GAGES FOR PRODUCTION

30 January 1953

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Mr. Clifford W. Kennedy, Quality Control Engineer, Federal Products Corporation, was graduated from Worcester Polytechnic Institute in 1917. He then joined the Remington Arms Company (U.M.C. Bridgeport Connecticut Works) as a factory engineer. For over two years he worked on factory layout, equipment, and methods connected with producing small arms ammunition. He then served the M.S. Wright Company of Worcester, Massachusetts, successively as product design engineer, service manager, and as assistant sales manager. He rejoined the Remington Arms Company before the start of World War II. A few months later he was assigned as chief inspector for the prime contractor at the Army operated Denver Ordnance Plant where he headed the contractor's inspection department. The work included devising, planning, and carrying out essential inspection, quality control, and gaging programs. At the close of World War II, he joined the Federal Products Corporation, makers of gages and precision measuring equipment, as chief inspector and later as field engineer. He is a member of the American Society for Quality Control, and the author of a book "Quality Control Methods." At present he is Quality Control Engineer with the Federal Products Corporation, consulting with manufacturers on problems connected with inspection, gaging, and statistical quality control.

GAGES FOR PRODUCTION

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MR. BAUM: General Greeley and gentlemen, at the risk of seeming obvious, I will say that this lecture is on gages.

As Colonel Cave pointed out, such qualities must be considered, to obtain mass production, as interchangeability of parts, the maintenance of proper standards of quality, and operational performance. Inspection and, in particular, the use of gages and other precision measuring instruments are the means of attaining these qualities.

Once again the college is fortunate in having as our speaker this morning Mr. Clifford W. Kennedy, Quality Control Engineer of the Federal Products Corporation. He has had a world of experience in devising, planning, and putting into practice essential inspection, quality control, and gaging programs. He is outstanding in this field. I know you will be pleased to hear his talk and see his demonstrations in his own inimitable manner.

Cliff, it is a real pleasure to introduce you to this class--gentlemen, Mr. Cliff Kennedy.

MR. KENNEDY: Alden, General Greeley, and gentlemen: I want to add to Alden's kind introduction by saying that ordinarily I speak to shop foremen and men of that type; I try to talk language that they understand.

I understand from Alden that the pressure is on in this course. I notice that I am coming here a little sooner this year. They are giving you more work. I presume you are a little tense. I hope that by the end of the period I will have relaxed some.

Your management here has ordered me to go ahead in my usual informal fashion. So from now on we will proceed to hurry just a little.

I think that first of all I should give you a little background, just as an artist paints the main subject of his picture, he also puts something in the back.

Measurement probably started way back in prehistoric days when some man back there said, "I want another thing like this." Unfortunately, he didn't get it, because it is a law of nature that no two things are alike. In other words duplication is impossible. It would be a great comfort to us if we could absolutely duplicate. Probably if we could, we could get rid of a lot of the engineers that we have around the country.

Historically, after that time they found they had to measure. If you are going to get something like this (demonstrating), you will have to measure this and then measure the new thing.

Then they discovered they had to have some standards. You well remember that one of the original standards was the yard, which at one time was the distance from King Henry's nose to the tip of his middle finger. And back in those days they measured with the thumb nail. It happened that the Latin word for "thumb" was "uncia" and from that comes our "inch."

I am not going to bother you with further historical sequence. I would like to take you right along rapidly to the days of Eli Whitney, right after the Revolutionary War, when he got a contract to manufacture muskets for the next war. Eli in our school days was famous for the cotton gin; but he is really, as you know, more famous for having invented mass production. It was Whitney and not Ford who devised mass production.

In those days the gunsmith made the gun himself--the stock, the barrel, the trigger, the little parts, and so on. Eli said, "Well, if I have one man make stocks, another barrels, another triggers, and another man put them together, I will get more muskets." He did and got them faster.

Then he discovered that these parts didn't fit, so he devised gages. His first attempt was to take a little flat piece of metal and cut a slot in it. He said to his man, "Now, your piece has got to fit this slot." If they did, they went together.

What I am trying to bring out by that is that we still have Eli Whitney's gages, after these many years. Here is one (demonstrating) a little bit more modern, a little bit changed, but no different from what they used back before 1800. They are still in use in our shops. They have their place--I am not denying that--but they are a symbol for lack of industrial progress. That is the first point that I want to stress.

Any of you who have been or may go to Watervliet Arsenal can see on the wall up there a set of wooden gages. They look like tennis rackets. In the time of the Mexican War those gages were used to measure cannon balls. You might be interested in passing this picture around, and take a glance at what they did back in those days. Watervliet now has those gages in a glass case. Its personnel are not using them. But, nevertheless, at Watervliet and Frankford and some other places the gages are no more modern, because they still have little slabs of steel with holes in them, and they call them gages.

I go into shops across the country, modern in every respect--automatic machinery, the latest in tools, parquet floors, conveyers--everything you can think of. And then I get down to the man on the machine, who is

actually making the product, and I look at some of the gages. I see something like that (demonstrating), some of this old stuff. I feel like the chap who is getting into a Cadillac in these days, but he is still putting on goggles, a cap, and duster.

I am not sure which came first, industrial progress or measurement; they are very much tied together. But one thing is certain: that as the ability to measure has progressed, industrial progress has come with it. I think right now we in our industry are a little ahead of manufacture. We are able to measure to the millionth of an inch successfully and readily. Manufacture can't yet come that close readily.

This thing called precision measurement is another part of the background which is growing up. In effect you in the armed forces are responsible considerably for the fact that we are demanding more precision today than we used to. Toward the end or at the end of the last war, there was a great deal of magazine publicity about the ability of the chap in the air to pin-point an oil barrel 30,000 feet below and hit it; they ascribed their success in bombing to the Norden bomb sight. Then the magazines came out with the story that these bomb sights were made in mass production to tolerances of a tenth of a thousandth.

That had its effect on the public, gentlemen. In the old days we might buy a dollar pencil and take it away from the clerk; and, if it went bad, we would go back and get another. Nowadays in the stores you see this customarily: You pick up a pencil and, even if it is only a dollar pencil, you look at the fit of its shoulder. You see how the lead is. The public is becoming precision minded. Thanks to that same publicity, this has occurred.

They have a practical reason for it. Some years ago I owned a well-known make of car. It did 50 miles an hour and it lasted about 50,000 miles. Today you expect a car to be able to do 100 miles an hour at the least and to last at least 100,000 miles. The difference between the two products is precision. In the old days two thousandths of an inch tolerance was a mark of master craftsmanship. Today two-tenths of a thousandth you can throw a cat through.

In those days we cut out two thousandths worth of metal and dropped it on the floor. Today we leave it on the parts, fit them together by selective assembly, and let you wear out that extra metal. You get more wear, you get less vibration, and you get less trouble. That is the modern tendency.

The next thing I want to bring out in this background is to urge you that in all of your dealings with industry where you are involved with gaging, with conformance and measurements, to deal with the operator--the man who actually makes. You will have to deal with engineers, with executives, and others of that type. But you will have much more success if you will get right down to the man who is making.

We can apply that to gages. You may give the man some sort of a gage, so far as that is concerned, that is somewhat inadequate; and you will get an inadequate product from him. You may give him some laboratory model of a gage, which the laboratory man and the engineer thinks is wonderful; but the operator on the machine breaks it up in about three seconds or it is so intricate that he can't operate it.

I will try to bring that out a little more in the further discussion. I am leading also to this next point, which is really an economic gem.

The further away from the source of operation that the decision is made that the product is right or wrong, the further away from the operation you make that decision, the more costly that product is. At the Massachusetts Institute of Technology we tried an experiment. We moved the actual measurement three feet away from the chuck, and the cost went up about 10 percent at that point. You can prove it time and time again.

And so when it comes to our subject this morning, if I can focus your mind on the man who is doing the setting, who is making--give it to him. If the inspector has to use a gage, let him use that one. If the engineer comes along and has to use a gage, let him use this one right at the machine.

I can give a little demonstration of what I mean. I don't intend anywhere this morning to get in a commercial plug in any sense. I represent the industry. I just want to get an idea across to you.

A man is making, we will say, pieces like this, multidimensional. They are shooting out of this automatic at the rate of 100, 200, or more a minute. We will admit that he is conscientious, that he takes a piece once in a while and checks it. He wants to be sure that his work is right.

Here he has a micrometer. I am not knocking the micrometer. We make it. But the first thing he does is to check this shoulder here (indicating). Then his second step is to roll this micrometer down to the next shoulder. Then the next step is to roll it down to the third shoulder and get that measurement.

Now, gentlemen, the biggest muscle in the body, so I am told, is the one that runs upward from the back of the knee and, being the biggest muscle, it gets the tiredest. I want you to get the picture of a man leaning against that muscle, measuring, concentrating, looking.

Suppose, instead of a 20-dollar mike you supply him with a 30-dollar gage, with which he can measure this piece this rapidly (demonstrating). Anybody can read a clock. Do you get my point? The actual timing on this job, gentlemen, is six seconds against 22 seconds. By that means you can help your job along.

For our next demonstration along that line we will go back to Eli Whitney. I can name a specific shop, so far as that is concerned; not only one, but a dozen, where I have been and they are making 20-millimeter slugs. A lot of them use this type of gage, or were using it before we got on the job. A man goes up to his machine, picks up a piece, and sees if it will fit the gage. It fits the gage on both sides, so he is in tolerance. Fifteen minutes later he checks the next piece, and fifteen minutes later he tries it again--O.K. Fifteen or twenty minutes later another piece--O.K.

What happens after that? Here is one of our troubles. I am going to pass this around the audience. I know you can't see it, but here is the starting piece. The hand is down here, so it is a couple of thousandths under zero. Fifteen minutes later the work has grown. You look on the dial and you see the hand up here. Fifteen minutes later the work has grown. Now it is over here. He is at tolerance--not quite, but almost.

Now, you see what happened. The next time he comes back to the old style gage, the piece won't fit; but it is too late. A certain number of these slugs have grown too big. They are oversize. This (indicating gage) tells him ahead of time. It also tells him in thousandths of an inch how much he needs to set.

We have another situation in this background. Most of the work that we make is multidimensional. This is a piece here. It has all of the dimensions. You can see this piece coming out of the machine. Tool after tool worked on this and brought this out, as we say, in one operation. The man has to check on every one of these things.

Well, you can see him here. He will try this one here with a thread gage. He will run over to another one. Then he will go over to a third one. How many pieces is he going to check at a piece rate with that kind of gaging?

So we tried to modernize that. We have the thing down now so that he makes this piece, he puts it in a gage like this, and he reads instantly everything that he needs. That one costs about 500 dollars. I don't know what this miscellany of gages does cost.

I was told by a Ford engineer--I am not certain of my figure, but you can get the precise one--that its people are willing to invest 1,500 dollars in equipment if it saves three seconds of time. They think that is good economy.

That is another thing I want to pass on to you. But I still want to hold to the psychology, the fact, of the operator being tired at all times mentally, his attitude in picking up and putting down the gage.

Think how often he would check if it is only a matter of passing the piece in a gage like that. You would get your product coming out better.

Speaking about there being a lot of gages, the gage industry can come up with almost anything you want, so far as that is concerned.

One of the things that you will run into a little bit on something new in the line of gaging is this: In other words 2 years ago, 10 years ago, 20 years ago, a machinist has been trained on something like this (demonstrating). He definitely doesn't like changes; I don't have to tell you that. We find constantly that with apparatus of this nature, with small hand apparatus, there is resistance; that is natural. So we have a stunt. We come up to the machine and we fiddle around with a piece that this man is making. We fiddle around some with a gage. Then we just leave it there and we walk away. Apparently we forget it, or we are busy or something else. We probably leave it there two or three days.

Well, as soon as the chap can get his foreman out of sight and everybody else and maybe the fellow next to him isn't looking, he will commence to fiddle with it. So we go back in about three days and we pick up the gage and we start to walk off with it.

The fellow will say, "Hey, bud. Where are you going with that gage?" We say, "Well, shucks. You didn't like it the other day. We didn't think you cared for it. We forgot that we had left it with you."

He said, "Bud, I want that gage or one just like it." And he meant it.

"Well," we said, "why? What happened here?" He said, "Were you ever driving at night and have your headlights go out suddenly?" He says, "That is the position I am in now when you take this away from me. I can't see where I am going."

Well, you not only get resistance there, but you get resistance higher up. I don't know why there is this blind spot. I can't explain all the ramifications of higher management. I can start with the foreman and all that stratum of methods, tooling, and what not, the engineers in between, and then the big boss. But you go to them with a gage that costs 200 dollars. "No. We won't buy it." There is that blind spot.

Let me give you an example. I think this will make the point a little clearer. This is part of a hydraulic valve. The Air Force is quite interested in this valve. If I remember correctly, this valve has to stand something like 10,000 pounds to the square ince of oil. This is the part as it comes off the original automatic.

In this particular shop the lad was given a gage like this--a plug gage, we call it. I am going to pass this around. I want you to see it. These plug gages have a habit of doing that (demonstrating). If the fellow wants to nail up something, as I did this morning, he does this with it. This one costs 5 dollars, and the fellow gages with it like that.

This job was making a lot of scrap. I won't try to give you the figure. But, what is more to the point, when these parts were asembled into the valves, the valves had up to a 40-percent leakage on the final check. They would make 100 valves and discard 40 and give you in the Air Force 60. I don't think that is good procurement.

So we went to the boss and said, "Why don't you give the operator this gage?" He said, "What does it cost?" We said, "165 dollars." The price seemed almost excessive to him.

So we did our usual stunt. We went down on the job and put this to work. Here are the figures: With the use of this indicating gage, the operator is shown what is happening. It saved on the job itself 3,800 dollars a year. We asked that company to spend 165 dollars to save 3,800 dollars. On top of that, the leakage went down from 40 percent to 7 percent, because this gage also shows out-of-round, taper, and those other important elements in leakage, besides the actual dimensions which this one wouldn't show.

Along with that, we have come up in the industry in the last few years with what is known as the air gage. I would like to demonstrate it for a second. You are going to see it in the motion picture, but it is better seen in action than over a film.

The other thing I want to bring up is this: I will say dogmatically that when it comes to hole measuring, probably the best solution in the world up to date is the air gage.

So you have one little gage here (demonstrating) that costs 5 dollars. Or you can take a gage like this, which is about 165 dollars. These run about 380 dollars. There is that same old blind spot up here--confusion between price and cost.

Here is a little job. I will admit that this is a trolley wheel, but it has a bearing in here that is a little important. According to the plug gage, this is perfectly all right. It goes in the "go" and doesn't go in the "no go." But you have seen trolleys come off. You may have wondered why they come off so readily. Perhaps I can demonstrate it with this air gage. It is about four-tenths of a thousandth off size. It has taper and it is out of round. Yet under the conventional method, the old-fashioned method, this trolley wheel was perfectly acceptable. No skill required on the air gage.

While I am demonstrating air gages, let me also suggest one other point. Up to this minute I have brought the work to the gage; that costs money. It is much better if the worker is able to bring the gage to his work. Well, we are all set (demonstrating). The work is in the chuck, all held in there. He just brings his plug over it, reads the gage, and there he is.

We will show that in the picture. I did want to give you just a look at that ahead of the picture and fasten in your mind the matter of air gaging.

The next thing in the gaging line is this: If you are not getting the quality of product that you want, it is necessary to do something about it. I don't mean sending out letters and directives; and I don't mean pounding on the desk. I think it was someone in the Air Force who was talking to a pilot and said: "Now, when the paper work in connection with this flight equals the weight of your plane, take off anyway."

What I mean by doing something about it is have somebody responsible; get out on the job, to the operator. For instance, at the Denver Ordnance plant during the last war, where I was the chief inspector, there was a shortage of gages. Somebody sent us some glass gages. They were of this general type, but made of glass. They were perfectly good gages and they measured all right; but if you dropped them on the floor, they weren't any good any more. So we went out on the floor and said: "Fellows, these are all the gages we have. They are perfectly all right, but please be careful with them. Don't drop them."

I went out on the floor the next day and, to my astonishment, I found those fellows out there actually gaging for a change, instead of reaming holes the way they were before. What I want to demonstrate is, we did something about it. It doesn't matter what the higher ups supply the man, if it is something new, something along this line, something different, he gets the idea that the men up above mean that they want conformance and quality, because they don't write a letter and they don't post a bulletin, but they do something about it.

I am here primarily to talk about measurement. So I will give you a quickie from about a sixty-fourth of an inch to a millionth of an inch.

The basic industrial measuring tool is the steel rule. You can measure with reasonable accuracy to a sixty-fourth or fifteen thousandths with that. A little depends on the type of piece that you have, that you are trying to measure.

If it is a matter of diameter, the usual thing that he does is get a pair of calipers and check the measurement that way.

Coming up a little modern, we have taken the caliper and we have put an indicator on it, and we can measure the diameter of a piece directly and quickly, like that (demonstrating). I know of one concern out west that, several years ago, when the foundry shortage was on, bought a bunch of these and used them in its shops and foundry. The employees of that concern controlled the wall and the web thickness of their castings with the calipers. Previously they had done it with a steel rule. They control it so well now with an instrument of this nature that they commenced to buy castings by the piece instead of by the pound, and both the foundry and the concern made money, and the deliveries picked up.

Probably the next thing to be talked about is the micrometer, which came out just about in the Mexican War days. That is a marvelous tool. A recent addition to it is to put an indicator on it, and also to put on what we call a constant-pressure micrometer. I can have six of you measure a pin with this micrometer and come up with six different readings. One of you may have a hand like a ham and another a hand like a schoolgirl. But with the indicating type of mike with the spring-loaded anvil one of you has to get the same reading as the other. When you are working down to tenths, that is essential.

Back around 1850 a fellow by the name of Brown went over to France to view an invention of a man by the name of Vernier, who had gotten out the Vernier caliper. This chap Brown also found a Frenchman over there who had a little screw thread device which would measure. So these chaps came back here and made micrometers; we have had Brown and Sharp micrometers ever since 1850 and the Vernier caliper beginning about the same time. They are still in use.

You have a measurement like this (indicating) to make. A chap will come in with a Vernier caliper. He will fuss around like this. He usually has to use a glass. I haven't taken as much time as he would take to get that measurement correctly. What I want to point out is this: How much faster, how much more accurate, it is to do that (indicating). The indicating gage measures instantly. You have a gain in time, a gain in effort, and a gain in accuracy, which is essential today.

With the indicating type of instrument we come down to tenths of a thousandth, or to half a tenth, to fifty millionths. With the air gage we come down to fifty millionths. In a minute or two I will regale you with millionths.

Back of it all, of course, I couldn't talk about measurements without mentioning the gage block. There (indicating) are five inches in space, which is accurate to about five millionths. This is our basic measuring tool. With a set of these gages we can rack these up together like this, pile them up to any length we want, and things of that nature. I bring that up because it is part of a gaging talk.

You are going to have a recess and have a chance to play with some of these gages; so I am not going to discuss them any further. I simply have to apologize at the scarcity of them. When I set these out to go to Washington a week or so ago, I could hardly find a gage in the plant. They are on demand. They are shipped out. You can't keep them there an hour. They are on their way out. So I picked up what I could.

Now, following along from a sixty-fourth or fifteen thousandths, to the thousandth, to the tenth, and to the half a tenth, to fifty-millionths, we come next to the electric and electronic, and, incidentally, to the millionth of an inch.

With the electric we introduce one other feature. We can hook an electric gage to the ordinary indicator. The man still has the ability to read his indicator, but on top of that he can see lights flash--red for oversize, green for on size, and amber for undersize.

The American eye is conditioned to see a light. Having something of this nature hooked up to your machine and going by flashing lights would speed it up tremendously, because you obviate the instrument reading lag.

In creating an electric impulse, you have done another thing. I mean, in order to light that light, we have created an impulse. Now, we can amplify that impulse. We can send it anywhere we want to. We can have it, if it goes red, travel through and stop the machine. You can have it ring a bell. I don't care what you want it to do, you can do it as soon as you have created an impulse. That is the next point I want to bring to your attention.

Then finally, with practically the same idea except that it is electronic instead of electric, we not only have the electric impulse, but because of electronics we can begin to measure in millionths.

This instrument here will take millionths. You can see, I am working backward here. That millionth flashed by so fast, working backward, that I could hardly control it. You will see a lot more of this in the picture.

The other point I wanted to bring up especially to you in front is the effect of temperature. I am just simply going to put my finger on the back of this column, and you down here, at least, can see that needle crawling right along. What the heat of my finger is doing is buckling that piece of this instrument.

We in industry are working to ten-millionths, fifteen-millionths, five-millionths, and things of that nature; and for that an instrumentation of this nature is necessary.

We can also take this impulse again and, as you will see in the picture, we can classify parts by sizes, we can stop machines, we can do things of that nature.

I don't have half an exhibit here; I couldn't strip our shipping department of the necessary gages. But as we stand in the industry today, we can come up with almost anything that is needed.

We have a picture which takes us from this stage that I have shown you right up through the automatic gaging that is now in vogue. I will discuss that after the picture. We now begin to get into what I call automation and what I guess you call cybernetics. We cut a lot off the first part of the picture because we had a lot of advertising in it.

Motion Picture

As an old-time inspector I have used some of this that you have seen with considerable awe. This picture is now a year old, but it is already behind the times. We have advanced so much in the last year. We are trying now to get out another picture that will carry us up to date.

The picture couldn't show it, but we have gone many steps beyond what you saw here. For instance, on these wrist pins we take those from the conveyer; we gage them for hardness, taper, and diameter; throw out the rejects automatically; stamp them with the size; grease and pack them--that sort of business.

Another one we are doing now is illustrated by this punch press. We have already done the grinding and some other operations. Every piece as it goes through the punch press shoots down a trough, and it is gaged. If it gages correctly, it is allowed on the conveyer. If it is incorrect, it is shot off into the salvage box. When the red light comes on, a bell rings and the machine is stopped. In one of our recent experiments we found that one man can now control 22 presses, where it used to take 22 men; and no bad work goes on the conveyer.

Now, taking automatic gaging and so on, if you can get the proper and suitable gaging equipment at the proper place, at the proper time, with the proper men, you will gain in this way: Practically every shop that I know of has a substandard, salvage and scrap figure of something between 10 and 30 percent. You make 100 pieces and you get a net of 70. So I put this to you: that with what has been implied this morning, applied, you could save 30 percent of your procurement problems.

The meeting is yours. Thank you for your attention.

QUESTION: It looks as if all these gages with dials and indicators on them would be subject to damage from shock. How subject are they? How do you check to see that your gages are not out of whack?

MR. KENNEDY: I will drop one of these on the floor and you can see that it is still working. We design them against shock.

QUESTION: Doesn't dropping a gage damage it?

MR. KENNEDY: I don't think you could get these out of order. They are not so fragile as you would think. They compare somewhat with the gage block. That would still measure to five millionths and stand a great deal of abuse.

As to the second question--how do you check them? With these air gages we usually master them. I didn't master that gage before I used it, but we usually do. With a gage like that you stick it on some known dimension like a gage block and check on the reading.

The average practice is to do that once a day, at the start of a shift. We try to design our gages so they will go an eight-hour shift without deviation, but they usually go longer.

QUESTION: What is the principle on which the air gage operates?

MR. KENNEDY: You have here air coming out through a jet. Here you have virtually an inside caliper, just as you have here, except that here you have an air jet.

Now, there is static pressure in the gage; and, even though air is escaping, when you put the work piece over those jets, you make the air turn a corner. That builds up back pressure and the gage is designed simply to register that back pressure. The closer the work piece is, the more back pressure the gage registers. The further away, the less back pressure. The whole thing is calibrated together. We get an accuracy of at least 10 to 50 millionths. It is a circumstance, but it works.

QUESTION: I appreciate that this discussion is primarily on measurement. However, some place in the sequence someone has to begin to think about flaws in the material. Would you comment on how you discover them?

MR. KENNEDY: First of all, there is cutting the piece in half and looking at it; they still do that. Then there is the X-ray.

If I may venture a personal opinion, just purely an expression, I like the supersonic. You introduce this high vibration into your piece and then you register anything that stands in the way of your reflection. If you want that stated technically, if you will get in touch with the Sperry Instrument Company, Danbury, Connecticut, you can get some literature about the supersonic.

Some of the others are magnification and things of that nature. You can detect surface flaws pretty well, but for internal flaws you need X-ray or supersonic, as we stand on it to date.

That is just a personal opinion. The next fellow who stands up here may have another idea; it is a field that is developing.

QUESTION: What is our position compared with other parts of the world, particularly Europe and that general area? Are we way out in front?

MR. KENNEDY: Yes. The Swiss are doing very well. The Germans are doing pretty well at the surface. They are not worried too much about measurements under the surface. If I may venture a personal opinion, the British are copying. That is about the way it stands. The rest of it comes out of the United States.

QUESTION: When you are using the electronic type of measuring equipment, as you showed with your hand, temperature has a big effect. How do you surround the area to take care of temperature changes?

MR. KENNEDY: Usually when I get hold of you fellows--I am a shop man, I have to do things--I get you to invest in a temperature-controlled room. But that is not necessary. I will give you one secret.

If you will take your work piece and take your master and put them side by side on this gage like this (indicating) and leave them for 20 minutes, you will be stable enough for what you want to measure. Don't pay too much attention to this temperature-controlled room unless you are contacting steel with aluminum, steel, or brass; then you must have it. That is number one.

Number two: Even in an air-conditioned room you will have a draft of cold air coming right down on this thing. One fellow will put this up against a window or put it next to a door and leave the door open. People are most foolish. All you want is a stable atmospheric condition and vibration-free. You can get more harm from just plain dirt off your thumb than you get from any temperature. What was bothering you in my demonstration was just plain dirt, not temperature.

QUESTION: I noticed there was some oil on it.

MR. KENNEDY: That is usually impalpable in the measurement.

QUESTION: What has been the effect of the fluctuating nature of the national economy on the stability and progress of your industry?

MR. KENNEDY: Not much.

QUESTION: Any feasts and famines?

MR. KENNEDY: We had a famine. In our VJ-day disagreement of the leaders, we had a faminine for something like two and a half weeks. But then we started up again.

QUESTION: The whole economy was that way then. What about 1949?

MR. KENNEDY: Not much worse. There is a reason for that, too. I railed this morning about the lack of progress, the lack of progressive thinking--well, it is coming along enough.

I can cite one instance that perhaps is in your line. Take the paper industry--its representatives want very much to control the thickness of paper, like you saw on some of these machines. They want us to pay the bill for developing the necessary instrumentation. We won't do it; if we put up what we estimate will be needed to develop that instrumentation, there aren't enough paper mills in the world to buy it. If each one bought our equipment, there aren't enough paper mills in the world to pay for that development. We are asking them to come in with us. We have told them that if they will pay half of the development, we will meet the other half. We will take that gamble.

MR. BAUM: Our time is up. On behalf of the college I thank you for your very excellent demonstrations and your talk, made, as I said, in your inimitable manner.

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