

Envisioning the Next Software Development Era

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Sustainability

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."^[3]

But everything around us is changing so rapidly...

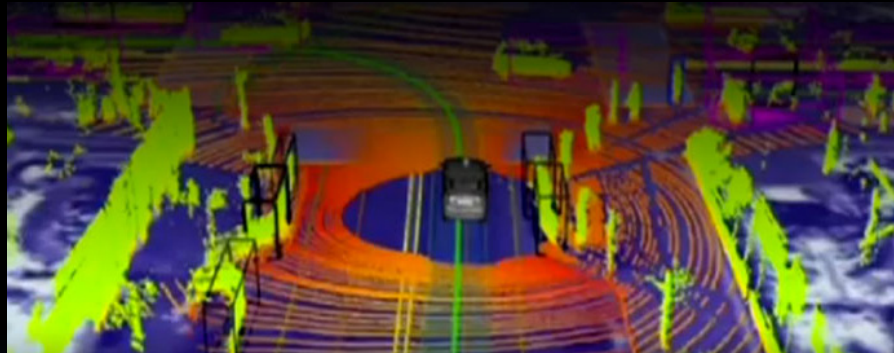
What is changing?

And how do we relate the concept of sustainability to software development?

Recent Technology Paradigm Shifts

Change is in the air...

Artificial Intelligence in the Google Autonomous Car



[3a]



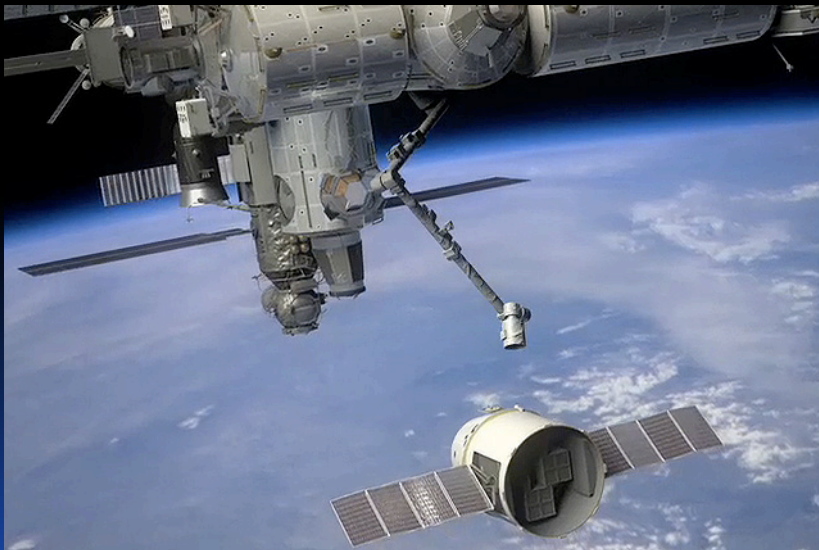
[3b]

Recent Technology Paradigm Shifts

Change is in (and beyond) the air...

Autonomous air- and spacecraft

SpaceX Dragon



[4]

Artificial Swarm Intelligence



[4a]

Recent Technology Paradigm Shifts

Change is not that far away

Robots and AI are getting closer to us



[5]



[5b]



[5a]

Recent Technology Paradigm Shifts

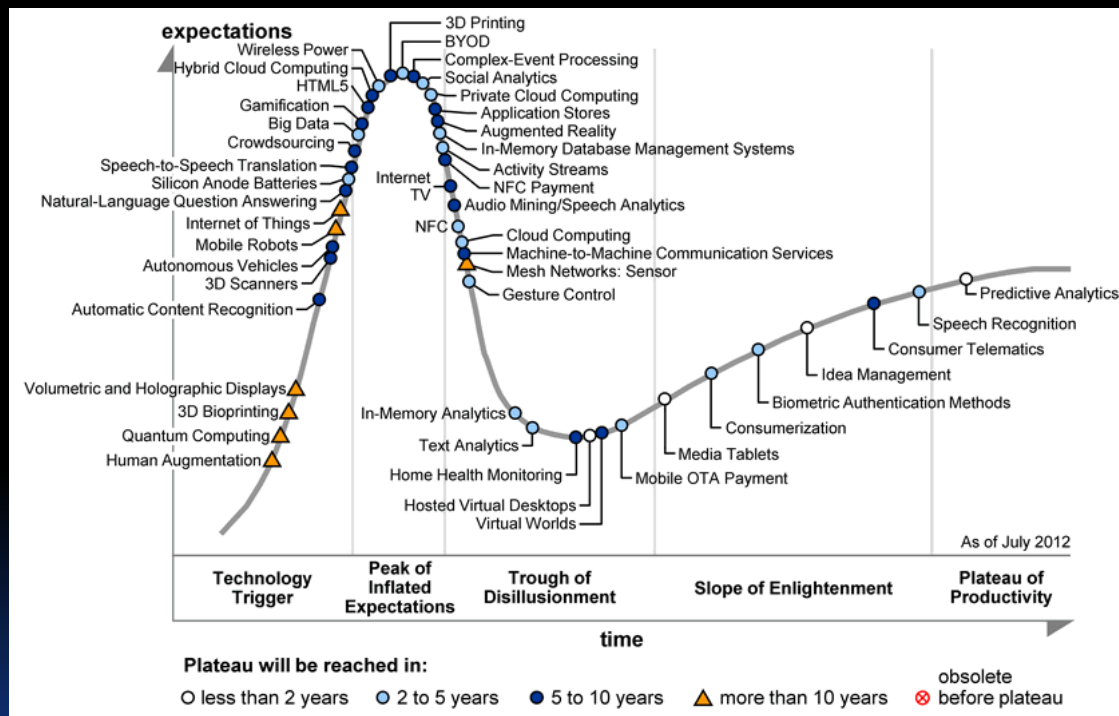
Some change is already considered “normal” and likely in someone’s pocket...

AI in the hands of the Masses:
Apple’s iPhone Siri™

““The difference between Siri and what came before is massive amounts of data. Data allowed the construction of algorithms that decipher voice. Data on the Internet allows Siri to have a lot more situational awareness than it would have had in the past. Data about your location massively increases the usefulness of anything an assistant could offer. You can tell a lot about an era by its visions of automata.” - Alexis Madrigal, senior editor at The Atlantic

Technology Hype Cycles

Yet *software* technological change is far more difficult for us to *perceive*.



Some move faster, some slower. Perhaps we are now seeing signs that AI is finally moving beyond the trough of disillusionment because of access to massive amounts of data and context awareness.

Software Development Paradigm Shifts

Where/Who/When/How Axis Changes:

- Affecting Transparency, Accessibility, Independence, Flexibility
 - Global Software Development
 - Open Source and Crowdsourcing
 - Cloud Computing and Service-Oriented Computing
 - DevOps
 - Etc.

Software Development Paradigm Shifts

How Axis Change:

- Changes affecting Productivity
 - Agile practices
 - Continuous Integration
 - Dynamic and domain-specific programming languages
 - App Development and Distribution Platforms
 - Composability as a common reuse mechanism
 - Etc.

Current State of our Software World



- Ubiquitous IT
 - Society's increasing dependence
 - In 2010 7.1 billion embedded systems shipped ^[10a]; 9 billion devices connected ^[10e]; Internet of Things would encode 50-100 trillion objects ^[10c]
- Exobyte computing already in 2007 ^{[10][10f]}
- Big Data Explosion 8 fold in past 7 years ^[10e]
- Multi-Trillion LOC worldwide
 - LOC size metric ignores all library/service dependencies!
- Likely more than 17 Million SW developers ^[10d]

Are we ready for this brave new world?

We don't have a problem (yet)...

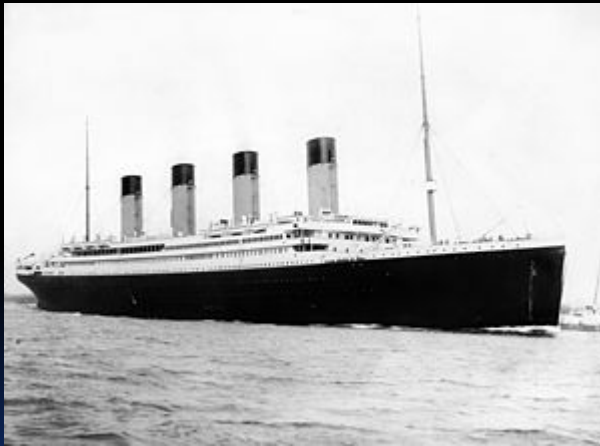
We can adapt to new situations...



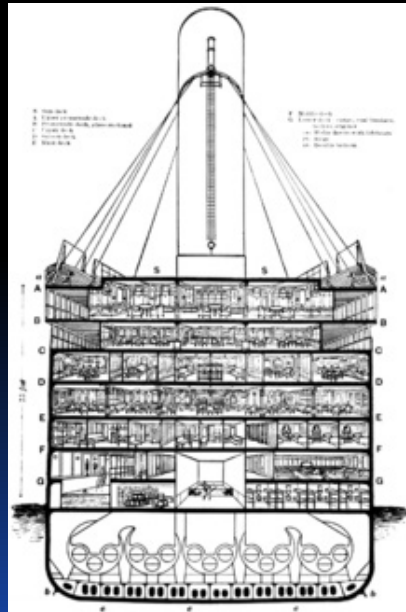
[13]

We don't have a problem (yet)...

We believe in & are fully confident in our technology and engineering to deal with any contingency...



[15a]



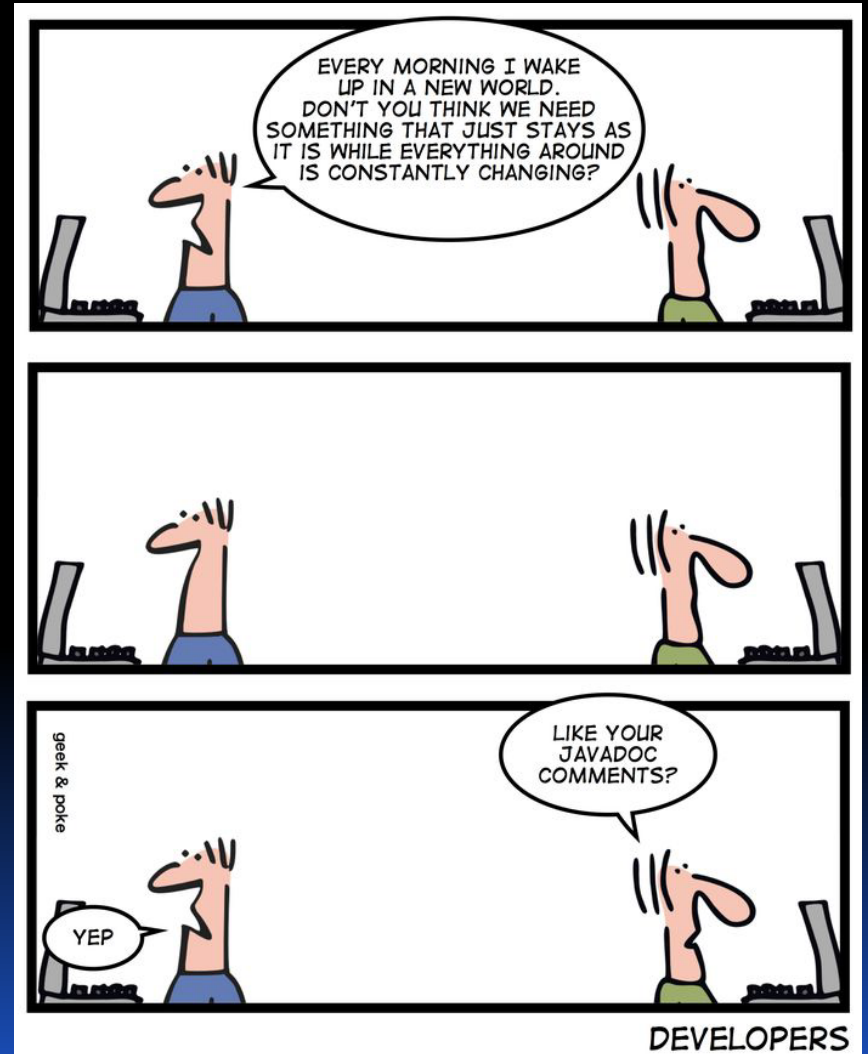
[15b]



[15]

Software Development Challenges

WHEN YOU HEAR THIS:



Software Development Challenges

- Business & Quality Pressure
- Brook's Essential Difficulties
- Software application growth rates
 - Application size doubling every 4-5 years ^[16]
- Archaic storage, tooling, and visualization issues
- Data island and interoperability issues
- Operational-level development process issues
- Human issues related to quality

Missing automated holistic and systematic context-sensitive guidance and support

X-Modernism

- *Modernism* - belief in rational, universal truth
 - Master narrative of progress through science & technology
 - Hierarchy, order, centralized control
- *Postmodernism* - incredulity toward metanarratives
 - Rejection of universal/shared truth and knowledge, skepticism
 - Belief: relative truth determined/interpreted by each individual
 - No dominant narrative, subjectivity of master narratives and claims of truth; embracing contradictions; anti-technology

Yet the world is moving beyond Postmodernism...

Metamodernism

The world is now in the Post-postmodernism era

Continuous oscillation that negotiates
between universal truths and relativism

Recurrent theme:

An integral and holistic paradigm and mindset

Situational tailoring of appropriate paradigms

Implications for SW Development in the Metamodernism Era

Society has a need for:

- Appropriately-engineered quality products
- Industrial-level, deterministic, rigorous processes that do not ignore human and knowledge-worker aspects

Towards:

- Integrative, holistic human-techno system-level processes and support
 - Increasing prominence of Quality Assurance ^[7]
 - Integrative pro-/reactive; flexible/agile; individual/collaborative
 - Not overly/purely human-centric nor overly confining

Within this Metamodernism Era: A Personal Narrative among our many fascinating Narratives



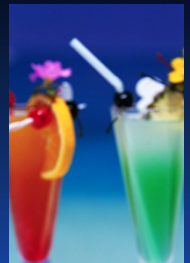
"To measure is to know."

"If you can not measure it, you can not improve it."

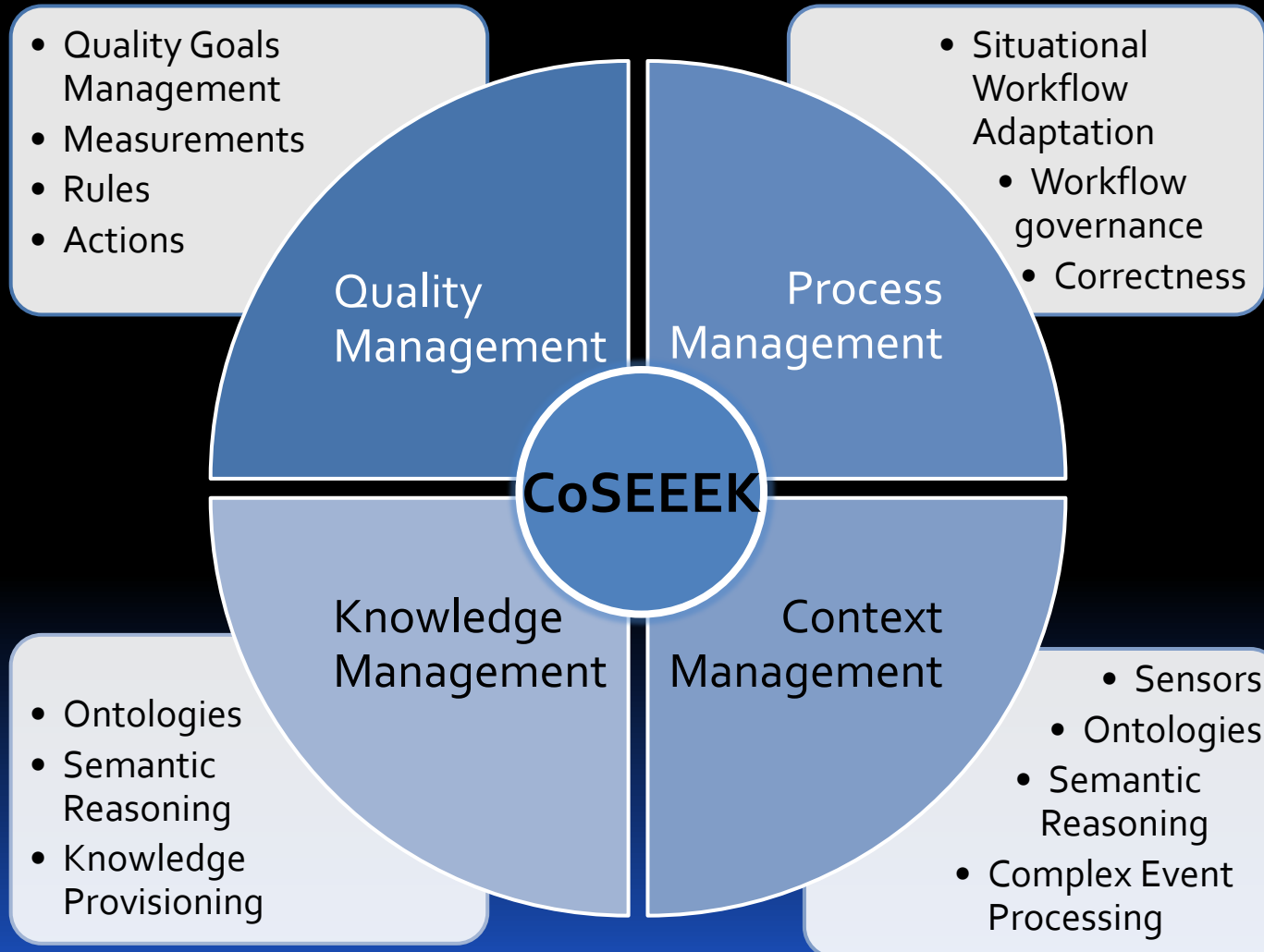
- Sir William Thomson (Lord Kelvin)

For efficient and effective *quality* one
"must do the right thing at the right time in the right way."
Thus quality is highly process-dependent.

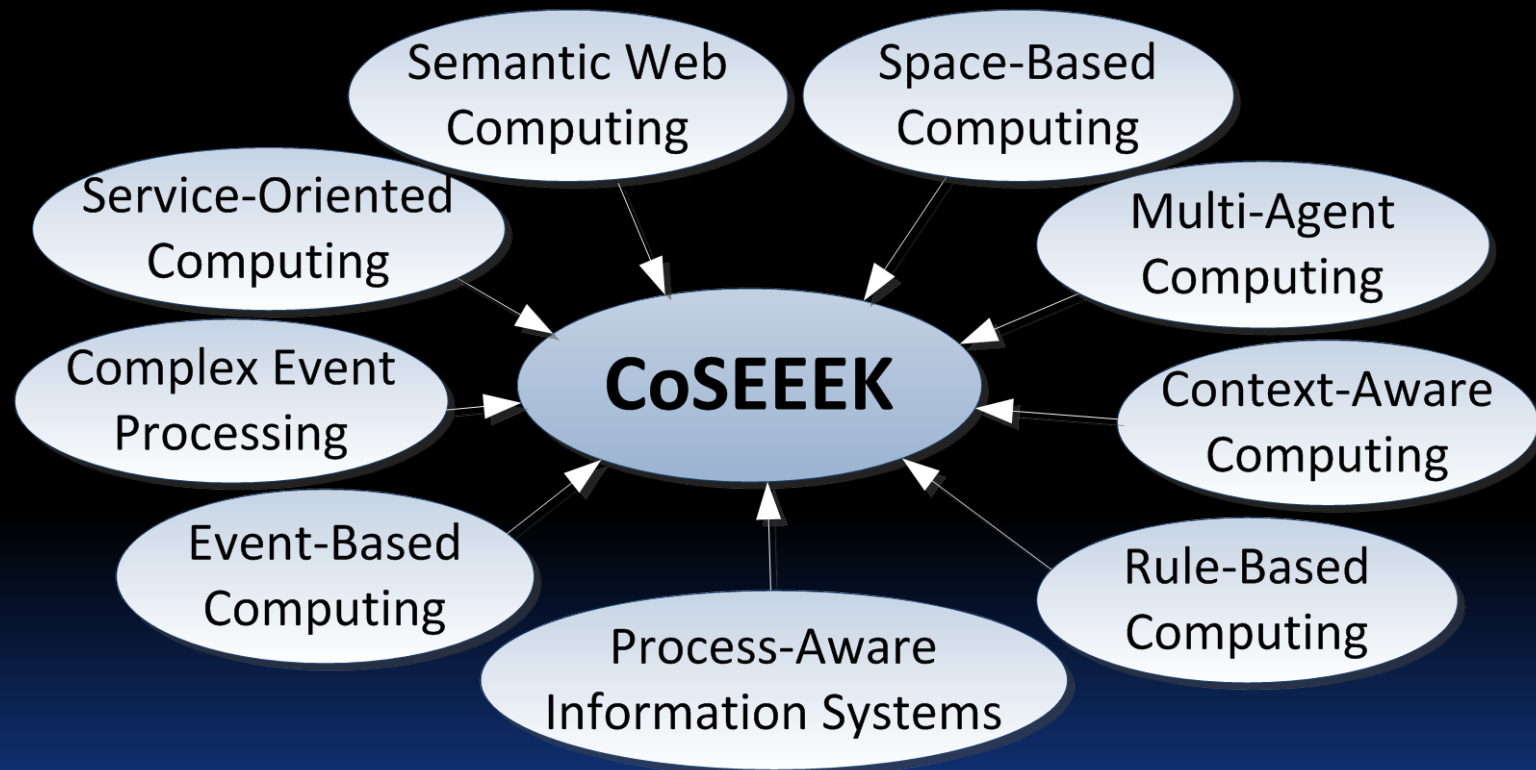
In essence *Quality* is a cocktail that
depends on right blend of "ingredients"
for the given context



A holistic approach to software quality: Context-aware Software Engineering Environment Event-driven framework (CoSEEEK)



CoSEEEK: An Integrative Multi-Paradigm Approach



Oberhauser: "Leveraging Semantic Web Computing for Context-Aware Software Engineering Environments"
In "Semantic Web", IN-TECH, 2010, ISBN 978-953-7619-54-1, pp. 157-179.

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Providing Developers with Assistance

Context-aware Software Engineering Environment Event-driven framework

The navigability paradigm:
The benefits of contextual focus.



Providing Developers with Assistance

Context-aware Software Engineering Environment Event-driven framework

Our research with CoSEEEK [see pg. 56-57]:

SE environment context-awareness

Operational SE workflow modeling

Automated adaptive process management

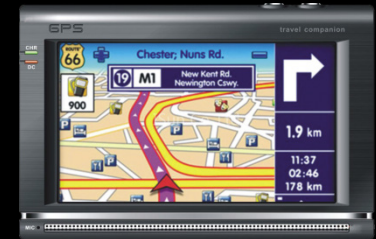
Automated coordination

Automated knowledge provisioning

Automated process assessment/improvement

Automated pro-/reactive quality issue assessment & governance

Heterogeneous instrumentation & technical infrastructure



CoSEEEK Context-Aware Quality Coach

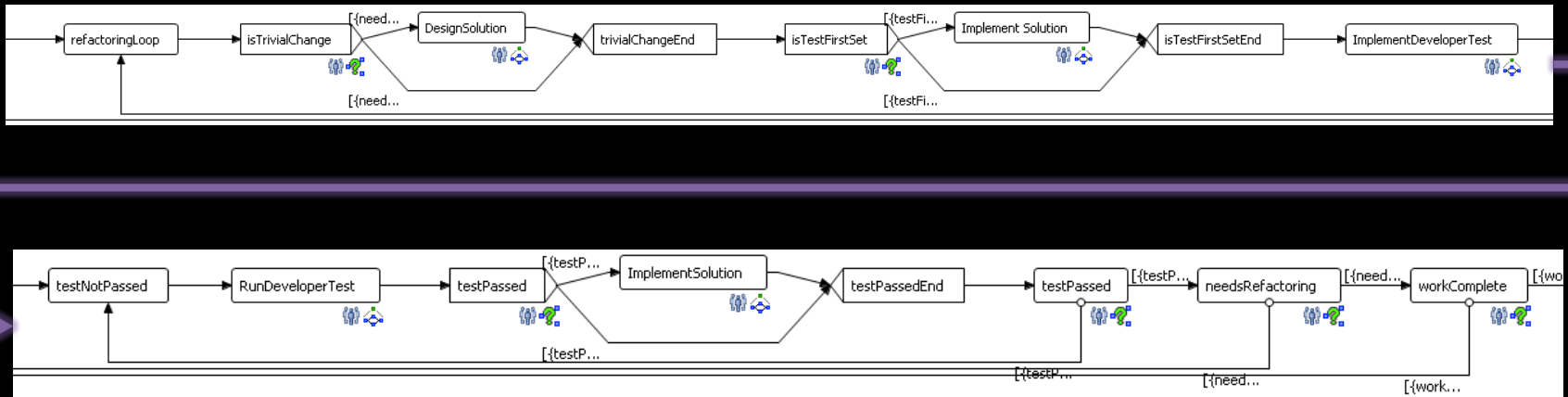
The screenshot displays a web-based interface for the CoSEEEK Context-Aware Quality Coach. At the top, there are five tabs: "Context", "Checklist", "Links", "Settings", and "About". The "Checklist" tab is currently selected. Below the tabs, there is a checklist with three items, each followed by an unchecked checkbox:

- Have all open cursors been closed?
- Related statements grouped?
- Nominal path through code clear?

Below the checklist is a "Complete" button. At the bottom of the main content area, there is a "Message:" label followed by an empty text input field and a "Send" button. Below the input field, there is a section of context-aware information presented as a list of key-value pairs:

- Project:** Customer X Request
- Assignment:** Change DB
- Iteration:** 5
- Process Module:** Develop Solution Increment
- Activity Group:** Development
- Activity:** Implement Solution
- Activity Step:** Write source code
- Task:** Checkout

CoSEEEK: Operational SE Workflow Enactment and Assessment

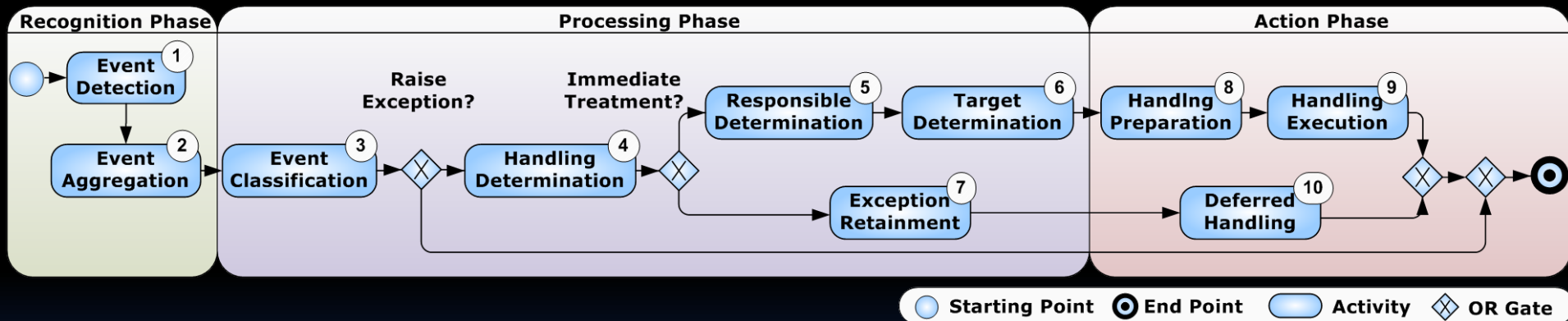


Grambow, Oberhauser, and Reichert: "Towards a Workflow Language for Software Engineering" (SE 2011).

Grambow, Oberhauser, and Reichert: "Towards Automated Process Assessment in Software Engineering" (ICSEA 2012).

Oberhauser: "Towards Automated Test Practice Detection and Governance", (VALID 2009).

Adapting SE Processes for Exceptions and User Intentions

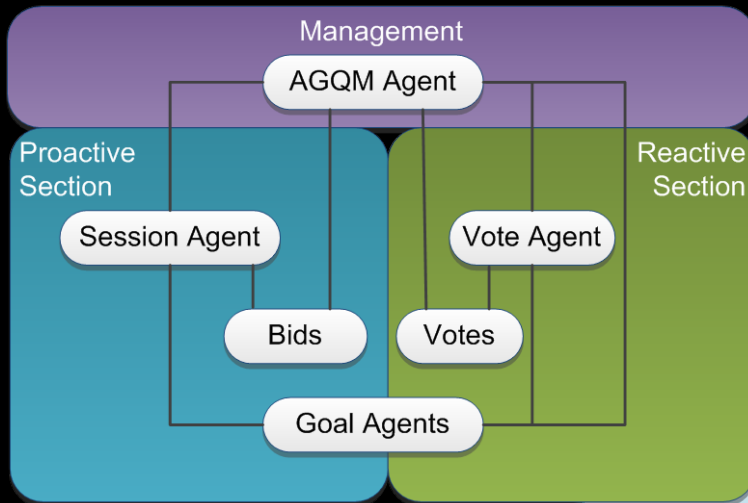


Grambow, Oberhauser, and Reichert:

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“User-centric Abstraction of Workflow Logic Applied to Software Engineering Processes” (HC-PAIS 2012 @ CAiSE12) .

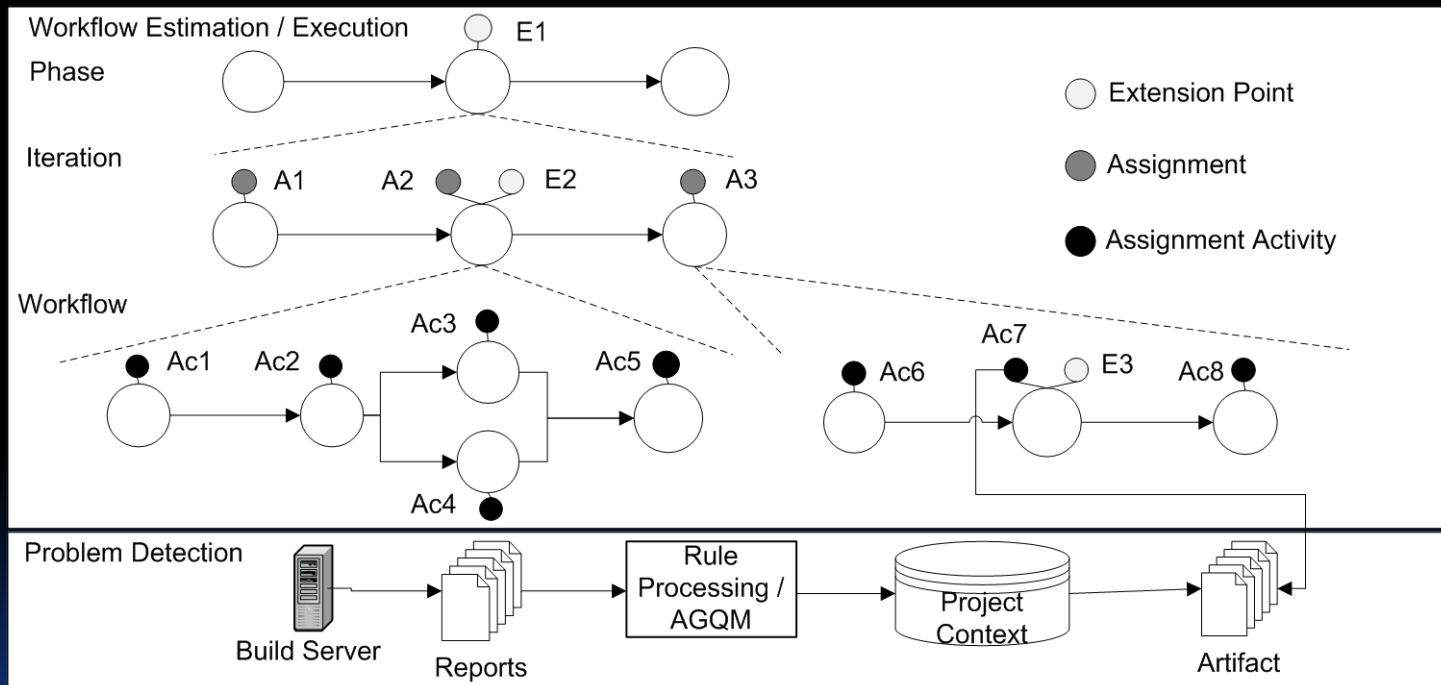
Agent-based Quality Action Selection via Automated Goal-Question-Metric



Agent	Points	Strategy
Functionality	100	Offensive
Reliability	80	Balanced
Maintainability	80	Balanced
Performance	60	Defensive

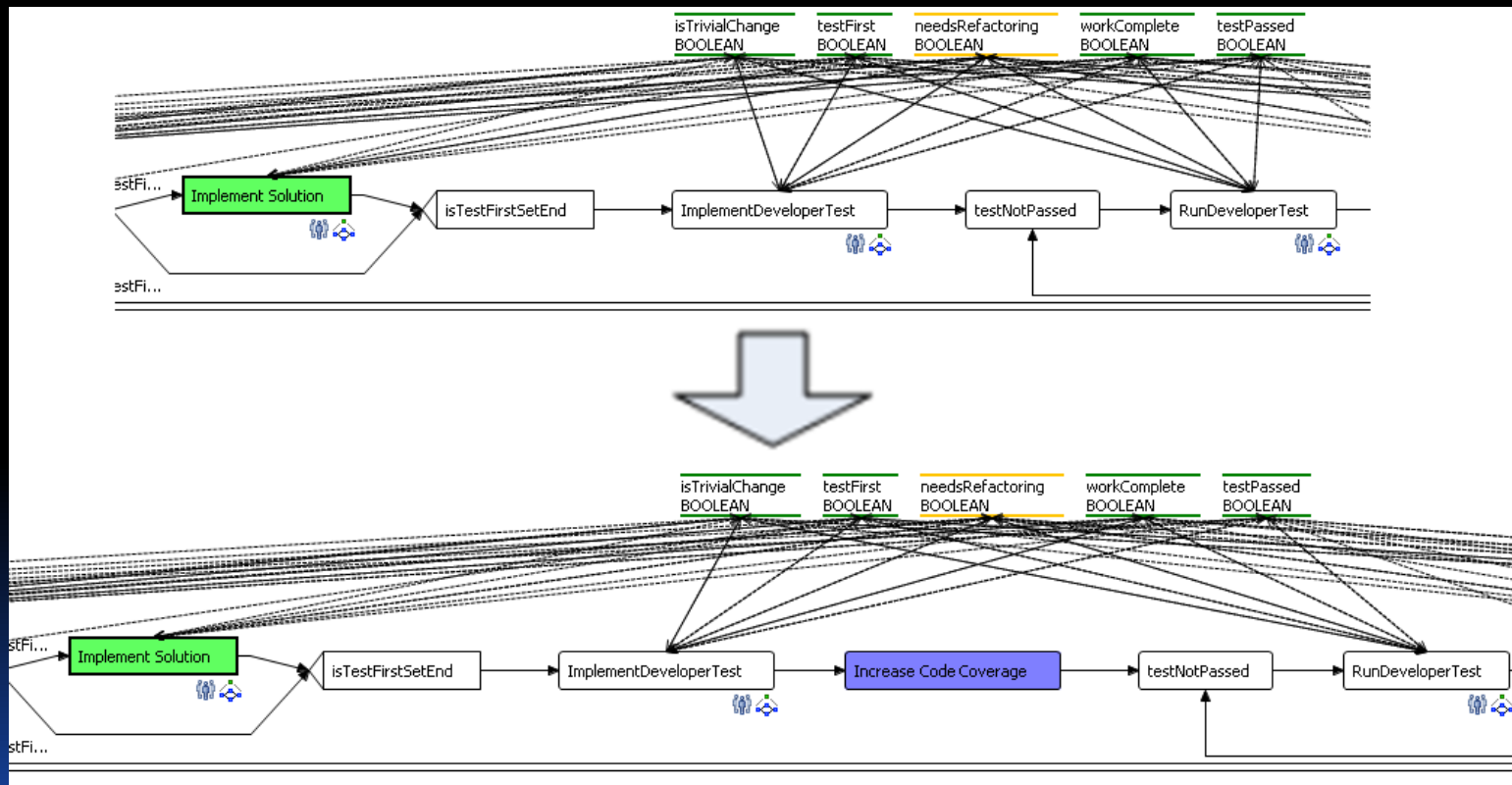
	Winner	FUNC	REL	MAINT	PERF
	FUNC	35	24	24	15
2	FUNC	31	28	28	17
3	REL	28	32	32	19
4	MAINT	34	28	37	21
5	FUNC	34 (41)	32	32	23
13	MAINT	0	37	37	25
15	REL	0	43	32	28
20	PERF	0	25 (37)	26 (37)	31

CoSEEEK: Semantically-Driven Integration of Quality-Actions with Process Management



Grambow, Oberhauser, and Reichert:
“Employing Semantically Driven Adaptation for Amalgamating Software Quality Assurance with Process Management” (ADAPTIVE 2010)

CoSEEEK: Semantically-Driven Integration of Quality-Actions with Process Management

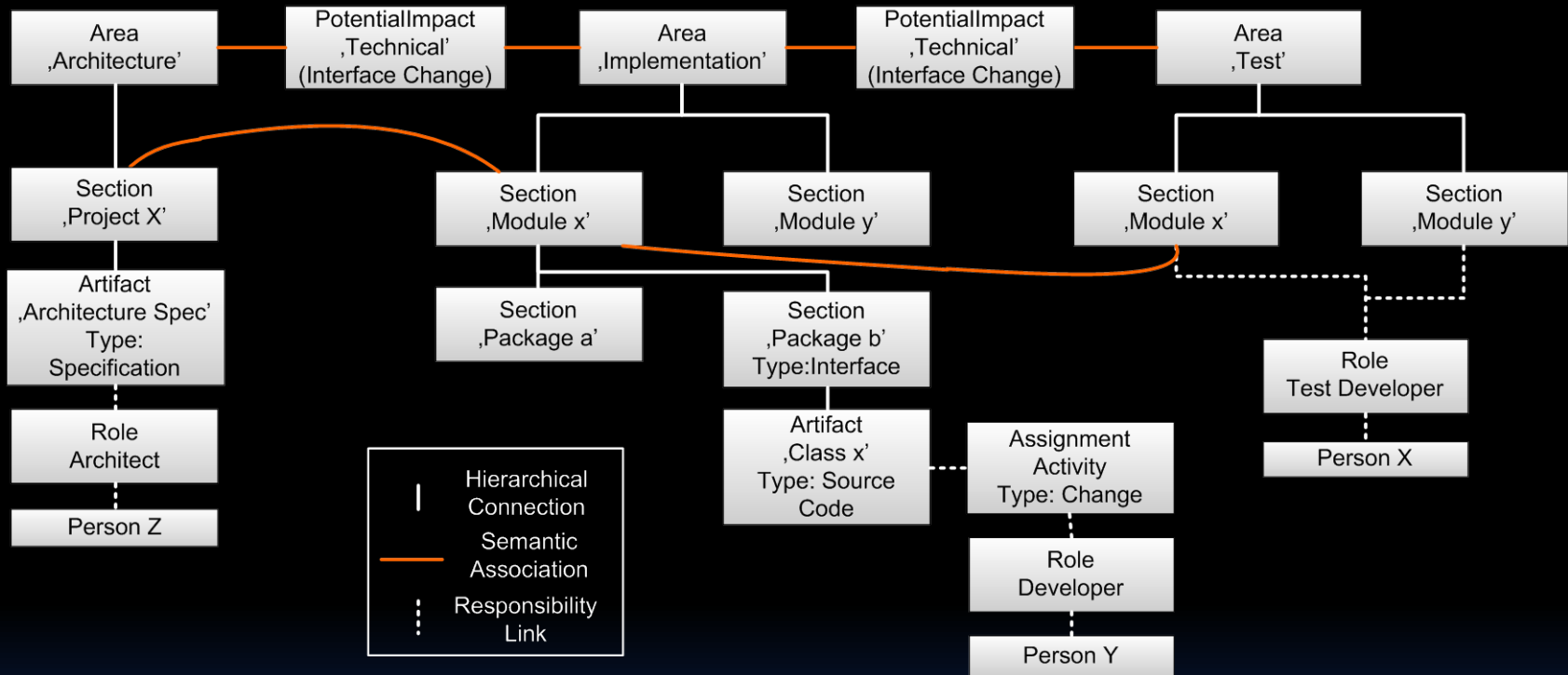


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CoSEEEK Automated Coordination Scenario



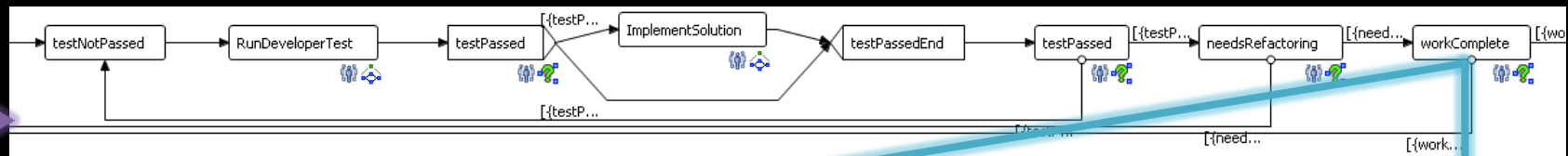
Grambow, Oberhauser, and Reichert:

"Towards Automatic Process-Aware Coordination in Collaborative Software Engineering" (ICSOF 2011).

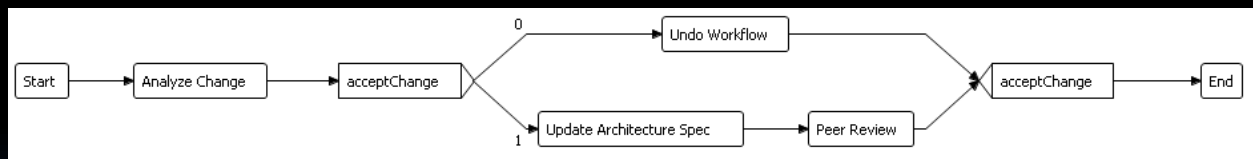
"Enabling Automatic Process-aware Collaboration Support in Software Engineering Projects" in CCIS Series by Springer.

COSEEEK: Auto-Triggered Workflow Collaboration

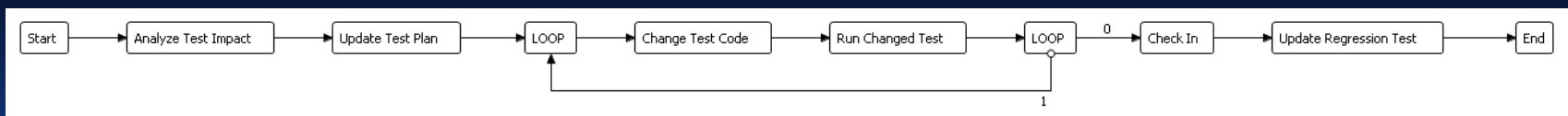
Developer Workflow



Architect Workflow



Tester Workflow

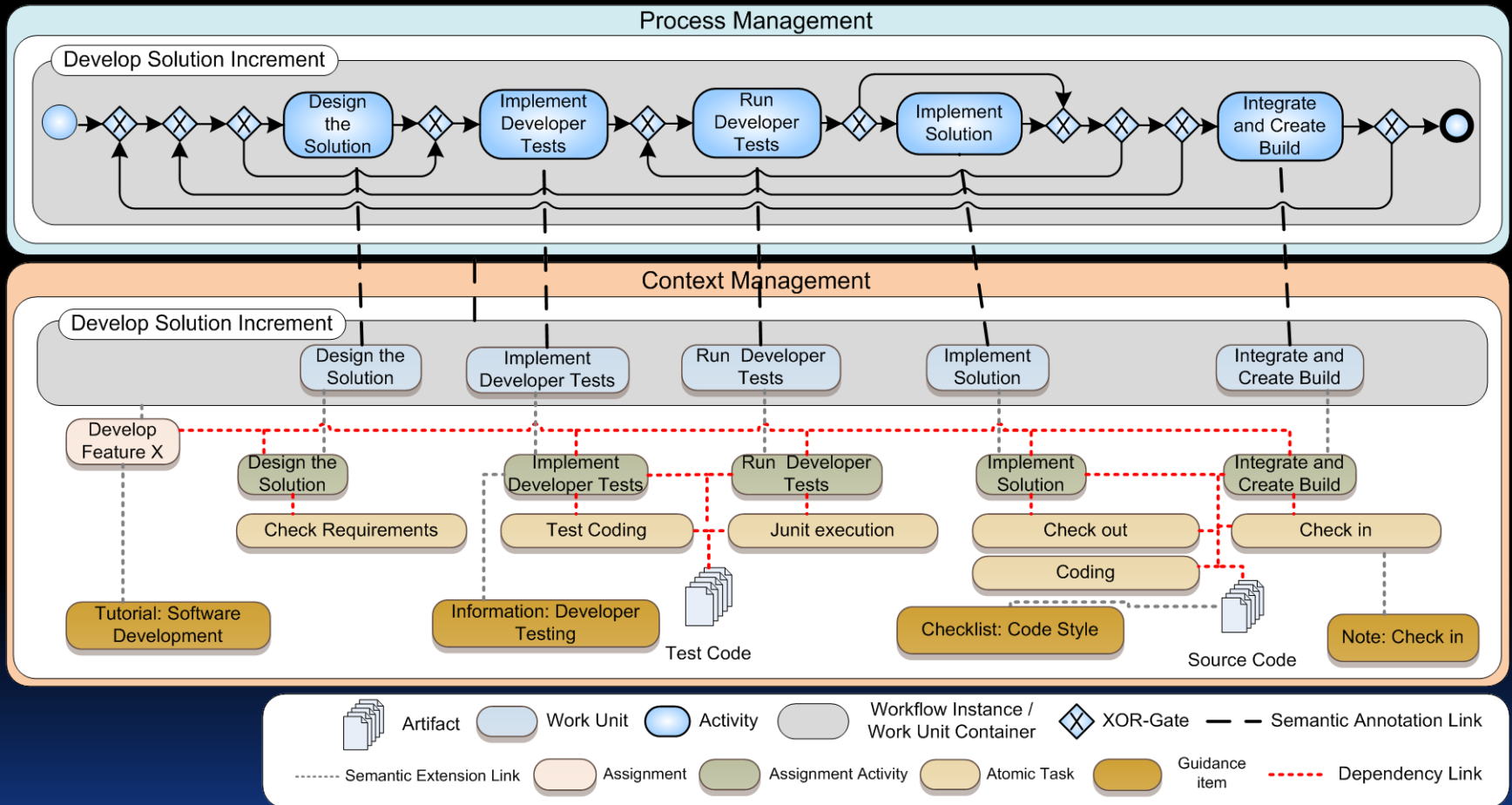


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CoSEEEK: Automated Knowledge Provisioning



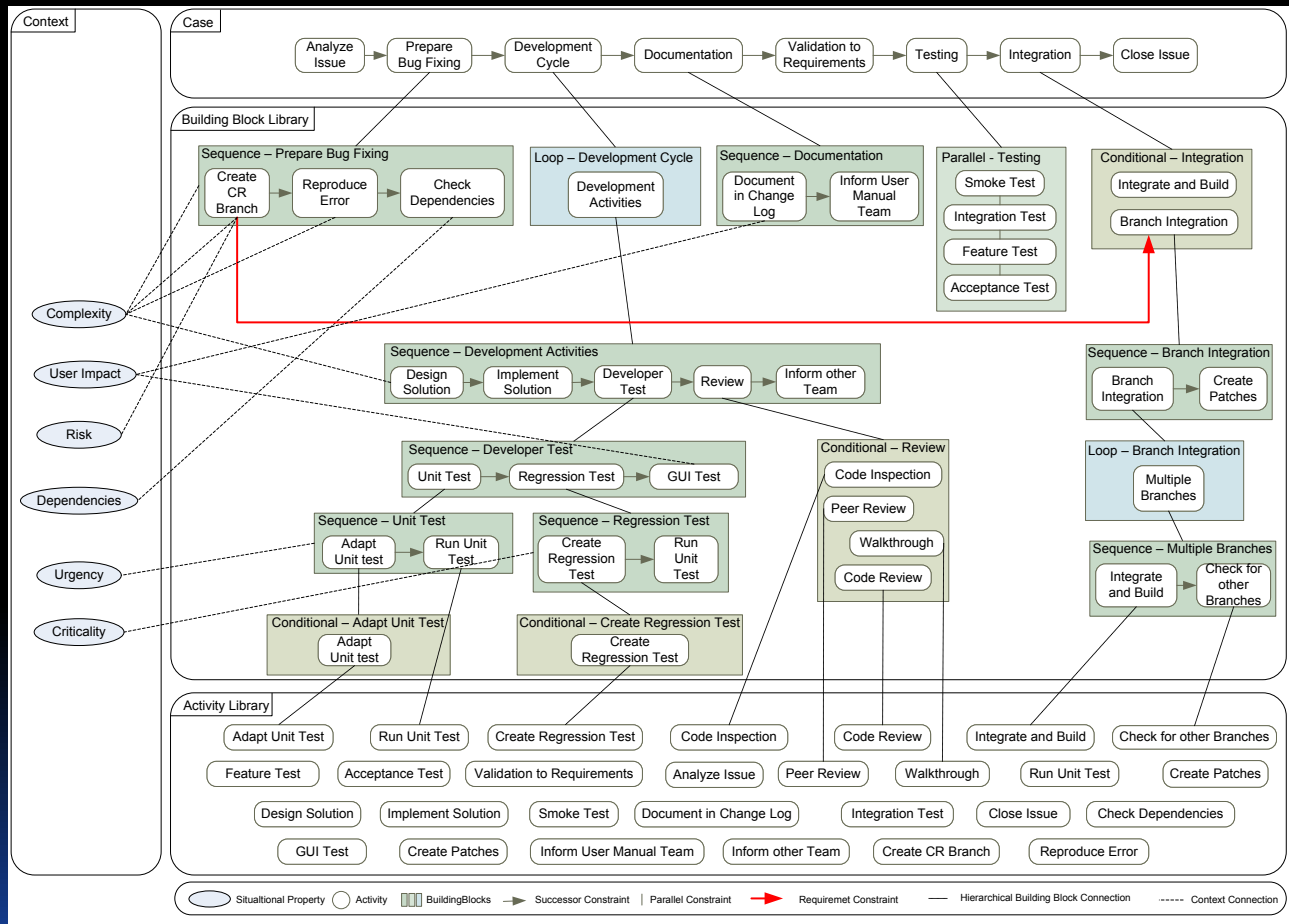
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"Towards Dynamic Knowledge Support in Software Engineering Processes" (AST 2011 @ INFORMATIK 2011)

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Declarative Situational Method Engineering Specification of SE Workflows



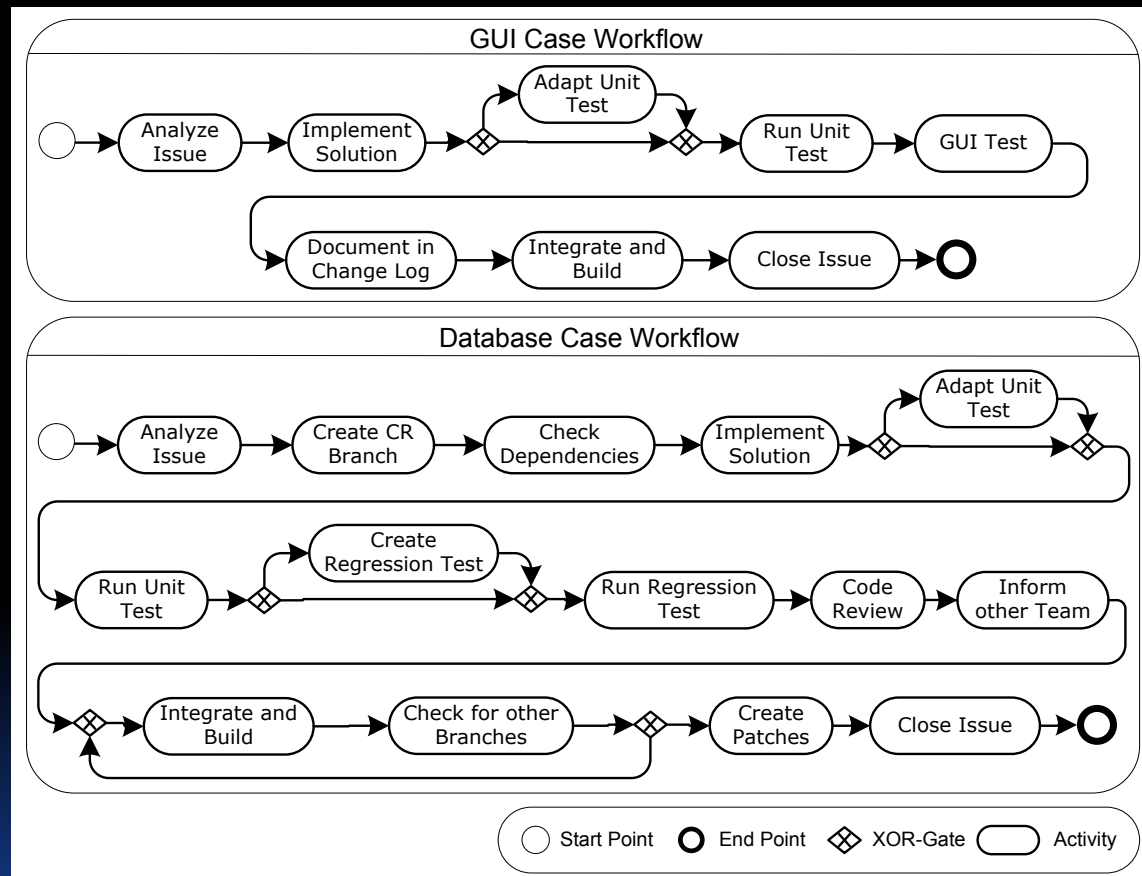
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“Contextual Generation of Declarative Workflows and their Application to Software Engineering Processes”

International Journal On Advances in Intelligent Systems, published by IARIA, ISSN: 1942-2679, vol. 4, no. 3 & 4, year 2011, pp. 158-179

Declarative Situational Method Engineering Specification of SE Workflows



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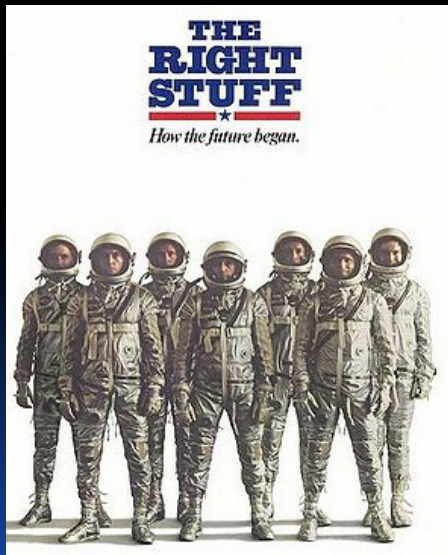
International Journal On Advances in Intelligent Systems, published by IARIA, ISSN: 1942-2679, vol. 4, no. 3 & 4, year 2011, pp. 158-179

Transitioning to a Vision

We are on the verge of one type of
“Software Peak”

The “(good) old heroic” days
are passing...

Beyond conventional “tools”
towards super-tools and
integrative system convergence...



[35a]



[35]



On Continuous Change

“It is change, continuing change, inevitable change, that is the dominant factor in society today. No sensible decision can be made any longer without taking into account not only the world as it is, but the world as it will be....

This, in turn, means that our statesmen, our businessmen, our *everyman* must take on *a science fictional way of thinking.*” (italics mine)

- Isaac Asimov, *Asimov on Science Fiction*

Digility: A Futuristic Vision for Metamodern SW Development Sustainability

- Digility = to agilely navigate in the digital world.
 - What is meant by the term is an integrative and adaptive interplay between the human software developers and the digital world; a human-techno holistic system view of software development that involves super-, intelligent and integrative tooling.

For future concepts not yet in existence, I use of “Integrative” and the prefix e- to indicate that it is something different and more complete than what we know and understand with the term in use today

Digility: A Futuristic Vision for Metamodern SW Development Sustainability

The concepts involved:

Integrative intelligent e-CoSystem

Integrative e-Collaboration

*Integrative e-Fabric interweaving of
e-Narratives, e-Methods, e-Knowledge*

Integrative rE-purposing

Integrative e-SupplyChain

Integrative e-Quality, e-Testing, e-Governance

Integrative E-nvironmental remediation, e-Recalls

Integrative e-Trust, E-thics

Integrative e-Research, e-ducation

Digility: A Futuristic Vision for Metamodern SW Development Sustainability



Integrative intelligent e-CoSystem

- *e-CoSystem*: A new bidirectional developer ↔ e-nvironment (habitat) relational paradigm.
- Integrative *e-Toolchaining* and *smarttools*
 - Holistic, system-level ambient intelligence tooling “on par”(tner) w/ developers
- *e-Sherpas*: Intelligent agent(s) (embodied or not) valued to agilely accomplish the mission
- Smarter SW entities: integrative application of *Intelligence-Oriented Architecture (IOA)* and *Intelligence-Oriented Computing (IOC)* paradigms

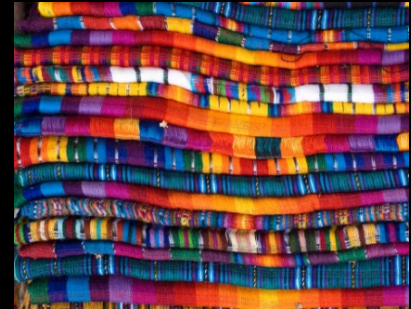
Digility: A Futuristic Vision for Metamodern SW Development Sustainability

- *Integrative intelligent e-CoSystem*
- *Integrative e-Collaboration*



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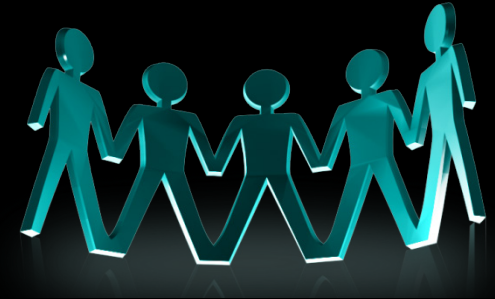
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See Oberhauser & Schmidt: ""Improving the Integration of the Software Supply Chain via the Semantic Web" (ICSEA 2007)

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[44]

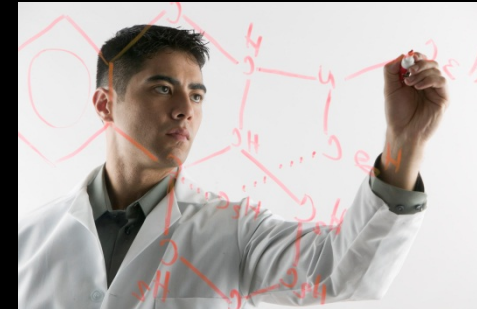
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Digility: A Futuristic Vision for Metamodern SW Development Sustainability

Sherpas are elite mountaineers,
experts in their local terrain.



[49]

Digility: A Futuristic Vision for Metamodern SW Development Sustainability

The dawn of the “*e-Sherpa era*”

An intelligent agent as an
accepted co-partner and guide
(part of the whole human-techno system)
in the e-CoSystem
to assist developers in navigating
this vast, harsh, and changing
e-landscape



Digility: A Futuristic Vision for Metamodern SW Development Sustainability

Review:

Integrative intelligent e-CoSystem

Integrative e-Collaboration

Integrative e-Fabric interweaving of
e-Narratives, e-Methods, e-Knowledge

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Summary

Long-term sustainability depends on the coordinated small actions of many.

“Smarttooling” provides a mechanism to continually, rapidly, and systematically assist many developers.

Digility provides a vision.

What e-nvironment will we leave the next generation?



Conclusion

Our research narratives will be interwoven in this metamodernist software development era. Collaboratively we can realize aspects of **Digility**. Society (and especially developers) can benefit.

Thank you!



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<http://www.htw-aalen.de/personal/roy.oberhauser>

Acknowledgment

The referenced work from CoSEEEK was sponsored by the Federal Ministry of Education and Research (BMBF) of the Federal Republic of Germany.

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- [3] World Commission on Environment and Development. "Our Common Future, Chapter 2: Towards Sustainable Development".
- [3a] google; [3b] forbes
- [4] NASA; [4a] University of Pennsylvania GRASP Lab
- [5] Robert Bosch GmbH; [5a] Honda; [5b] <http://img.xataka.com.mx/2011/12/robocup.jpg>
- [7] Gartner Hype Cycle for Emerging Technologies, 2012
- [10] <http://www.sciencemag.org/content/332/6025/60>; [10f] <http://www.washingtonpost.com/wp-dyn/content/article/2011/02/10/AR2011021004916.html>
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- [12] <http://www.securityfocus.com/news/8016>
- [13] Photograph by Luigi Costantini, Associated Press
- [15] Willy Stöwer: *Der Untergang der Titanic*; [15a] F.G.O. Stuart; [15b] wikipedia
- [35] Sebastian Terfloth [35a] The Right Stuff poster
- [44] WALL-E poster by pixar
- [49] Pem Dorjee Sherpa from wikipedia

CoSEEEK Research Work Contributions

"Contextual Generation of Declarative Workflows and their Application to Software Engineering Processes" by Gregor Grambow, Roy Oberhauser, and Manfred Reichert. In the International Journal On Advances in Intelligent Systems, published by IARIA, ISSN: 1942-2679, vol. 4, no. 3 & 4, year 2011, pp. 158-179

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"Contextually Injecting Quality Measures into Software Engineering Processes" by Gregor Grambow, Roy Oberhauser, and Manfred Reichert. In the International Journal On Advances in Software, ISSN 1942-2628, vol. 4, no. 1 & 2, year 2011, pp. 76-99.

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CoSEEEK Research Work Contributions

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