Abstract
The challenge for the architect is to cover a wide range of subjects, with many unknowns and uncertainties, while decisions are required all the time.

The basic working methods, such as viewpoint hopping, modelling, handling uncertainties and WWHWWW questions are described.
Many viewpoints
The seemingly random exploration path

thinking path of an architect during a few minutes up to 1 day
Scanning modes of the architect

open
perceptive
scanning

while
structuring
and judging

drunkard's walk
the world is full
of interesting
needs, technologies, ...

scanning

bad

goal

good

straight for the goal
ignore everything
that is not contributing
directly to the goal
Combined open perceptive and goal oriented scanning

room for open perceptive exploration

increasing goal orientation

time
Coverage of problem and solution space

covered or touched by architects

covered by engineers and experts

level of detail

subjects
Decomposition, interfaces and integration
Successive quantification refinement

- Back of the envelope
- Benchmark, spreadsheet calculation
- Measure, analyze, simulate
- Cycle, accurate

Order of magnitude
guestimates
calibrated estimates
feasibility

<table>
<thead>
<tr>
<th>Measure</th>
<th>Analyze</th>
<th>Simulate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Back of the envelope</td>
<td>Benchmark, spreadsheet calculation</td>
<td>Measure, analyze, simulate</td>
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<table>
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<th>Order of magnitude</th>
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<td>Guestimates</td>
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<td>70</td>
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<td>90</td>
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<table>
<thead>
<tr>
<th>Accuracy</th>
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<td>99.999</td>
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</table>
Example evolution of quantification
Quantified understanding of waferstepper overlay

- process overlay: 80 nm
  - matched machine: 60 nm
  - single machine: 30 nm
  - process dependency sensor: 5 nm
  - matching accuracy: 5 nm

- stage overlay: 12 nm
  - stage grid accuracy: 5 nm

- metrology stability: 5 nm

- global alignment accuracy: 6 nm

- off axis pos. meas. accuracy: 4 nm

- stage Al. pos. meas. accuracy: 4 nm

- system adjustment accuracy: 2 nm

- blue align sensor repro: 3 nm

- interferometer stability: 1 nm

- frame stability: 2.5 nm

- tracking error WS: 2 nm

- tracking error X, Y: 2.5 nm

- tracking error RS: 1 nm

- tracking error phi: 75 nrad
Architect focus on important issues

- Architecting time: 80%
- All other issues: 20%

Most important issues: 10%
- New
- Solved

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Architect “worry” list

1. response time
   from key press until first image on display

2. cost price
   resource budgets

3. layering to separate
   separation of concerns
   self sustained
   life-cycle separation
   robust: paranoia validations

4. reliability of storage
5. database redesign
6. integration schedule
7. movement artefact
8. standby power
9. weak signal handling
10. location-based twiddle
A model is a simplified representation of part of the real world used for:

communication, documentation, analysis, simulation, decision making, verification
Some examples of models

**formal analytical model**

\[
t_{\text{processing}} = t_{\text{overhead}} + n_{\text{rows}} \times t_{\text{row}} + n_{\text{row}} \times n_{\text{col}} \times t_{\text{pixel}}
\]

**synchronization model**

Req

Ack

Strobe

feedback frequency: 4 kHz (0.25 msec)

**feedback model**

**value chain model**

consumer

retailer

box-maker

semiconductor supplier

service provider

content provider

**mockup**

wooden model

**model of coordinate system**

6 degrees of freedom
## Types of models

<table>
<thead>
<tr>
<th>Mathematical</th>
<th>Visual</th>
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<tbody>
<tr>
<td>Linguistic</td>
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<tr>
<td>Formal</td>
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<td>Abstract</td>
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<td>Accurate</td>
<td>Approximate</td>
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<tr>
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← Rational →        ← Intuitive →
<table>
<thead>
<tr>
<th>Why</th>
<th>Who</th>
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<tbody>
<tr>
<td>What</td>
<td>When</td>
</tr>
<tr>
<td>How</td>
<td>Where</td>
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</table>
Why broadens scope, How opens details

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BWMAreursionWWh
Flow from problem to solution

vague problem statement

1. Problem understanding by
   exploration and simple models

2. Analysis by
   + exploring multiple propositions (specification + design proposals)
   + exploring decision criteria (by evaluation of proposition feedback)
   + assessment of propositions against criteria

3. Decision by
   + review and agree on analysis
   + communicate and document

4. Monitor, verify, validate by
   + measurements and testing
   + assessment of other decisions

insufficient data

no satisfying solution

invalidated solution

conflicting other decision
### Multiple propositions

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<thead>
<tr>
<th>Throughput</th>
<th>Cost</th>
<th>Safety</th>
<th>High-performance sensor</th>
<th>High-speed moves</th>
<th>Additional pipelining</th>
<th>350 ns</th>
<th>9 m/s</th>
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*low cost and performance 1*

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*low cost and performance 2*

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<th>High-speed moves</th>
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*high cost and performance*
 Assessment of propositions

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Basic Working Methods of a System Architect

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TORcriterionsVsPropositions
Recursive and concurrent application of flow

1. Problem understanding
2. Analysis
3. Decision
4. Monitor, verify, validate

Legend:
- Decision flow
- Analysis flow
Exploration by rapid iteration

system level  detail level