Agile development for big machines

Holistic Lithography acceptation enables Rapid Application Development

Tom Hoogenboom, System Engineering, ASML

v2 | 6-oct-2015 | Mechelen

~~52~~ 42 slides

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~~52~~ 42 slides (including animations)

Holistic Lithography acceptation enables agile development

Wafer scanners are complex systems [ref1].

A system of wafer scanners, integrated in a ‘fab’ with metrology tools, reticle designs etc.
is even more complex [ref2].

There is now a new ‘holistic’ environment enabling the industry to continue to pursue Moore’s law in an agile way.

This is illustrated in this talk using stability control software as an example.

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*) solutions evolve through **collaboration** between **self-organizing, cross-functional** teams.
Methods:
adaptive planning, evolutionary development, early delivery.
encourages **rapid** and **flexible response to change**.

[source: Wikipedia]

Summary

The semiconductor industry demands continuous development

A holistic architecture enables agile application development

System Architecting is driving the agile development cycle

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The semiconductor industry demands continuous development

The semiconductor industry is driven by Moore's law.

- Continuous shrink, now working with < 25 nm lines
- Economy of shrink drives continuous innovation
- Continuous innovation requires change
- Changes (e.g. new SW) can affect High Volume Production

Holistic Lithography opens up new areas for improvement:

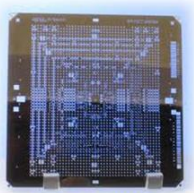
- In Holistic Lithography all aspects of the wafer production process are optimized together [next slides]
- Changes can be introduced in production in a controlled way [last section]

The scanner is the Central Processing Unit in a fab

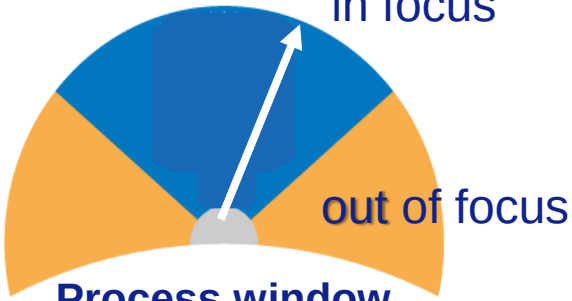
Scanner + mask determine the process window

1.Advanced lithography capability
(Imaging, overlay and focus)

mask



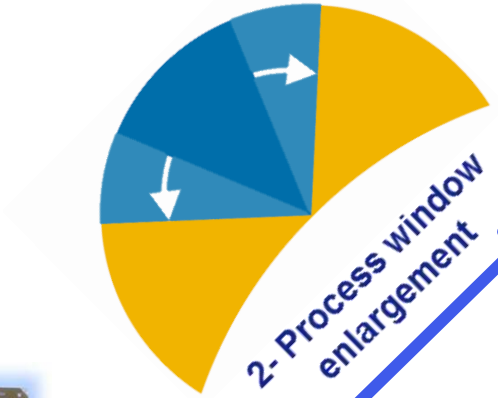
Product reticles

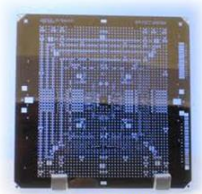


Process window (in/out of focus)

Off-tool SW optimizes mask for max process window

1.Advanced lithography capability
(Imaging, overlay and focus)

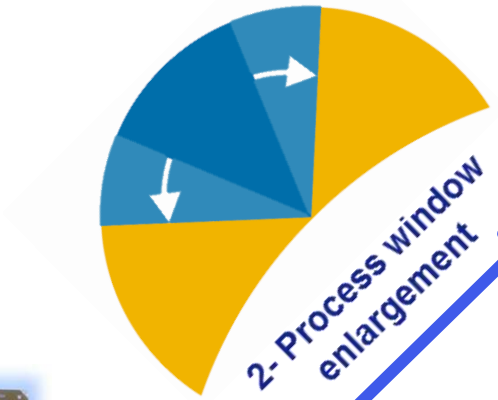


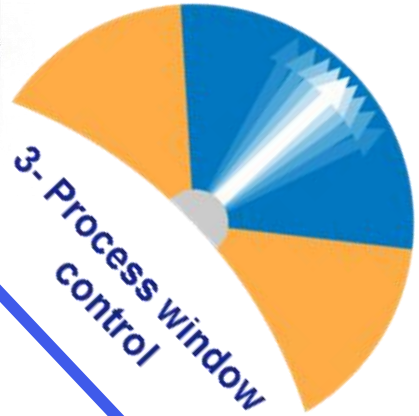


Product reticles

Off-tool optimization SW

YieldStar metrology tool measures process window





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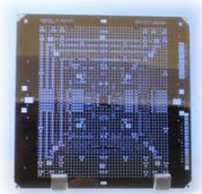
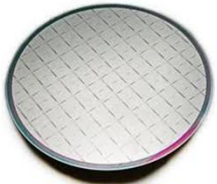


Product reticles

Off-tool optimization SW



Product wafers

Metrology and control SW

Holistic Litho: mask design and measurements stabilize scanner focus

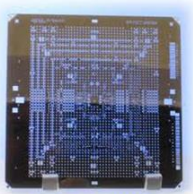
Scanners

1.Advanced lithography capability
(Imaging, overlay and focus)

2- Process window enlargement

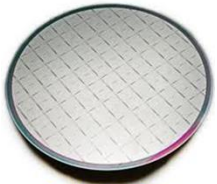
3- Process window control

4 - stabilization



Product reticles

Off-tool optimization SW



Product wafers

Metrology and control SW

Holistic Litho:
improvements do not require to change the scanner but instead we use it in a better way

Scanner

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Application == nm gain

Nr. of releases / year

A holistic architecture enables agile application development

Scanners:
Controlled
change

Nr. of releases / year

A holistic architecture enables agile application development

Scanners: Controlled change

Holistic SW platform: easier to change

Nr. of releases / year

A holistic architecture enables agile application development

Scanners: Controlled change

Holistic SW platform: easier to change

Rapid Application Development

Nr. of releases / year

A holistic architecture enables agile application development

Easier to change:
- More frequent, smaller trips
- Needs more Quality control
- But overall less effort and better results

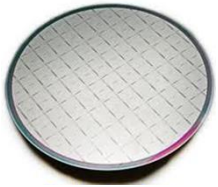
Scanners: Controlled change

Holistic SW platform: easier to change

Rapid Application Development

Nr. of releases / year

A separate ‘holistic’ SW platform is used for the scanner stability SW



Test wafers

- Scanner Drift

Control of scanner stability

Measurements

The Control of scanner stability SW is now independent of scanner SW

Stability control SW runs on an independent platform

- No direct link to scanner HW/SW
- Tested separately from scanners
- Integrated in customer environment

Still not super-rapid, because of the startup and integration steps:

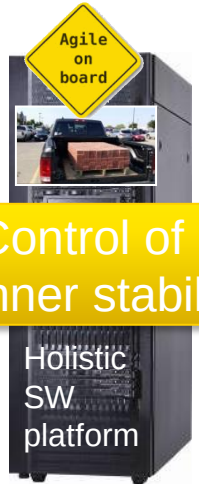
- Find better stabilization algorithm & prove it works
  - adapt scanner stabilization control SW (agile/scrum)
    - integrate and test at beta site (including scanner integration)
      - Then release for all sites

Holistic architecture:

production Scanners are stabilized by
independent SW systems
to enable agile development

Test wafers

- Scanner Drift



Control of
scanner stability

Holistic
SW
platform

Measurements

A holistic architecture enables agile application development

Application == nm gain

Scanners: Controlled change

Holistic SW platform: easier to change

Rapid Application Development

Nr. of releases / year

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1 nm = 1000 x 1 pm

Rapid Application Development

Nr of pm / year

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Production Scanners are stabilized by independent SW systems

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➡ System Architecting is driving the agile development cycle

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The role of the System Architect

is to set up a few pointers out there

that help guide the developers

into the right direction

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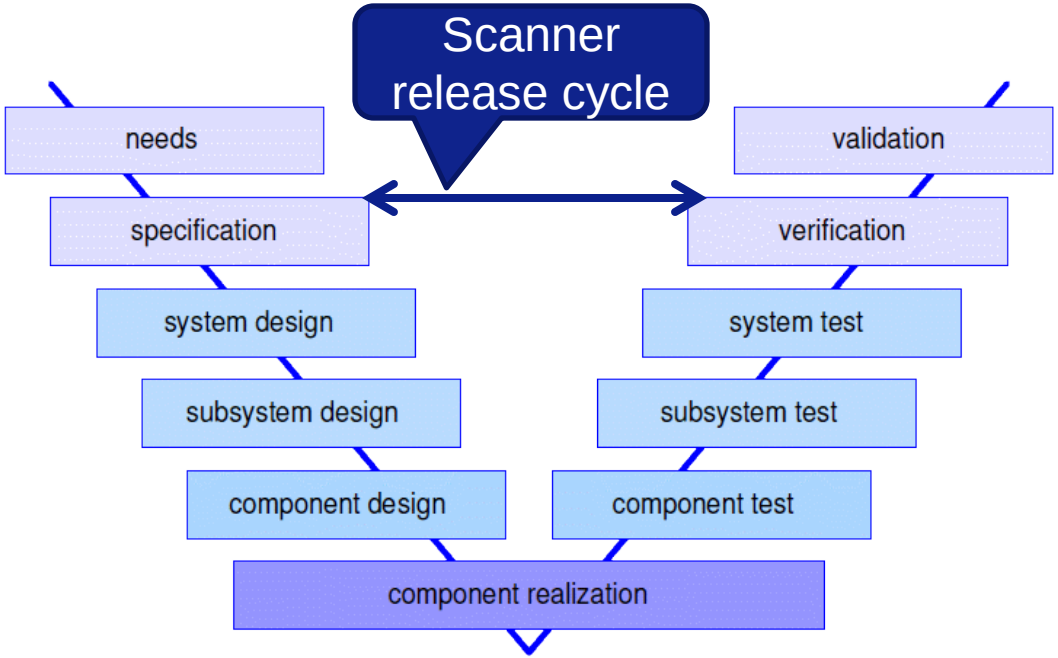
Using the V-model [Ref3] to cross the waters

System Architecting is using the V-model

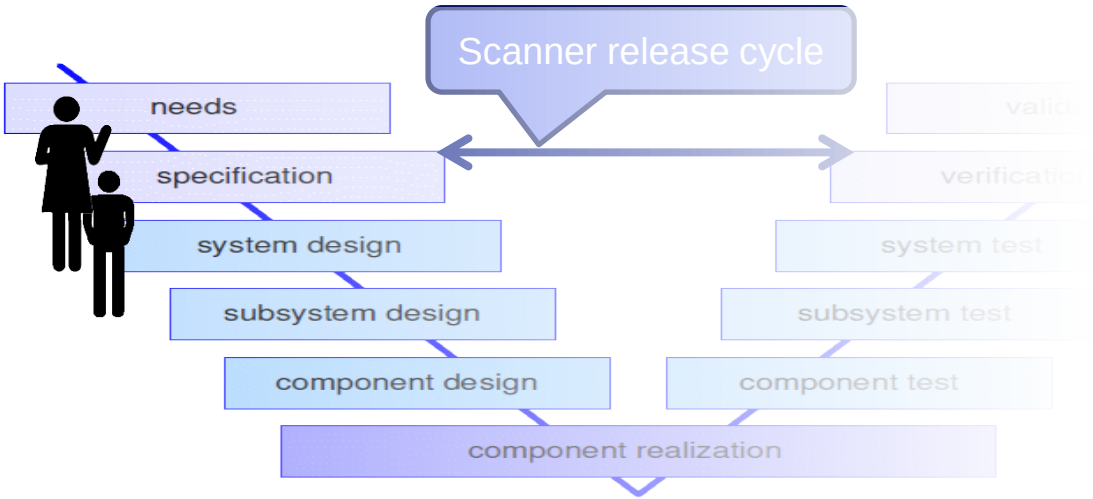
The scanner HW cycle is the leading **V** for 1 nm of gain:

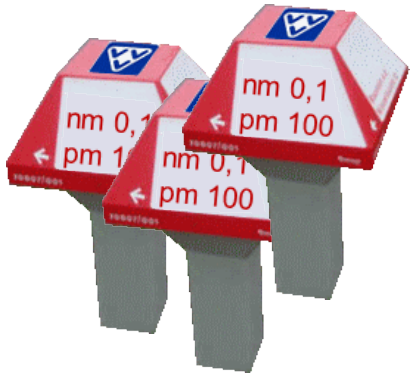


The agile / holistic approach is a team effort

Agile development adds two new key points:

1) System architecting is done by a team
   End users are in the team and
   have a say in where the team is going

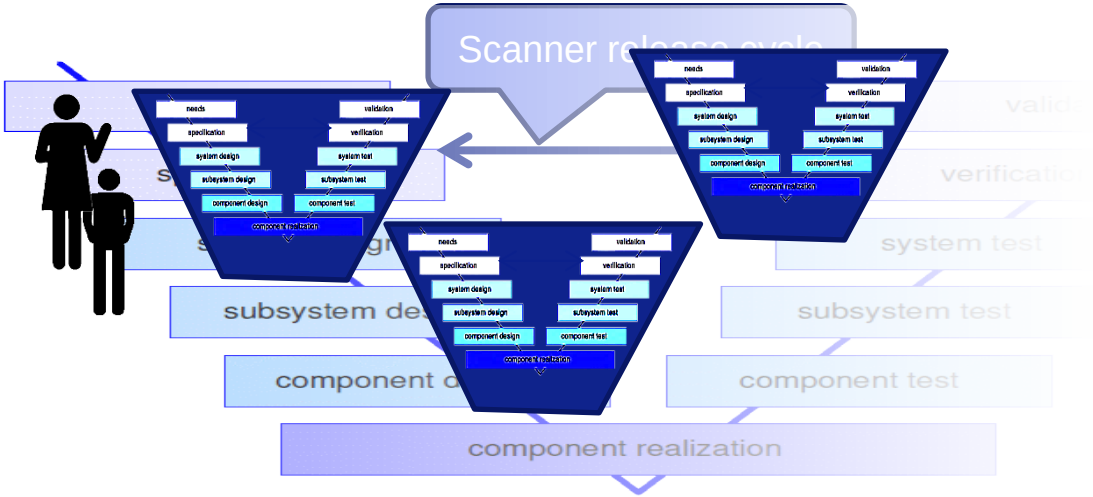


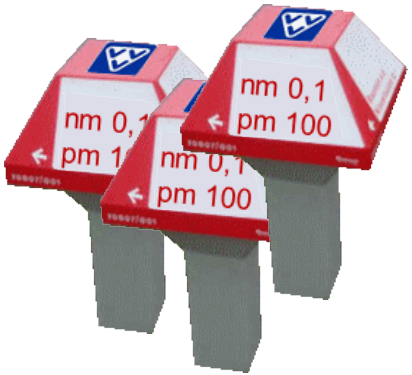


System Architecting teams drive the agile development cycles

Agile development adds two new key points:

1) System architecting is done by a team
   End users are in the team and have a say in where the team is going
2) Many smaller V's deliver a few 100 pm at the time

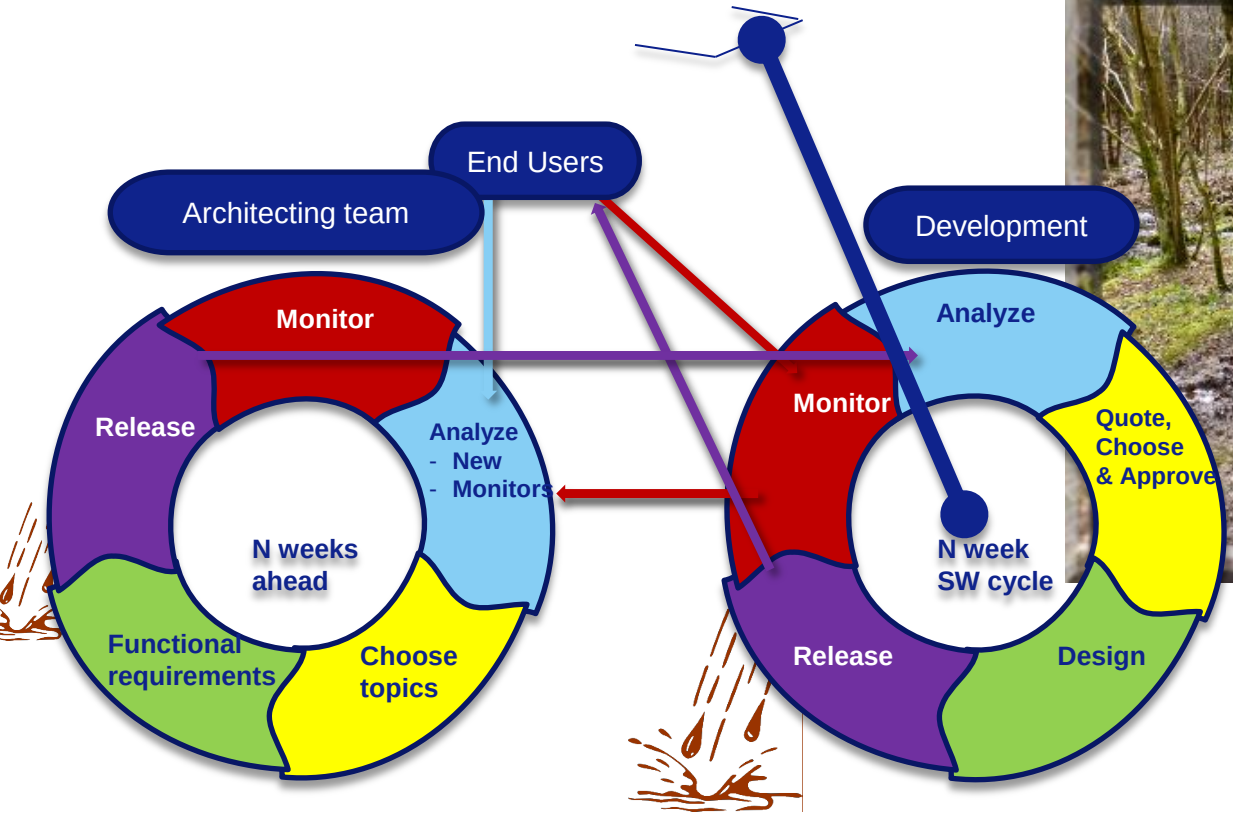




Conclusion: build an architecting team

Conclusion: build an architecting team and learn how to drive

Conclusion: build an architecting team and learn how to drive the agile architecting cycle



Final summary

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Production Scanners are stabilized by independent SW systems

System Architecting is driving the agile development cycle

The familiar engineering V model has become a vvv model

References

[Ref1] The Waferstepper Challenge: Innovation and Reliability despite Complexity, Gerrit Muller
http://www.gaudisite.nl/info/IRCwaferstepper.info.html

[Ref2] ASML Holistic Lithography, ASML,
http://www.asml.com/asml/show.do?ctx=38884

[Ref3] All About Systems Engineering; Introductory Course, Gerrit Muller
http://www.gaudisite.nl/info/SEintroductionCourse.info.html