



# Experience with Global Analysis: A Practical Method for Analyzing Factors that Influence Software Architectures

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## Outline

- What is global analysis
- Differing perspectives
- Some details of the artifacts and process
- Experience along the way
- Lessons learned



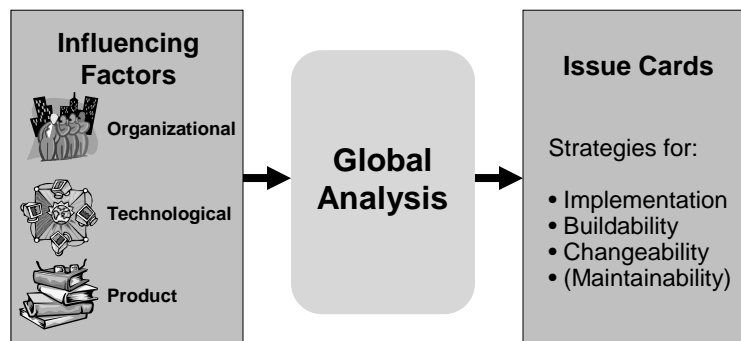
## What is Global Analysis?

Global Analysis (GA) analyzes organizational, technological, and product factors that globally influence the architecture design of a system.

The result is a set of key issues and corresponding global strategies that guide the architecture design and improve its changeability with respect to the factors identified.



## Global Analysis





## Why Global Analysis?

Key issues transcend boundaries between:

- Development activities
- Subsystems
- Architecture viewpoints.

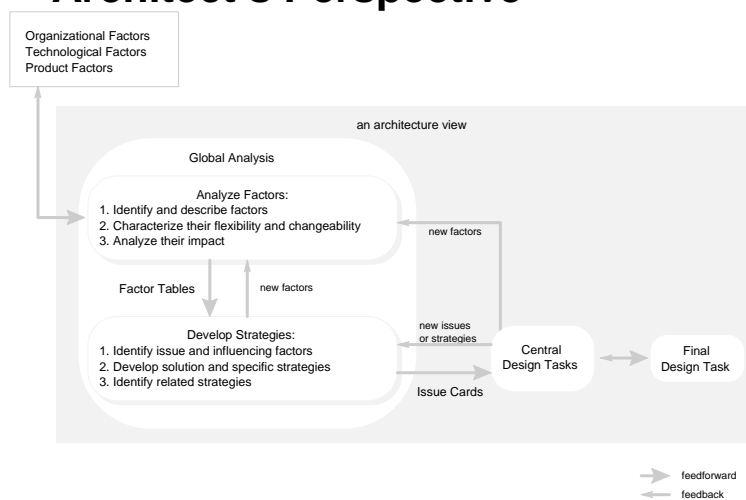
Influencing factors always involve change.

Successful projects prepare for change by:

- noting the flexibility of influencing factors and their likelihood of change
- characterizing how factors interact and their impact
- selecting cost-effective design strategies and project strategies to reduce expected impact.



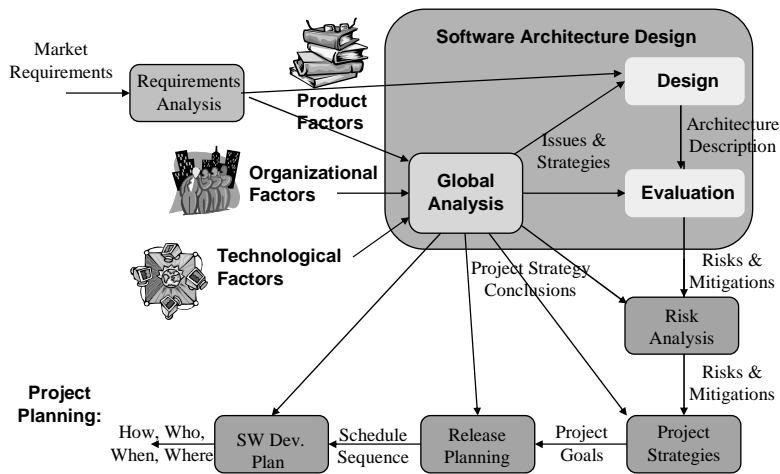
## Architect's Perspective



## Manager's Perspective

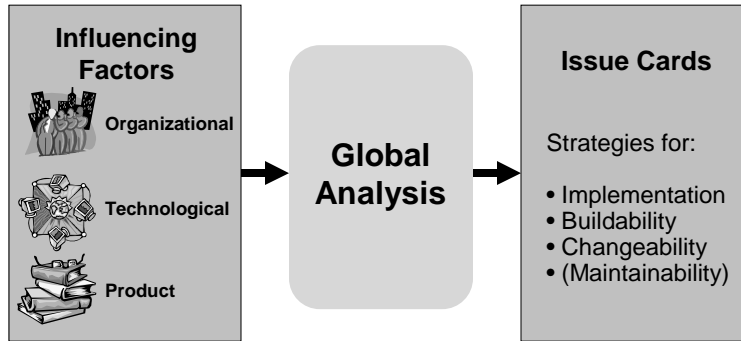


## Lifecycle Perspective

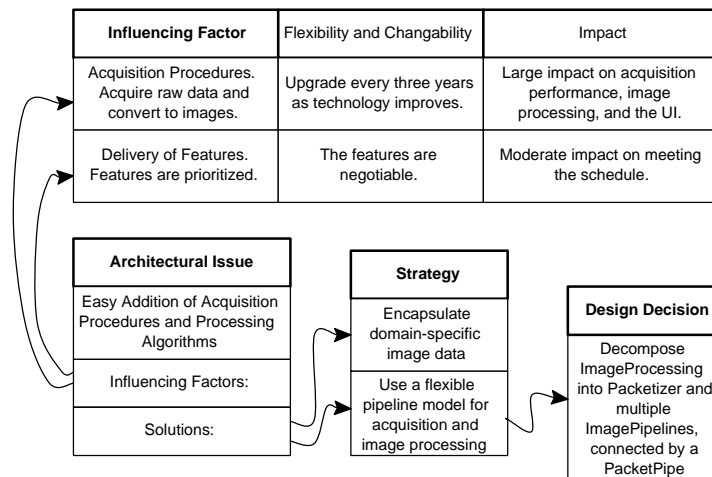




## Global Analysis Detailed Description



## Global Analysis Artifacts





## Global Analysis Activities

### Analyze Factors

1. Identify and describe the influencing factors.
2. Characterize their flexibility and changeability.
3. Analyze their impact.



### Develop Strategies

1. Identify issues and corresponding factors.
2. Develop solutions and specific strategies.
3. Identify related strategies.



## How Software Changes: Examples

New features are added and existing ones evolve.

The system is ported to new software and hardware platforms.

The product is configured in new environments.

Performance requirements become more stringent.



## Phase 1: Analyze Factors



### 1. Identify and Describe the Influencing Factors

- Consider factors that have a significant global influence, those that could change during development, those that are difficult to satisfy, and those with which you have little experience.

### 2. Characterize Factors – Flexibility and Changeability

- Describe what is negotiable about the factor.
- Describe what could change about the factor.

### 3. Analyze the Impact of the Factors

- If the factor will change, what will be affected and how: other factors, components, system modes of operation, design decisions



## Format of the Factor Table

Organizational Factor	Flexibility and Changeability	Impact
<b>O1: &lt;Factor Category&gt;</b>		
O1.1: <Factor Name>		
<description of factor>	<what aspects of the factor are flexible or changeable>	<components affected by the factor or changes to it>
O1.2: <Factor Name>		
<description of factor>	<what aspects of the factor are flexible or changeable>	<components affected by the factor or changes to it>
<b>O2: &lt;Factor Category&gt;</b>		
O2.1: <Factor Name>		
<description of factor>	<what aspects of the factor are flexible or changeable>	<components affected by the factor or changes to it>



## Example Factor Table

<i>Factor</i>	<i>Flexibility/ Changeability</i>	<i>Impact</i>
<b>O4.2 Schedule</b> Feature Delivery		
Features are prioritized	Negotiable	Moderate impact on the schedule
<b>T2.1 Domain-specific Hardware</b> Probe Hardware		
Hardware to detect and process signals	Upgraded every three years as technology improves	Large impact on image acquisition and processing components
<b>P1.1 Features</b> Acquisition Types		
Acquire raw signal data and convert into images	New types of acquisitions may be added every three years	Affects UI, acquisition performance, and image processing



## Experience Developing the Method Categories of Factors

<i>Organizational</i>	<i>Technological</i>	<i>Product</i>
O1: Management	T1: General-purpose Hardware	P1: Features
O2: Staff Skills	T2: Domain-specific Hardware	P2: User Interface
O3: Development Environment	T3: Software Technology	P3: Performance
O4: Schedule	T4: Architecture Technology	P4: Recovery
O5: Budget	T5: Standards	P5: Diagnostics





## Experience

How the factors were identified

When new factors needed to be added

Engineering concerns

Need input from issues in order to prioritize factors.



## Phase 2: Develop Issues and Strategies

### 1. Identify Issues and Factors

An issue may arise from factors in many ways:

- limitations or constraints
- reducing the impact of changeability
- difficult-to-satisfy product factors
- common solution to global requirements



### 2. Develop Solutions and Strategies

Strategies address the issue and one or more of the following goals:

- reduce or localize the factors' influence
- reduce the impact of the factors' changeability
- localize required areas of expertise
- reduce overall time and effort

### 3. Identify Related Strategies



## Format of the Issue Card

**Issue:** <name of the architecture design issue>

<Description of the issue.>

**Influencing Factors**

<List of the factors that affect this design issue and how.>

**Solution**

<Discussion of a general solution to the design issue, followed by a list of the associated strategies.>

**Strategy:** <name of the strategy>

<Explanation of the strategy.>

**Related Strategies**

<References to related strategies and discussion of how they are related to this design issue.>



## Example Issue Card

**Issue: Easy Addition and Removal of Acquisition Procedures**

There are many acquisition procedures. Implementation of each feature is quite complex and time consuming. There is a need to reduce complexity and effort in implementing such features.

**Influencing Factors**

O4.1: Time to market is short

O4.2: Delivery of features is negotiable

PI.1: New acquisition procedures can be added every three years.

PI.2: New image-processing algorithms can be added on a regular basis.

...

**Solution**

Define domain-specific abstractions to facilitate the task of implementing acquisition and processing applications.

**Strategy: Use a flexible pipeline model for image processing.**

Develop a flexible pipeline model for implementing image processing. Use processing components as stages in the pipeline. This allows the ability to introduce new acquisition procedures quickly by constructing pipelines using both old and new components.

**Strategy: Introduce components for acquisition and image processing.**

...

**Strategy: Encapsulate domain-specific data.**

...

**Related Strategies**

See also **Encapsulate domain-specific hardware.**



## Experience Developing the Method Examples of Strategies

<i>Organizational</i>	<i>Technological</i>	<i>Product</i>
Reuse existing components	Encapsulate hardware	Use feature-based components
Build rather than buy	Separate processing, control, and data	Separate the user interaction model
Make it easy to add or remove features	Use vendor-independent interfaces	Separate time-critical components



## Experience

Keeping track of factors and strategies,

- tool support and process
- updating

Communicating strategies

Each team leader and developer need to understand sufficient but not overwhelming number of factors and strategies

Reference to patterns (minimal structure)

- factors define the context
- issues define the problems in that context
- strategies are the abstract solutions



## Experience Deploying the Method

	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>
Application	data mgt.	image mgt.	business mgt.	automation mgt.
Factors				
Org.	14	9	28	28
Tech.	8	7	22	14
Product	7	11	28	25
Issues	11	3	19	23
Strategies	24	21	100	64



## Lessons Learned

*What value did global analysis add that wasn't present before global analysis was used?*

- Global analysis specification document
- Importance of organizational factors
- Global analysis strategies
- Improved documentation
- Links to project management



## Lessons Learned -2

*What should be improved as a result of using global analysis in practice?*

- Support for other kinds of changeability
  - variability and product lines
- Global evaluation
- The iterative nature of issue cards
- Dependencies and traceability



## Lessons Learned -3

*What needs further study for improving the global analysis method?*

- Generality of collection of factors and issues:
  - Codification of factors
  - Codification of issues
- Strategies
- Views of global analysis data



## Conclusions

Identifies factors that influence the architecture and yields strategies that guide decisions.

Designing for change and building flexibility into the system.

Two phase approach for analyzing factors and developing strategies

Validated approach

1. Developed during design of imaging system
2. Retrospective analysis of four systems
3. Use in new development projects