The Logic of Design: Design Process Principles.

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Dynamic Design: a summary

I believe that the process of design has a set of logical principles, that are worth making more explicit. My premise is that design is not an inspired artistic process. Design is, at its best, a logical and quantified process. Design is based on pursuit of objectives, within constraints. Design is not merely a once-off up-front process. Design can be optimized by making the design-component implementations into a prioritized series of increments towards the objectives, and using feedback from each increment in order to adjust the designs, to better deliver the remaining gaps towards the objectives, with respect to remaining resources. Dynamic evolutionary design should, in addition, be able to consider any changes to objectives, resources, technology, economics and politics that modify the initial design objectives and constraints.

Engineering or Poetry

The ideal design process, is an engineering process, using numbers to clarify all critical variables. But, the design process can function, without all critical variables being numeric and measurable. However such an *informal process* is doomed to be less efficient, and is inappropriate, a cause of failure, for large and critical systems.

The Basic Design Steps Logic: a summary

1. Constraints determine environments.
2. Environments determine stakeholders
3. Stakeholders have values and priorities
4. Values have many dimensions
5. Stakeholders determine value levels
6. Design hypotheses should be powerful and efficient ideas, for satisfying stakeholder needs
7. Design hypotheses can be evaluated quantitatively, with respect to all quantified objectives and resources
8. Designs can be decomposed, to find more efficient design subsets, that can be implemented early
9. Designs can be implemented sequentially, and their value-delivery, and resource costs, measured
10. Designs that unexpectedly threaten achievement of objectives, or excessive use of resources, can be removed or modified.
11. Designs that have the best set of effects on objectives, for the least consumption of limited resources, should generally be selected for early implementation.

12. A design increment can have unacceptable results, in combination with previous increments, and they, or it, might need removal or modification
13. When all objectives are reached, the process of design is complete: except for possible optimization of operational resources, by even-better design.
14. When deadlined and budgeted implementation-resources are used up, it might be reasonable to negotiate additional resources; especially if the incremental values are worth the additional resources.

Some more detail

1. Constraints determine environments.
Every project or planning process selects some subset of the universe to work on. Some people, some place, some purpose. This subset is the planning environment.

2. Environments determine stakeholders
The defined planning environment should allow us to determine our stakeholders, especially our critical stakeholders, who can make or break our project. The stakeholders are any person, group or thing that has needs, values, laws, standards or rules that we must consider respecting; bringing into our planning explicitly. The number of stakeholders can be many dozens, and each on can have several things we need to be concerned with. We are by no means limited to 'users and customers'. Activist groups nd European Law are examples of potentially important stakeholders. These will have decisive influence on choice of designs.

3. Stakeholders have values and priorities
Each stakeholder has a set of values, and a corresponding set of priorities for those values. We do not have to deal with all their values. But we do have to determine which values might be critical to our own success or failure, and to consider those.

4. Values have many dimensions
Stakeholder values, for example, quality, pollution, ethics, legality, alignment, costs, will usually apply to a set of dimensions. Dimensions can include type of person, activity performed, timing, geographical location, hypothetical conditions, events, and more. The critical (for us and them) stakeholder value is usually not general and universal. It is more likely to apply to specific sets of conditions only. We need to determine exactly which sets of conditions apply to us. This will dramatically reduce the number of concerns we must plan and design for. Such dimension determination will also allow us to deliver designs for the most critical dimensions early.

5. Stakeholders determine value levels
Stakeholders' subjective opinions will determine the levels of performance (including all quality notions) that are acceptable (constraints for us), and desirable (targets for our planning). If we fail to design to meet their acceptable levels of performance, they will

punish us with the power they have. If we achieve their desired performance levels then they might help us succeed by buying, recommending, authorizing, our product, service or system. Their value levels will change over time, so our designs need to be capable of adapting to those new value levels.

6. Design hypotheses should be powerful and efficient ideas, for satisfying stakeholder needs

Each design suggestion should be powerful in term of having the ability to deliver the critical stakeholder value levels. The set of designs need to be powerful enough to reach our target levels of values. At the same time we need to find sets of designs that consume the *lowest quantity of limited resources* for building and operating the planned system, product or service. The designs with the highest ratio of value satisfaction in relation to resources needed, are the most 'efficient' designs.

7. Design hypotheses can be evaluated quantitatively, with respect to all quantified objectives and resources

All defined design suggestions can be estimated regarding their impacts on our critical objectives, and our resource limitations. We should be able to estimate the range of potential impact. We should be able to give evidence and source for our estimates, so that estimation credibility, thus our design risk, can be determined. For any one design, no matter what its primary purpose it, we need to estimate the design's side effects on all other critical value objectives, and all limited or budgeted resource areas for both development and life cycle operation. Failure to have reasonable evidence for estimates constitutes a risk. Estimation uncertainties can to some degree be resolved by better research, pilot studies, experiments, and even contracting out the risks to others.

8. Designs can be decomposed, to find more efficient design subsets, that can be implemented early

Most design ideas, architecture, and strategies can be decomposed into subsets which can be implemented earlier than the whole design. This will give some useful results earlier, and to give some proof of validity,. It will also give us practical design implementation insights, before we risk more effort on that design. One of many methods of decomposition is to target a critical set of stakeholder conditions initially, for example 'European, Teenagers, Using Apple Watch'. There are many other tactics for decomposition [1, 2]. Intuition, intelligent thinking and domain knowledge usually suffice for finding decompositions of use.

9. Designs can be implemented sequentially, and their value-delivery, and resource costs, measured

Most all designs can be implemented to a live system, early. This early delivery is with a view to improving some values, and to testing how well they work, and sensing problems.

You do not have to build a complete new system before testing new design ides. The old product, the old system, and the old services system is usually an excellent place to try out new ideas. This has several real advantages: early evaluation, early value and a realistic environment. People have a defeatist tendency to explain why this early implementation on existing systems is impossible. For decades I have experienced that they are always wrong.They lack knowledge of how to do it, imagination to find solutions, and motivation to get early results. In the background are poor managers who do not insist on getting early value deliveries immediately, or finding other people who can do it.

10. Designs that unexpectedly threaten achievement of objectives, or excessive use of resources, can be removed or modified.

Designs are just a hypothesis about the results and costs we can expect. If initial delivery of the designs, results in bad results and costs, we need to consider the design hypothesis as false, and take immediate action to remove it, and replace it with something that delivers necessary results.

11. Designs that have the best set of effects on objectives, for the least consumption of limited resources, should generally be selected for early implementation.

All designs contain an unavoidable set of impacts on most of our objectives, and on our limited resources. When initially deciding which designs to prioritize delivery of, we should be looking at the ones that promise to give the best values for their costs.

12. A design increment can have unacceptable results, in combination with previous increments, and they, or it, might need removal or modification.

A design might give good results under many circumstances, but it can give surprising and bad results, conflicting with previously installed designs, or with to-be installed designs. Bad mix. We need to be prepared to remove or redesign to solve this potential problem.

13. When all objectives are reached, the process of design is complete: except for possible optimization of operational resources, by even-better design.

We need a clear definition of 'done'. Meeting all current objectives is a useful start in deciding we are done designing, even if we have remaining resources, and even if we have proposed designs that are not yet implemented.

In addition to this, new requirements can emerge, and require continued design effort. We can also choose to spend available resources, as an investment to reduce future higher costs of operation and maintenance.

14. When deadlined and budgeted implementation-resources are used up, it might be reasonable to negotiate additional resources; especially if the incremental values are worth the additional resources.

When deadlines have arrived, and budgets are used up, the honorable action is to pause and negotiate with the relevant resource stakeholders. If we want more resources, even though we have not reached all planned objectives, we should put a case forward that there is a clear case of high value for additional resources (profitability). And if so, we should be prepared to prove the case in small, high-value steps; rather than just getting a big new budget, based on perhaps-false value estimates. That would be prudent management.

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References:
1. Value Planning book ms. tinyurl.com/ValuePlanning
If the reader would like great practical detail on implementing these ideas of design logic, they will find the answers in this book.

2. T. Gilb, Competitive Engineering, 2005
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