AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523

BIBLIOGRAPHIC INPUT SHEET

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Batch 74

1. SUBJECT CLASSIFICATION

A. PRIMARY: Development and economics — DC00-0000-0000

B. SECONDARY: Development assistance

2. TITLE AND SUBTITLE

Designing organizations to increase reliability and minimize error

3. AUTHOR(S)

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4. DOCUMENT DATE	5. NUMBER OF PAGES	6. ARC NUMBER
1976	3p. 5p.	ARC

7. REFERENCE ORGANIZATION NAME AND ADDRESS

MUCIA

8. SUPPLEMENTARY NOTES *(Sponsoring Organization, Publishers, Availability)*

(In PASITAM design note no.8)

9. ABSTRACT

10. CONTROL NUMBER

PN-AAF-117

11. PRICE OF DOCUMENT

12. DESCRIPTORS

Project design
Systems

13. PROJECT NUMBER

14. CONTRACT NUMBER

CSD-2958 211(d)

15. TYPE OF DOCUMENT

AID 590-1 (4-74)

PN-AAF-117

PASITAM DESIGN NOTES

No. 8 CSD-2959 211(d) JUNE 1976

AID/CDA

Designing Organizations to Increase Reliability and Minimize Error

Duplication of efforts and overlapping of functions are generally regarded as wasteful and inefficient. Yet duplication and overlap are essential to efficiency, reliability, and flexibility under certain conditions—conditions which often exist in development efforts. Typical development projects and programs are marked by high levels of uncertainty and substantial risks of failure. Managers yearn for system reliability, error avoidance, and flexibility. Duplication and overlap can help produce these conditions.

Designing tight, linear, detailed organizational arrangements is aimed toward economy and efficiency. The organizational model is a machine which assumes known means and clear purposes. Given these conditions, plus a stable, predictable environment, one can design a reliable organization with little or no redundancy. The machine model makes sense in these circumstances as long as it acknowledges that all organizations are composed of people, who are sometimes unreliable, unpredictable, and multifunctional.

Real-world environments are unstable and unpredictable. Organizations often lack perfect knowledge about the means they must use, or they do not have complete control over those means. Purposes or goals are often debatable.

Given such uncertainties, wisely designed organizations do not follow the machine model. They deliberately arrange to make certain kinds of decisions by bargaining or trial and error. They try to minimize mistakes either through *redundancy*—deliberate duplicating functions, *overlapping* jurisdictions, or a combination of both. Such arrangements sometimes emerge unplanned, in spite of formal organizational designs.

DUPLICATION

A certain amount of breakdown or failure is inevitable in complex organizations. Duplication of means is one way to compensate. It allows us to construct a chain stronger than its weakest link, an organization more powerful than its weakest member, an arrangement more reliable than its least reliable component.

Information channels offer one example of how this works: a communication system with two points, A′ and B′, has a connecting channel. There is a good chance that this channel will fail once in every ten times.

A′----------B′

But the goal of the system is to move messages from A to B with maximum reliability and minimum failure.

The reliability of this system can be greatly increased by adding an identical separate channel, A″ and B″.

A′----------B′

A″ ----------B″

NOTE: Previous Design Notes have dealt with examples of redundancy: Design Note No. 5 presents essentially a redundant information channel in the international technological gatekeeper. Design Note No. 1 presents another example in the multiple means chosen by some governments to effect land reform.

Each of these Design Notes states a lesson which may be useful to those engaged in planning, managing, or evaluating development efforts, such as technical assistance projects. A given note may describe a technique and discuss its use, may present and explain a useful concept, or report a functional relationship between some intervention and some outcome. Design Notes are backed by cited evidence from PASITAM studies, published literature, or the reports of development agencies. Comments and queries are invited, along with requests for additional copies and supplemental materials.

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Now the probability that a message will not get through is reduced to one chance in one hundred (1/10 X 1/10). Adding more channels will further multiply reliability. Arithmetic increases in channels cause geometric or exponential increases in overall system reliability.

The usefulness of duplication for lowering the chance of failure is not limited to communications. It dramatically increases the reliability of aircraft, human beings, and farming systems.

A few decades ago, it could be assumed that an aircraft engine would fail once in every 500 hours of operation, for some reason other than faulty maintenance. Adding a second engine and designing a plane that could fly on just one of those engines reduced to almost zero the statistical (and real) chance of disaster from simultaneous engine failures (assuming good maintenance).

Duplication does not *eliminate* errors. Mistakes or breakdowns remain probable. Duplication *minimizes* the costs of such errors to the system.

To exploit the possibilities of duplication, individual units or channels must be arranged so the failure of one does not impair the others. This arrangement is labeled "parallel" channels (or units, or workflows). The machine model of organization generally calls for the arrangement of units or workflows in "series," and the breakdown of one unit stops everything. Serial arrangements also create a "ripple effect." The effects of an error at some point may be magnified as the action moves along the organizational channel. Duplication reduces the effects of breakdowns by taking advantage of probability. It will not work in the event that all channels or units are simultaneously eliminated.

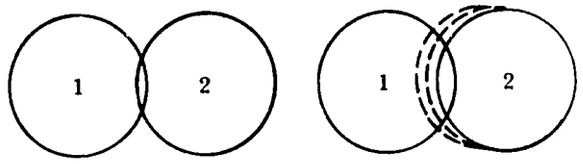
Well-designed duplication may actually be cheaper than a non-redundant system with high maintenance costs and periodic losses from breakdown or errors.

As a useful rule of thumb, duplication is justified when the cost of a failure exceeds the cost of duplication. When the probability of breakdown can be estimated, the cost/benefit value of duplication can also be established.

OVERLAP

The effects of a breakdown within an organization can also be minimized by overlapping functions—in direct violation of conventional organization theory. Overlapping units have excess capacity. Each can do some of the work of one or more other units. While this is generally considered wasteful, in some cases it is actually quite efficient.

Overlap may add to the repertoire of organizational capabilities. It can be illustrated by a relationship between two jurisdictions, A and B, within a system. In response to a breakdown in unit A, unit B takes over some of A's functions because the capacity to do so already exists. The system can continue to operate at reduced capacity until the damage is repaired.



One source of overlap is evident in staff members whose skills and knowledge exceed the requirements of their jobs.

Overlap involves costs which must be measured against the costs of breakdowns. It can create problems of jurisdictional disputes. But it can also increase an organization's adaptive capacity.

CONCLUSION

The most reliable systems are marked by high levels of duplication and overlap. Eliminating redundancy can be downright dangerous. Loss of diversity and "excess capacity" in the genetic properties of plants increases their vulnerability to disease, just as the lack of such capacity in organizations makes them more vulnerable to error and breakdown.

There is no cookbook for designing efficient redundancy in human organizations. There are some practical models and rules of thumb. Most important, there is a very sound basis for recognizing that efficiency does not necessarily equal parsimony, and that some kinds of "waste," in the form of excess organizational resources, are a wise investment against the probability of costly breakdowns within the system.

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This Design Note was prepared by Paul Cunningham.

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