

CUSTOMER FEEDBACK AND FEEDFORWARD

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Synopsis Control systems, whereby a final customer may obtain a satisfactory product after it has passed through several stages of manufacturing, are characterised by considerable time delays in both feedforward and feedback paths. These systems are examples of the industrial dynamics problems investigated by Forrester and others. The matter under discussion in this paper is concerned with the establishment of sensible control systems and the maintenance of their reliability and accuracy. It specifically considers paper products used in data processing as punched cards and forms for optical character recognition.

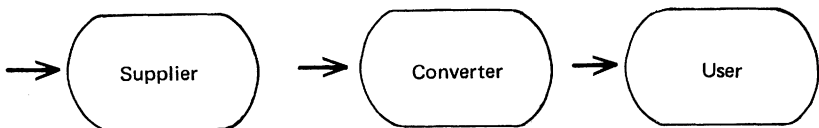
Generalities

SIMILAR control engineering techniques as described in this paper are those used for dealing with hardware systems. In Fig. 1, an ideal case for a supplier-converter-user control system is compared with a moisture control circle of a papermachine.

Some of the principal weapons that can be used in a sensible control system are—

1. Use of cascade systems.
2. Local loops for accuracy checking.
3. Development of refined control algorithms.
4. Improvement of measurement accuracy.
5. Updating systems for control of drifts.
6. Reduction of time delays.

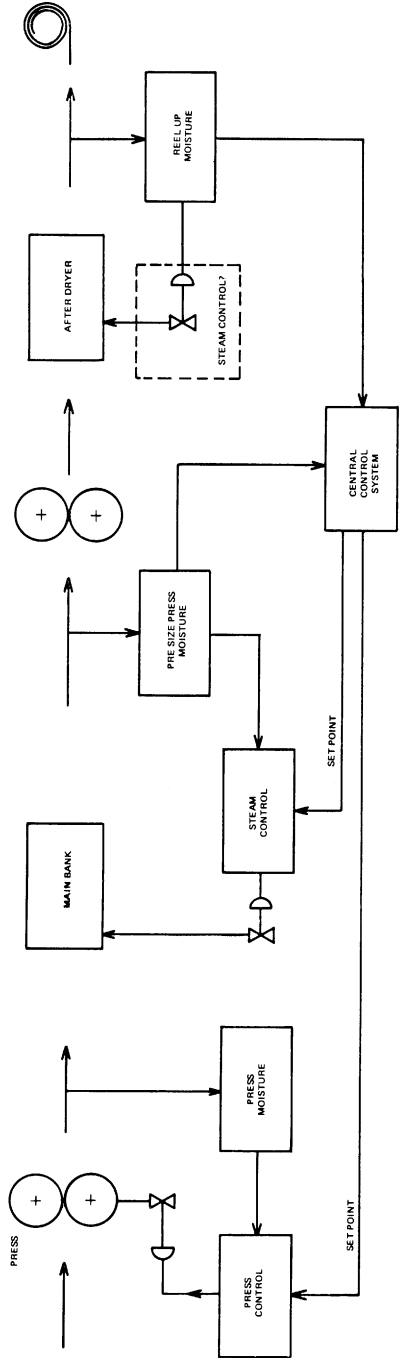
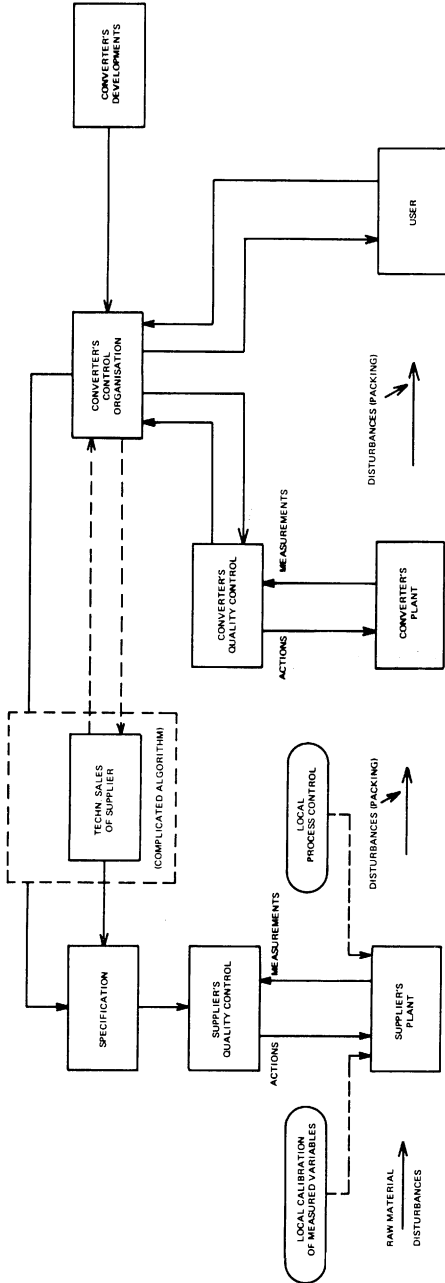
Before going into the specific subject of this paper, it is necessary to define the position of the parties concerned.



Supplier
Converter
User

Papermaker
Data processing industry and/or printing industry
User of data processing equipment

Under the chairmanship of M. I. MacLaurin



Establishing the control system

IN GENERAL, most of the activities start with a feedback from the converter, the papermill receives a specification, which should be based on existing standards, as established by a national or an international standardisation organisation. In the case of a new product or new specification, it is recommended that co-operation between converter and papermill should prove that it can be realised.

Based on the specification, paper samples will be handed over to the converter together with a test report of the product. At this point, it must be stressed that among reliable partners the customer cannot be the king as far as justification of test results is concerned. In other words, test results from a supplier cannot be ignored even if they are not in correlation with the customer's report. Too often it happens, especially in paper testing, that, because of specific conditions such as changes in relative humidity, wrongly adjusted test equipment or unskilled test personnel, deviations of results occur that can cause drastic and costly reactions to nobody's benefit.

We all should stick to the basic test philosophy that the test results of the supplier are as good as those obtained in our own laboratory. The only way in cases of disagreement is the performance of a correlation test.

A correlation test between converter's and supplier's equipment should be executed under all circumstances, after having decided to step into closer co-operation and before any test runs of paper. After completion of a successful correlation test, both partners should agree to a small test run of paper. The initial small test run of paper is mainly destined for—

1. Determination of the possibility of making paper according to given specification.
2. Detection of difficulties during converting on printing presses or other machines.
3. Performance of product tests of the finished product on processing units such as computer input and output equipment or business machines.

These test activities should finally result in a justification of the developed specifications.

It is depressing that so often negligence of these rules wastes money and serious psychological and legal problems occur between the partners involved.

From Fig. 2, one can see the time consumption that, in my experience, is rather optimistic. Time delays are certain if one or more points of the program are not in line.

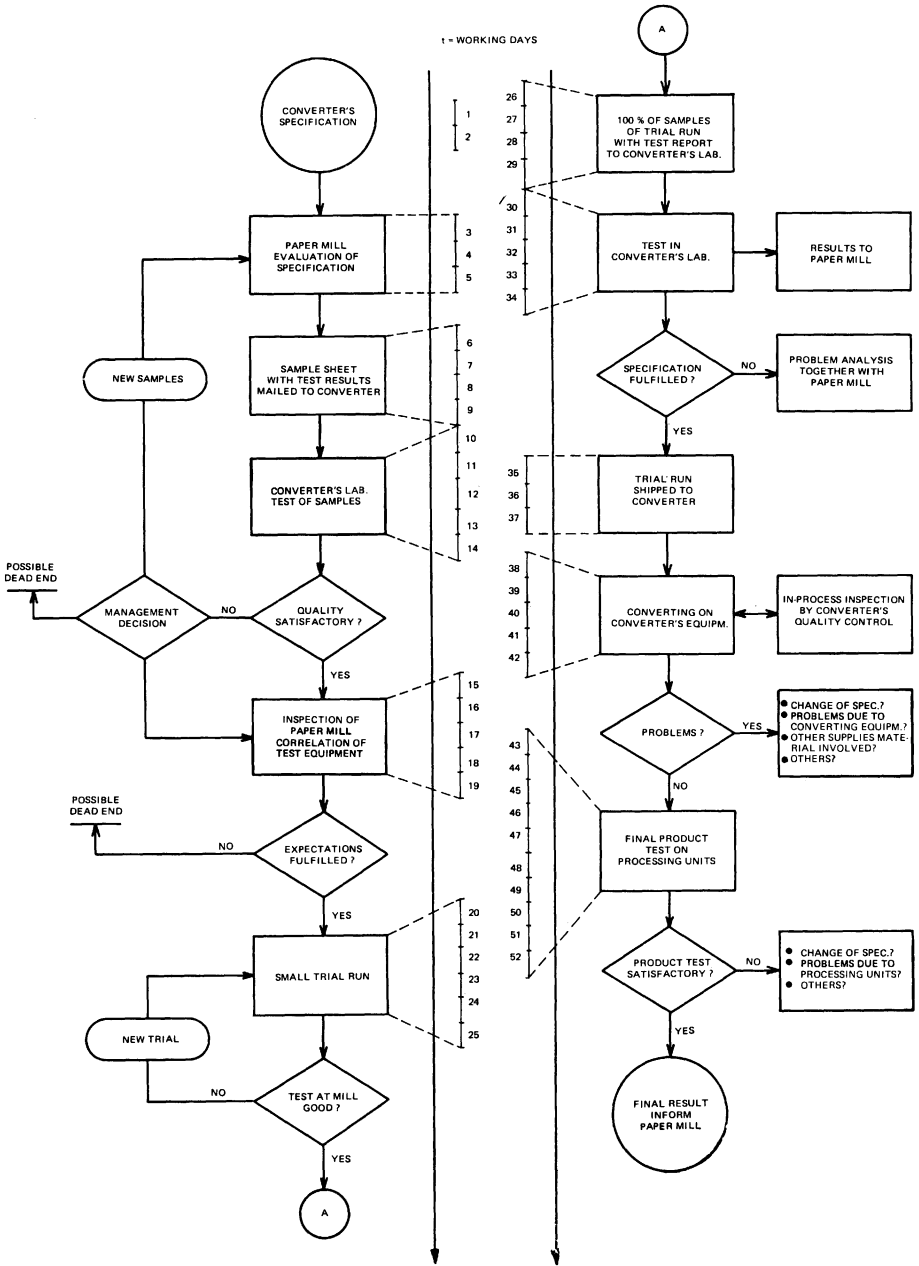


Fig. 2

Papermill qualifications

IN FURTHER test runs with increasing quantities, the papermill should be qualified as a good source of supply. The main reason for qualifying a papermill is to reduce one's own test activities and to procure material without time delays. One should finally aim at having the supplier make his own release without approval of the shipment by the converter's quality control.

Product acceptance

PURCHASED material is normally inspected by sampling, conducted on a statistical basis. This entails a factor of risk for both customer and supplier. The element of risk, however, is maintained at a known level. All characteristics should be classified and, as a result, inspection effort is concentrated on those characteristics that are considered most important for the satisfactory function and appearance of the material.

In Fig. 3, an acceptance method is described that is used in my company for paper from unqualified vendors. The acceptance test is performed on sample strips, not on paper reels. Our experience with this procedure is extremely good, especially if shipments to foreign countries are involved, when duties have to be paid and transport charges are high. Depending on the paper grade, the time from making up to release of shipment by customer's quality control can vary considerably. In this example, it takes approximately 10 days.

A qualified vendor should be allowed to release shipments by himself, although he should continue to send sample strips for correlation purposes. For products released by the supplier's quality control, considerable time can be saved.

At the beginning of the flow chart in Fig. 3, it is recommended to elaborate mill limits. The main reason for this suggestion is to avoid discrepancies between converter and supplier, caused especially by variation of test results through the effects of test equipment, handling and environmental conditions. In quality control at the papermill, it is advisable to plead for a separation of responsibility between production people and those carrying out the final test. It is actually the man on the papermachine who makes the quality—it is obviously his responsibility. In modern papermills, he has so many means of controlling the process—nowadays, even by computers—that he needs simply good co-ordination with the mill's quality control department to obtain optimum quality.

Once the paper has arrived at the customer's location, it is most important to check its arrival condition. It is well known that the method and kind of transportation can have significant effect on the quality of the raw material and can give rise to difficulties during converting processes. Since it is often

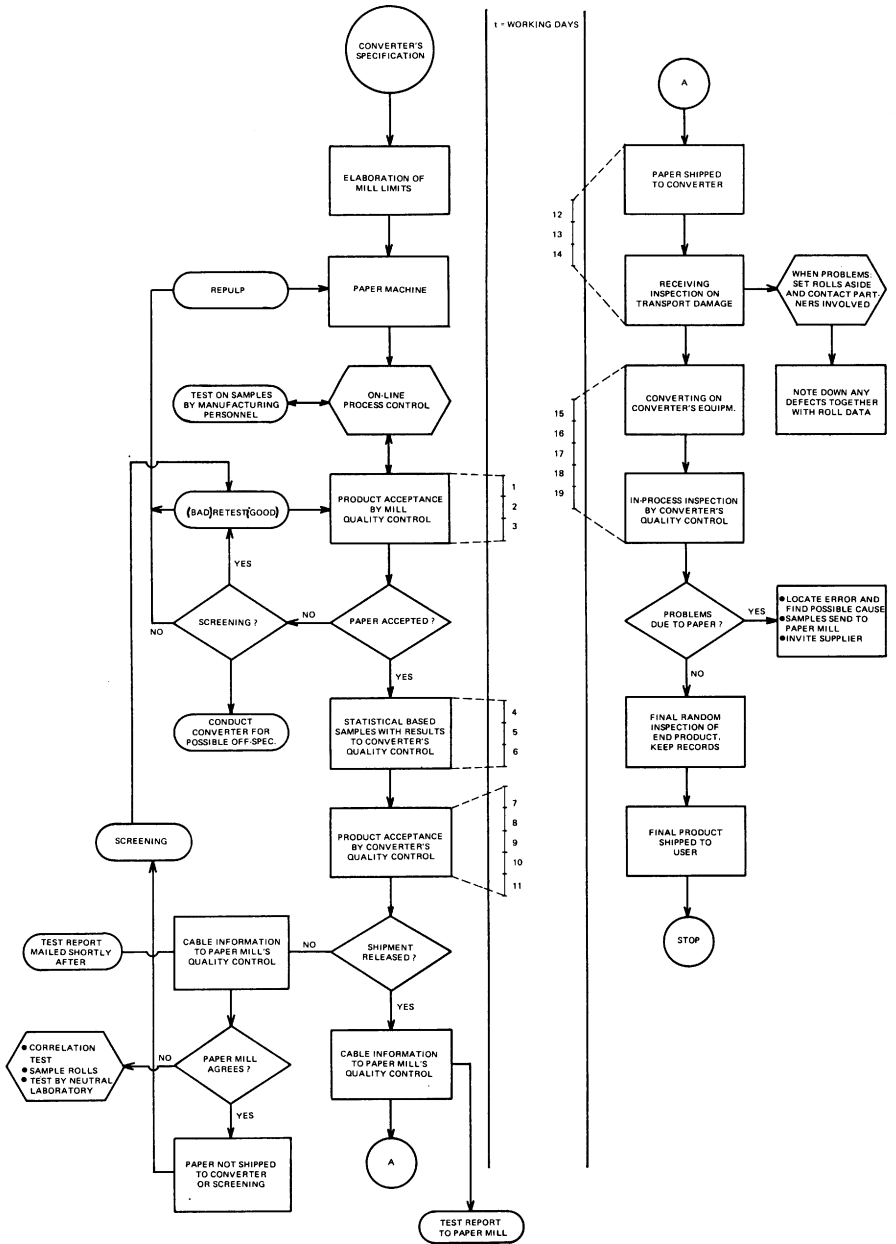


Fig. 3

difficult to state where these problems have been derived from it, goes without saying that records must be kept with all the necessary data and photographs being taken to demonstrate the defects.

Being familiar with the converter's side of the business, I must admit that not all of our people have enough insight into paper technology to be able to give definitive statements whether or not the paper was the most likely cause of the problem with which they have been faced. It happens very often that they ignore converting machine problems and trace everything back to the raw material. It is essential therefore to co-operate very closely with the papermaker and to give him the best information feedback. For all steps of the converting process, reel data must be kept in order to simplify problem analysis. In complicated situations or in applications, joint studies are often the only way to achieve the best solution.

Inspection of product

THE final inspection of the final product is interesting not only for product quality, but also for possible changes in the raw material in the course of the converting process. This happens more often than one believes. Surface properties such as friction and smoothness also such other physical characteristics as thickness and stiffness, are subject to mechanical and/or atmospheric influences. Finally, it pays to be aware of these facts and to submit these findings to the papermaker. Both can take steps to prevent or at least to simplify potential problems.

Complaints from user

DEPENDING on existing contracts or legal obligations, the converter as well as the papermaker may be responsible for complaints arising from the final product at the user's location. In the first place, it is the converter's duty to contact the user and to evaluate the complaint. Fig. 4 describes the steps that are suggested for the converter to follow. The example is taken from the business machines industry, in which paper is used as input and output media. Especially in this field of business, it is sometimes extremely difficult to locate the possible cause. Quite frequently, we have a multiplicity of parameters causing the complaint. Only sophisticated methods of problem analysis, complete collection of all available data and sound record keeping lead us to an optimum solution.

As the majority of the sales people and field engineers of the converter industry lack a sound background of paper technology, it is absolutely necessary to establish questionnaires to be used in complaint handling. Data obtained by

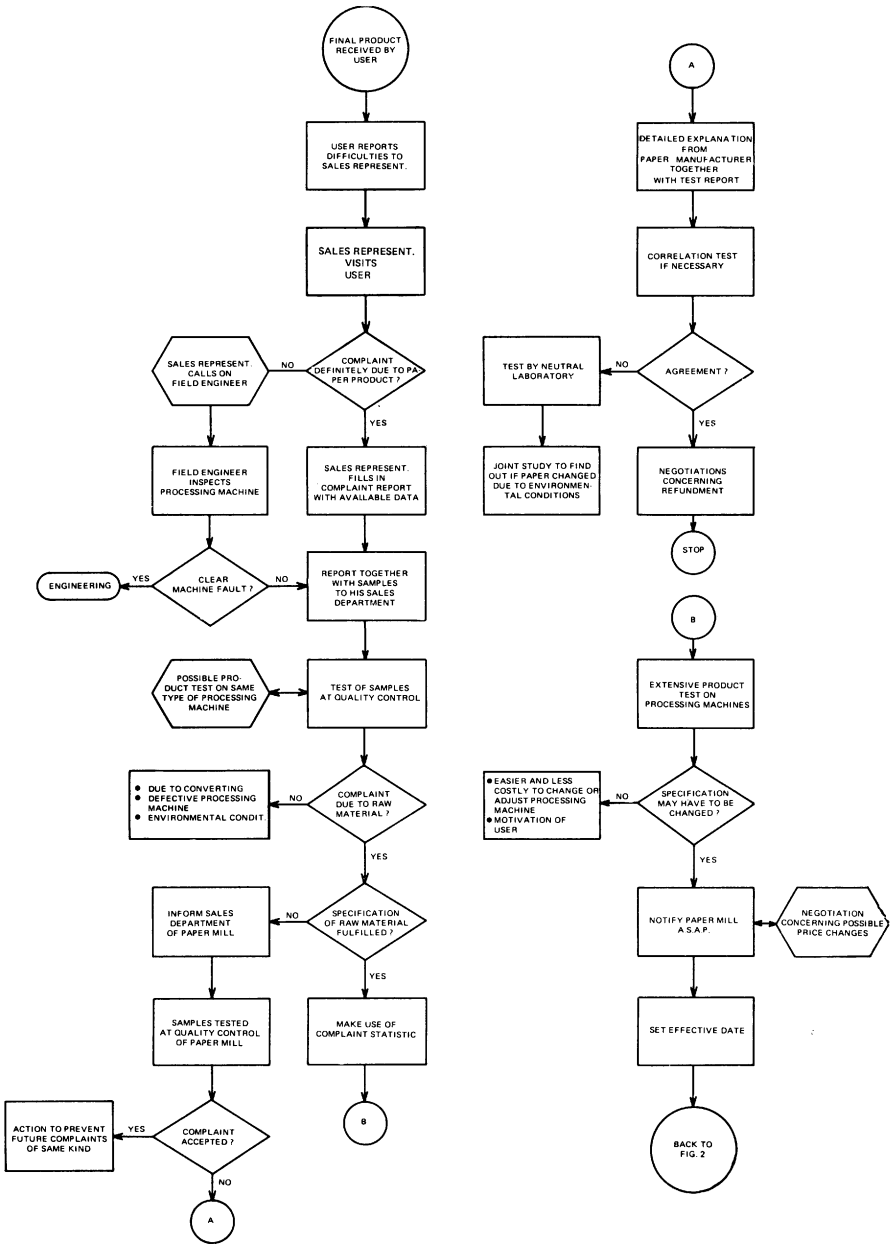


Fig. 4

the questionnaires can be used for statistical evaluation, which most probably are the best tools for complaint analysis and for decision making.

Because of possible variables, it is impossible to give any time schedule for complaint handling. It goes without saying, however, that one must give priority to all complaint situations.

Transcription of Discussion

Discussion

Dr F. L. Hudson Mr Stopper, like Mr Mardon earlier, has referred to psychological problems. My recent experience with paper users has led me to believe that the delays and confusion caused by misleading specifications are still serious and perhaps the weakest part of the whole paper system. The example I quote is very old, old enough to be safely discussed, yet the worst I have seen and quite the most apposite to Mr Stopper's paper.

On joining a quality control laboratory about 35 years ago, where tabulating card was tested, I found the number of cards per lb, according to the customer's specification, was supposed to increase by $2\frac{1}{2}$ per cent only when oven-dried. The moisture content was therefore specified at $2\frac{1}{2}$ per cent, but as any technologist would know this is quite unworkable and the card was actually sold at 7 per cent. No one would have the specification altered, however, for it was psychologically inadvisable to annoy the customer by mentioning it and more convenient to apologise to periodic complaints. In the event, the specification remained intact for the ten years for which I held that position, quite possibly for a long time after I left it. Surely a time delay of 0.1 century for feeding information forward to a customer must be unusual even for psychological reasons. This would not happen now for this particular material, but I am afraid there are still serious time delays with other papers due to stupid specifications.

The answer to this kind of thing is more education and I would refer here to Mr Ball's contribution to the discussion following McFarlane & Hoath's paper (page 321). His 1956 publication* did not pass unnoticed in Manchester. One student memorised (I will not say learned) it so thoroughly that he reproduced an obvious misprint in an equation for an examination script!

In 1957, Dr Kirk was appointed at Manchester University to lecture on automatic control to paper science students and he has done so for 12 years. Suitable laboratory apparatus was obtained in 1958. A number of Manchester graduates who have taken this course have attended this symposium; one of them has read a paper. In this kind of education process, too, the time delay before one gets obvious results is about a decade. I trust that Mr Balls will get some satisfaction from what he initiated. Perhaps, on Fig. 3 of

* *Proc. Tech. Sect. B.P. & B.M.A.*, 1956, 37 (2), 201-210

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Mr Stopper's paper, there should be an outer loop with a long time delay and with a paper science school somewhere in it.

Mr W. Stopper I am very glad not to have been in the company at that time, because, coming to that particular department, those specifications had been changed. I believe they are very definite now and very strict, but I think everyone can understand them. On the other hand, we shall be connected more and more with standardisation organisations—for example, the paper for OCR forms are already being discussed by national standardisation bodies. Thus, by the time the volume of such forms is increasing, there should already be existing specifications.

The Chairman Thank you. I must say, when I heard you use the words 'definite' and 'strict', you describe Mr Stopper's point of view fairly well in most cases.

Mr H. B. Carter I must congratulate the speaker for a magnificent display of a system: it clearly indicates that, in order to reduce the time delay, some rather obvious changes in the system are required. This system essentially is to produce cards for the user from paper made in a papermill and there seems to be at least one completely irrelevant stage in the process—perhaps two.

It seems unnecessary to have the intermediate user (the equipment supplier) monitor the quality of the paper being shipped to the converter and monitoring the quality of the converter's output. Surely, he can do this for himself. This may be only the development process, but, if it is the system used in routine business, the time delay is quite easily reduced. It is not only the speaker's company that does business in this way. This is a clear case for the system to be re-organised.

Mr Stopper Well, we cannot, firstly, for psychological reasons and, secondly, for cost reasons, have a man sitting next to the papermill or supplying directly to the mill. Companies might have ten or even more paper suppliers having a man sitting directly in the mill. We cannot pay for that.

Mr R. H. McClaren In everything that Mr Stopper has described, I find complete opposites. Possibly this is why Xerox competes so well with other large companies like IBM. We frankly do not believe that anyone can describe paper or make paper for our machines as well as we can. From our viewpoint, only God can write specifications by looking at a product and we do not propose to be God. In our relationships with our papermills, the mills themselves write their specifications based on a given papermachine, using a

given raw material supply. Each specification defines a product from a machine in a mill. Mr Hopkins and myself control somewhere between 10–20 machine/mill outputs and, although we have provided them with guidelines that are general to our Xerox machine needs, the paper that is made by these mills based on these guidelines and paper that controls our specification writing is a product of a given mill using a given papermachine.

When the process of using these guidelines, a manufacturer makes a paper that is suitable for our machines and can triplicate this within narrow limits of control, we then derive a specification from the analysis of these productions. In purchasing paper from the mill, we require a 95–99 per cent statistical conformance with the specification. If this performance is not met, we reject that paper. We are fully aware that our Xerox machines may meet that product later, but we have no control over it, nor do we care what the manufacturer does with the rejected paper.

From my personal viewpoint, the major problem in any papermill is personnel. If we could remove people from the papermachine and provide statistical control derived from a computer, we would be able to make uniform paper within a run and from run to run. In other words, the people running the papermachines that make the paper we buy are ordered not to vary the machines once they are running properly. In fact, if they need something to adjust, I suggest that we provide them with computers, because the operator of a papermachine, in his manipulations, can do us far more harm over performance goals in meeting specifications than any inherent machine variation could provide. I hope in the near future to find a papermill where we would find no people at all, except those taking the product away from the reels.

I suggest that Mr Keyes had some of the priorities for the computer's potential misplaced. He identified quality as high up his line of priorities. I define quality as a beautiful woman or, in beautiful picture, as a sensual thing. I cannot find quality in paper. Uniformity is the magic word for paper and I am sure it is so in all of your worlds. Most of you cannot make uniform paper and only two or three mills in U.S.A. can do so. I am defining uniform paper in this context by a given product from a given machine made week in and week out, month in and month out, that conforms to a specification.

Mr Hopkins' many colleagues ignore the psychological effects identified by Mr Stopper and, in his control of the production in the European area, he provides full-time inspectors in the firm's supplying mills. We have found this to be most satisfactory and we get a good quality paper of reasonable uniformity in this environment.

Mr Stopper We are continuing to compete, but I cannot fully agree with what you have said. One point that I would like to mention is the uniformity

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of the paper produced and I can only refer to the European mills (maybe some in the Far East), but for our product at least, because of the connection that we have with the papermills, they are able with a very few exceptions to make uniform paper. Here again, we disagree. I do not know your product, but with punched card stock, for instance, the quality level of European manufacture is comparable with the American level—in some cases, even better.

Mr McClaren I hope I have an international point of view, but the cost to the corporation is about ten times greater to have other people's paper used in our machines and this to me is truly a measure of uniformity.