm sure you had nothing to do with it. As a matter of fact, there are a few people in your audience whom I know helped us very strongly. I know they're from Wright Field, or were from Wright Field. They felt we had a better engine. But here is the question, "Who really gets the contract?" Now, this all falls under the management problems of R&D. I have to go to my management now and they'll say, "How come you lost that contract?" And what am I going to tell them? I might tell them, "Well,

it's unfair. We lost. We were picked, but we lost." This doesn't help me one damn bit. And although I have a good standing in my company and am not afraid that I will be fired because of that, it is a real problem for us. It's a morale problem with my troops. They know that this engine was selected by four out of six. They're dealing with these people. We have installation studies. Presentations were made before the TFX committee. They said, "We want the General Electric engine," but they wouldn't take it.

I'm not only talking about GE; I'm just telling you what the problems are, and how little decisions can make life miserable or joyful for anyone. If Pratt-Whitney had lost, or Allison had lost, they too would say, "Darn it, we're better." Or, "We have more money." Or, "We know how to do it," etc. It wouldn't be fair of me to tell you that the decision to give this contract to Convair or Boeing was wrong, because I don't know their airplane. But with the engine I can see the point of why Pratt-Whitney got the engine contract for this aircraft. I can see it; I'm sorry to see it; but I can see it. They have an engine - not an identical engine, but a similar engine running under some military contracts.

I want to be completely fair and not do what I mentioned before, give you poor communication or half-baked stories. I can see the point. I'm unhappy about it, but I believe it a fair point that Pratt-Whitney did get the contract, although their engine was not on paper and was not as good as the one we said we would produce. They had an engine under development already. Some money had already been spent by the Navy, and I don't believe I have any justified complaint about the selection. I just wanted to be sure that you understood this.

Well, gentlemen, this is an outline of my problems; they're your problems, and what you can do to help. I tell my people to take a personal interest in whatever they are supposed to do. You can't sit in the office and delegate; I'm sure you don't do it anyhow; you've got to go down the line, you've got to walk around and look at the desks and the drawing boards, visit the troops, go out in the shop, look beneath the tables; watch a secretary type a letter and say, "What are you typing right now?" Ask what she's doing and see whether she's doing it. You'll find sometimes that she's typing some kind of crazy letter. You'll wonder who writes a letter such as that. I do every day, when possible, walk around the shop, be it in the engineering office or another plant - we have plants in Cincinnati, Ohio, Massachusetts and Vermont.

Go there and walk around, and don't announce that you are coming. When they know you're coming they clean up, do polishing and everything else. This doesn't work. Go in suddenly, be seen, talk to people, and take a personal interest, and you'll find out that you'll gain knowledge which you would never have gotten if you hadn't done these things. Before you make a decision, get some of them from down the line and say, "Now, you tell me." It will supposedly hurt the people under you who feel that you are by-passing them, but you ought to make it clear right from the beginning, as I did when I took over this new job; I said, "Gentlemen, I'll tell you right now, the way I operate is that I have confidence in you. When I don't anymore, I'll let you know when it happens; you'll feel it anyway. But my method of operating is to get my facts from down the line. So, I don't want any complaints. I don't want you to feel bad, but I'm going to operate this way. I'm going to get my

facts from down the line." And I think if you do this with your people you'll find it will work the same way.

Just tell them ahead of time that you're going to operate this way and there will be no hard feelings or anything else. Well, gentlemen, my time is exactly up. I thank you very much for listening and I hope I've been of some benefit to you.

QUESTION: Mr. Neumann, you mentioned that you have spent quite a bit of company money, making proposals on the TFX. This recent Bell Report that McNamara, Bell, Webb, and everybody signed, and after direct testimony by Dr. Brown, they said they were going to cut out all of this what they called "brochure-manship." Instead, they were going to go into a program definition phase. I had thought that they had started that when they said it was going to be done; that they had already started. Would you give me your opinion on what effect is the program definition phase going to have on you and the Army's bidding?

MR. NEUMANN: I don't know whether you heard the question back there, but in any case I'll answer as best I can. The brochuremanship McNamara referred to, I assume is the fancy brochuremanship which we know we have too much of; glossy binders, beautifully done, and everything looks just hunky-dory in there. This, I think, they want to bring down to just plain folders and simple paper, and not these fancy give-aways - model airplanes and all the other things, to sell the product - briefcases, etc.

But if they want to stop the manufacturers from studying and proposing different applications of an existing engine, or new ideas, I believe that R&D will be

seriously hurt to the detriment of the government. There are a lot of ideas coming out which don't originate in the government or in the services. Industry has some very capable people. I don't have to tell you this; you know it already. There are really capable people who suddenly think of a new way of doing BTOL, for example. I'll give you one example. I want to be brief in my answer, so, I'll give you one example.

General Electric has proposed to the United States Army, and received a contract for the development of two complete airplanes. We then subcontracted to our BTOL. It's called the BZ-11 - the new code number. It's an airplane that has lift fans - it has big fans in the wings, fans which are driven by the exhaust gas from a jet engine ducted into the wing. They're flush with the wings; you can't even see them because they have covers. But when they open up, their big wheels start spinning and they lift the airplane vertically. It can then fly horizontally by diverting the gas aft. The covers go down after the airplane is up.

This was an idea that came from industry. It came from GE, but I'm sure our people didn't invent it. Maybe the Russians did, or the Germans - who cares? It was proposed by industry to America. If such work were to stop, we would have lost, in my opinion, one of the most potential things to BTOL. I happened to be in on it, but I would have thought so even if I hadn't been in on it. This was an industry proposal to the military. It took brochuremanship, salesmanship, and all the ships we have there, to sell the thing. We couldn't sell it to the Air Force, we couldn't sell it to the Navy. The United States Army bought it - of all people - and I'm glad they did, because they have a real program there, and I'm sure it will be used by

others. So, I hope I've answered your question.

I think it's essential that industry has R&D funds or proposal funds, and if not, we will use our own.

QUESTION: Mr. Neumann, how do you use operations research as a tool of management?

MR. NEUMANN: Well, I don't know what you would call this one here. Now, this is operations research. Could I ask you a question? Could you define it a little bit better? Operations research of what type?

QUESTION: For more consistent engineering on applied research as differentiated from pure research.

MR. NEUMANN: Oh! Applied research as differentiated from pure research. Well, naturally, if I have your question right, this type of research we do in the laboratory. The laboratory is a big department. It sells about \$20 to \$30 million worth of work during the year. It's supposed to develop new materials - beryllium materials - some ram-jets - supersonic combustion ram-jets. Can you burn fuels - hydrogen or carbon fuels in supersonic airscreens? This is basic research as it applies to our product.

At General Electric we have a research laboratory up in Schenectady. They don't work for anyone. We are being assessed to some extent to support a pure research laboratory. They developed the artificial diamond, for example. They develop things completely different; not necessarily applicable to our engine business. In my own division we have a laboratory which does pure research on things we need - high-temperature materials; hydrogen-burning engines, a new-type of

ram-jet, a new principle such as this new lift fan I just talked about; this came out of our laboratory - this type of development.

This is done independently, by contract, or by assessment to my operating departments, which sell both little and big engines. They are assessed at my directive, for so much money, they're given a laboratory, and they do basic research. Then our departments which make either large or small engines, accessories, missiles, or whatever, they take from the laboratory what they think is good. The laboratory fellow will always be hurt if they don't buy everything he is doing. He will come to me and say, "Mr. Neumann, I think I have some real hot stuff here, but they don't want to buy it; they don't believe in it." Then I have to get into it and make peace. Perhaps I have to force him, or persuade him, or, perhaps, if it isn't any good in my opinion, I have to tell him so.

But, we do use basic research, which is free. They do all kinds of things. If they do one out of four things which are bought, I think they do well. They believe that one out of ten would be doing well, but they have different incentives. But I think if they do one out of four things that can be used later, in lift fans, or hydrogen-burning engines, or special boron fuels - if you work them for awhile, for a new-type after-burner, or new infra-red detection, or new sound-suppression whose blades are not radially arranged, but slanted - these things come out of a pure research development laboratory - and they may or may not be used, depending on how the operating department feels.

QUESTION: Mr. Neumann, you spoke of your utilization of the project manager system and the establishment of a small highly-skilled managerial team, draw-

ing, then, on the functional resources of other parts of the company. My questions are these:

No. 1, have you developed any new mechanism for arbitrating conflicting demands on the resources of those functional managers? And if so, in this mechanism where does the project manager stand in company authority related to the functional managers at least tacitly controlling those resources?

MR. NEUMANN: All right, the answer to your first question is, "Have I established something new?" The answer is no. We have conflict. I have the specialized project manager, and the manager of the functional organization, both of whom are on the same level, and both report to one department General Manager. There is no priority system. The problem, as you say, is there, and it is a problem. We have tried a priority system which was dangerous as hell, because you put priority on one project, the other fellow wonders why he didn't get it, and he asks you why he failed. So, if you have a priority system, don't admit it. This is my system. Don't admit you have it, although, you can say that you put a little more emphasis on one thing.

The moment you tell a fellow this man has a priority; everything he writes will be marked red and he has priority in the shop, you have trouble with the other people, and they'll use the excuse that they failed because they didn't have the priority. Where do they stand? Let me tell you this. I call the project manager the extension of the General Manager. "If I only had one project, the General Manager of this department would be in charge of this project. There would be no need for having everything there. He has all the means at his command.

I give the special projects manager the right to make all decisions. In fact, he must make decisions. If he wants to shy away I get him right back and tell him "You make the decision - the design layout, the application, the timing and the cost." He'll say; "It's unfair. How can I deliver the engine on time if so and so is in charge of manufacturing?" I say, "That's your problem; you just deliver on time." And you'll find that these fellows will work very well together. If they don't, they have to come to me, or did when I was a department manager. They will have to show up in the department manager's office. And you will find, as I have in six years of experimenting, that it works very well.

If you have intelligent managers they know the problems have to be solved. It takes the proper manager to make the final decisions. If he doesn't like the job one of the other people is doing he can first fight with him and then come up and see me. But there is a conflict of interest - purposely. I don't want such a harmonious group that everything works too smoothly - with everyone loving each other all the time. We've got to have some conflict, but it has to be intelligent. And they've got to realize that be it eight o'clock in the evening or twelve the next day, this has to be resolved. This is where the top man comes in. You say, "Gentlemen, we want a solution by eight o'clock tomorrow morning; if you don't have one by that time, I'll do it for you." And you'll find that they will do it real quick.

So, the answer is no, I don't have a new system. They are the same organizational level, but officially given as Project Manager A with responsibility for Project A, Manager B for B, C for C, and the project people have to do what the project manager tells them. And if they don't like it, they can both come up and

tell me about it.

QUESTION: Sir, the British have demonstrated a vertical takeoff fighter which is very impressive, and I have read statements to the effect that they think they're ahead of us in this field. Would you comment?

MR. NEUMANN: Yes sir. I'm glad you asked that question. It's the P-1127 you're talking about which has been flying for over a year, actually. For those of you who are not jet-engine people it may be of interest anyway. There are two systems which the British have and in which they are ahead of us. Time-wise, they are flying whereas we are not. Therefore, time-wise they're ahead of us. One of the systems is a whole cluster of jet-engines mounted - instead of horizontally pushing out toward the tail - vertically. They're very good engines and they lift the plane off the ground vertically. Then, they have a regular engine and when the plane is in the air, clear of trees and other obstacles, the other engine cuts in and the thing goes forward. That's one way of doing it.

The one you saw is a system of deflection. It takes a big engine which normally works like a regular jet engine, but which, by a large valve, can divert the gas downward and push itself up. Obviously, the push down has to be equal to or stronger than the weight of the airplane, or it wouldn't leave the ground.

The whole system, in my opinion, is clearly ahead of us time-wise, and we are clearly inferior in potential. I don't think there is any doubt about it. However, the Germans recently cancelled their support of this airplane - I don't know whether you heard about that or not; I was just in Germany and learned about it - but, they cancelled their support. They discovered that an engine which is strong

enough to lift an airplane off the ground is way over-powered in moving forward. When an airplane flies forward the wings take on the load of the airplane. It needs just enough push to overcome the resistance. It needs about 1/3 of the power necessary to push a heavy object into the air until it can depend on its own power going up. I hope I'm making this clear. It needs a hell of a lot of power. If the plane weighs 10,000 pounds the plane needs at least 10,001 pounds at least of push to get the thing into the air. But it only needs 3,000 pounds to fly forward.

Obviously, then, this engine is way over-powered - way too big - and fuel-wise it is very uneconomical. The demonstration was very clever - very slick. The grass was smooth. The airplane was very light; they had very little fuel in it - just enough to demonstrate it - and it looked real good. But if you really wanted to hover vertically; if there was confusion over the place you wanted to land - say a couple of jeeps or ambulances had to get out of the way first - and you had to hover, it would use a hell of a lot of fuel. Therefore, this system, in my opinion, totally insufficient to be of any real use. The only danger that is ahead of us is that I'm afraid our own military people will say, "Here's a beautiful system; let's buy this."

The best system is one like our lift fans where you have three times the power due to having a big fan in the wing, facing downward, as the plane has going horizontally. In other words, you need one third the power in order to fly forward, and this system is just the right combination. It's more expensive and more complicated, but it will do the job of flying vertically over the land and then horizontally - supersonic if you wish - coming to a halt and settling down.

So, they are ahead of us for the time being, but we are going to fly one next

year and so is Lockheed. And I think we have other systems which will be sufficient.

QUESTION: My question relates to the F-114 program in Europe. At one time the Air Force felt that the Europeans produced a good engine, but that they didn't have a complete weapons system, and that perhaps they weren't making adequate provisions; they didn't have the proper personnel, etc. Can you tell us whether any progress has been made in this respect and what the situation is at the present time?

MR. NEUMANN: Yes, I can. I arrive back from Germany just last week. While there I talked with various licensees of ours, and the NASMO, the Star Fighter Headquarters down there, operating the 104-G which is the NATO Star fighter - the G stands for Germany or something like that - they're making about a thousand aircraft, and the progress is very good. The Germans, the Belgians and the Italians, as well as Messerschmidt, Fokker, the Netherlands and others, have, as you said, had a big gap since the last war, when they weren't doing much aircraft building. They weren't able to handle a big system as easily as we thought they could.

Furthermore, we Americans have over-sold, I'm quite sure. The electronics system, the FM system, the engine, etc., we've worked on in competition with the French who were selling airplanes; and also the British. The Swedes had their plane, etc. And I'm quite sure we sold a little heavily down there, but anyhow we one. However, to sum it up, it is going very well right now. The engines that are coming out there, and which I'm familiar with, are in excellent condition. They're

as good as ours. They're doing a good job on them. And the initial problems are being overcome. The program is now rolling all right, I believe. Mr. Strauss was active in it, but he finally resigned because of that trouble over Der Spiegel, as you know. The magazine had particularly attacked the 1014 program. However, it is in good shape now.

QUESTION: Sir, what do you consider to be the role of government laboratories in your business?

MR. NEUMANN: The role of government laboratories in our business. I may sound awful, but I frankly do not know their role in our specific business. Now, I haven't seen any impact of government laboratories on our business either at Wright Field, or at Trenton where the Navy has an altitude test chamber, or at Tullahoma. Are you referring to that type of laboratory? Oh! This affects us very greatly. We in industry do not have facilities, of course, to test engines under full after-burning conditions at mach 3, etc., as Tullahoma has, for example. Or, take the Navy's test laboratory for small helicopter engines, taking them up to 25,000 feet altitude and trying an automatic start at 25,000 feet under controlled conditions. They are very essential to us. These laboratories are fine.

I thought you were referring, perhaps, to some other kind of laboratory. Anyway, I think they are very, very good. The people are excellent there, the cooperation is excellent, and we couldn't do without them.

QUESTION: Pursuing this a bit further, sir; going one step more. Referring to the government arsenal and the government laboratory which perform research and development in the same field. How do these affect you? What is your com-

pany's policy toward the continuation and possibly enhancement of these government facilities?

MR. NEUMANN: I thought you referred to those type of facilities. I cannot speak for the company. I have no idea what the company's relations are in further supporting or otherwise having these laboratories and getting help from them. Now, I don't know that my division takes advantage that comes out of these laboratories. I meant Tullahoma, Trenton, Edwards Air Force Base, Wright Field - those laboratories I know we are using. They've made their own studies and we are comparing notes. NASA, NACA, the old NACA, Langley Field and Moffett out in California - those laboratories which apply to our business, we are working with. But as to basic, fundamental research which I believe you referred to, I do not know what effect they have on my particular division in the business, frankly, and therefore I can't tell you what the situation is.

COLONEL TARDY: Thank you very much, Mr. Neumann, for another fine dissertation on R&D.