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June 28, 1968

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On June 19th, I visited the with to review the optical system of a stereo scanner.

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The group described in detail the optical system they plan to use in this scanner. The correlation principle was also described.

It was apparent that most of the efforts in this contract were limited to the mechanical and the electronics of the device. The budget on the Optics was limited and it was decided to use on-the-shelf optics. It is this part of the problem that I will report on.

As a general principle, it is difficult to use off-the-shelf items for a sophisticated optical system. The reason is that optical systems are almost always designed for a specific task and they are carefully optimized to meet requirements. This means a careful compromise has been made.

In mocking up a series of lenses, it is extremely unlikely that all the lenses will be used in the manner for which they were designed. Therefore, there is practically no possibility that an optical system mocked-up out of shelf items will be an optimum design. There is, however, justification for considering the use of off-shelf items under the following conditions:

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1. Optical elements would be very expensive.
2. The optical requirements are modest.
3. A short time requirement.
4. A limited budget.

It appears that these conditions for [redacted] except for 2, are true. Therefore, it appears reasonable that [redacted] elected to use off-shelf items. STAT STAT

If shelf items are to be used, it is necessary to set up an exact bench test of the system and determine if the optical system performs. Since almost nothing is known of the off-shelf item, it is essential that the mock-up duplicate exactly the optical system required. It is exceedingly dangerous to extrapolate from the mock-up to the final system. This procedure sounds cheaper and easier to do than it really is. There is a grave risk that the mocked-up system will not perform according to specification. The reason for failure will be obscure because nothing is known about the lenses. There is an almost irresistible urge to conclude that the failure is due to the mock-up not being made up as well as the final system will be. A particularly inviting hazard occurs when the system almost meets the specifications. It then becomes very difficult to say: "Stop! This is not sufficient. We will have to redesign a new system." The mock-up, almost meeting the specifications, provides strong pressure to convince the project leader to accept the design "as is", in place of starting all over again from scratch. Experience shows that the project managers will divert their attention to convincing themselves that it may be good enough or that by hunting a bit further they may find the lenses that they need.

If a project manager decides to go the route of using off-the-shelf items, it is tremendously important to carry out the following procedures:

1. Test the individual lenses and thoroughly understand how the lenses will interact with each other.

2. Put together a mock-up of the complete system.

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3. Thoroughly test the complete system to be sure it meets with the specifications.

4. Never plan on an optical system that has not been checked out in advance.

If these procedures are followed, one finds that on-the-shelf lenses do not offer the advantages most people think they have. When off-the-shelf optics prove to be successful, it usually indicates that the optical system problem is not very demanding.

STAT The [redacted] group essentially violated all of these rules:

1. They did not have tests on the individual lenses, and were quite unaware of the type of aberrations, vignetting or pupil distortions. They had done essentially no analysis which would enable them to estimate the field curvature, secondary color, pupil aberration, or distortion.

2. They had not put together a complete mock-up to prove that it would work. They did have a similar system mocked-up as a monocular instrument, but there was sufficient difference to cast doubt on the validity of the comparison. Even with this, however, they had not made sufficient measurements to prove to me that the system could meet the specifications.

SUMMARY

STAT [redacted] does not have sufficient evidence to predict that this system will perform as well as will be needed. They indicate that there are no real specifications. The instrument was built to compare stereo scanning with monocular scanning. The stereo scanning adds a great deal of optics. Even with an optimum design, it would almost certainly degrade the imagery seen through a monocular system.

I suppose there is a chance that the stereo system, with inferior optics, may enable people to perform better than without stereo, but if the stereo system does not, then what? Will the whole project fail? Will it be possible to attribute the failure to optics or electronics? It would have seemed to me that more consideration should have been given to the optics for this instrument, when the whole device depends so heavily on subtle visual effects.

RECOMMENDATION:

STAT [redacted] should be asked to provide adequate information on the optics and to provide a more defensible argument that the optical system they propose is adequate.

Finally, my note is hastily written and appears to be very harsh on STAT [redacted] To be fair, I should say that their approach is what one usually finds in design engineering groups. I was disappointed that [redacted] had not pressed the optics more vigorously, but I am afraid the same approach would have been taken at most companies capable of doing such a large project. It is also well to remember that hindsight is far easier than foresight. STAT

Before I could recommend what you people should do, I would have to spend much more time than I did.

Sincerely,

[redacted] STAT

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P.S. I mean by last sentence, the overall decision on whether to proceed or not.

R. H.