design FRAME
problem solving with the engineering design process
Frame Research Analyze Model Execute

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by John Chandler and Susan Talkmitt
Outcomes of activities during each phase inform subsequent phases.
Frame the problem

Guiding Questions
What are the needs and wants of stakeholders?

Actions
Identify:
• problem specific attributes
• technical demands
• societal and human impacts

Outcomes
Documentation defining:
• the problem
• the requirements

Phase 1.
Examine the problem
Guiding Questions
What do we know and what do we need to find out?
What are the possibilities, and how do we determine the best options?

Actions
Identify:
• existing knowledge and experience
• potential materials, processes, etc.
Test:
• to compare
• to eliminate
• to verify

Outcomes
Documentation recording:
• research data
• procedures, observations, and conclusions

Phase 2.
Research to inform design decisions
Phase 3.
Employ analytic methods to make design decisions

Guiding Questions
How does the research data determine design decisions?

Actions
Analyze:
- data
- conclusions

Outcomes
Documentation describing:
- rational for analysis
- design decisions
Phase 4.
Synthesize design elements into a model

Guiding Questions
How do we model and justify our design?
How do we derive performance predictions?
Do stakeholders have suggested revisions?

Actions
Illustrate / describe in detail:
• dimensions, materials, or other attributes
• production criteria

Review design:
• peer review
• presentation to stakeholders / experts for feedback / approval

Outcomes
Model:
• graphics
• specifications

Documentation establishing:
• justification of design
• performance predictions
Phase 5.
Produce the design as modeled and according to plan

Guiding Questions
What is our plan for managing the resources to execute the design?

Actions
Develop and implement a plan to make and test the product:
- define timeline with personnel requirements and responsibilities
- establish inspection / feedback procedures
- follow safety procedures
- adhere to pertinent policies, codes, or laws

Outcomes
Finished product:
- conforms to specifications
- meets requirements / expectations

Documentation showing:
- team and individual activities
- summary of plan and production process
- proper use / maintenance of product
Assessment and Evaluation are not separate parts of the process, but are continual and integral in the design process

“Assessment is not something that you do to someone.”

**Assessment:** measure of progress toward specific goals
- appraises change from a starting point
- applies pre-established criteria and methods for measuring

**Evaluation:** determination of effectiveness of the process and its outcomes
- weighs assessments to inform overall determination
- *formative evaluation* – occurs at milestones during the design process
- *summative evaluation* – retrospective determination at end of process
Formative Evaluation: assessments of activities in each phase are used to determine:

1. extent of progress toward completion, and
2. if the current outcomes support moving to the next phase by
   • satisfying the requirements
   • answering the guiding questions
   • being documented to inform next project phase

Formative Evaluation: stakeholders reach consensus to move on, or to make adjustments to current process / plan
Summative Evaluation: reflective determination of effectiveness of the process and finished product:

1. establishing whether
   • stakeholder needs were met within the requirements, and
   • performance of design was confirmed or problems identified, and

2. communicating and archiving lessons learned from the project