



# APS4ES & TDD4ES

Applications for Embedded Systems  
Test-Driven Development for Embedded Software

*Enterprise Programming research group*

dr. ing. Jeroen Boydens, EP – Professor  
[Jeroen.Boydens@khbo.be](mailto:Jeroen.Boydens@khbo.be)

ing. Piet Cordemans & Sille Van Landschoot,  
EP - Scientific Staff Members

 A2B forum 23/09/2010

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## Content



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- 1. EP Research group
- 2. Project APS4ES
- 3. Project TDD4ES
- 4. General contact



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# 1 EP research group

Founded: 2006 – 2007

<http://ep.khbo.be>

[Firstname.Surname@khbo.be](mailto:Firstname.Surname@khbo.be)



**dr. ing. Jeroen Boydens**  
+ founder  
+ professor  
+ project leader

**ing. Olivier Rosseel**  
+ academic staff  
+ ICTO coach

**ing. Piet Cordemans**  
+ TDD4ES  
+ PhD student  
+ lab assistant

**ing. Sille Van Landschoot**  
+ TDD4ES

**ing. Wim Catteeuw**  
+ APS4ES

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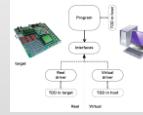
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# 1 EP research group



Threefold mission:

<b>Education</b>  <ul style="list-style-type: none"> <li><b>Software courses</b> <ul style="list-style-type: none"> <li>Prof. Bachelor EO/ICT</li> <li>Ac. Bachelor EO/ICT</li> <li>Master ICT</li> </ul> </li> </ul>	<b>Research</b>  <ul style="list-style-type: none"> <li><b>With K.U.Leuven</b> <ul style="list-style-type: none"> <li>Concurrent software</li> <li>Software testing</li> <li>Transactional behavior</li> </ul> </li> <li><b>Tetra/PWO/theses</b> <ul style="list-style-type: none"> <li>Embedded development methodologies</li> <li>Gaming frameworks</li> </ul> </li> </ul>	<b>Social services</b>  <ul style="list-style-type: none"> <li><b>Seminars</b> <ul style="list-style-type: none"> <li>Software testing</li> <li>State-of-the-art technologies</li> </ul> </li> <li><b>LED</b> <ul style="list-style-type: none"> <li>eg. Medical Reminder System</li> </ul> </li> </ul>
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## Content



1. EP Research group

2. Project APS4ES

funded by



3. Project TDD4ES

funded by



(TETRA 090191)

4. General contact

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## Content



1. EP Research group

*presented by P. Cordemans*

2. Project APS4ES

1. Co-design

2. Goals

3. Research process

4. People

5. Resources

3. Project TDD4ES

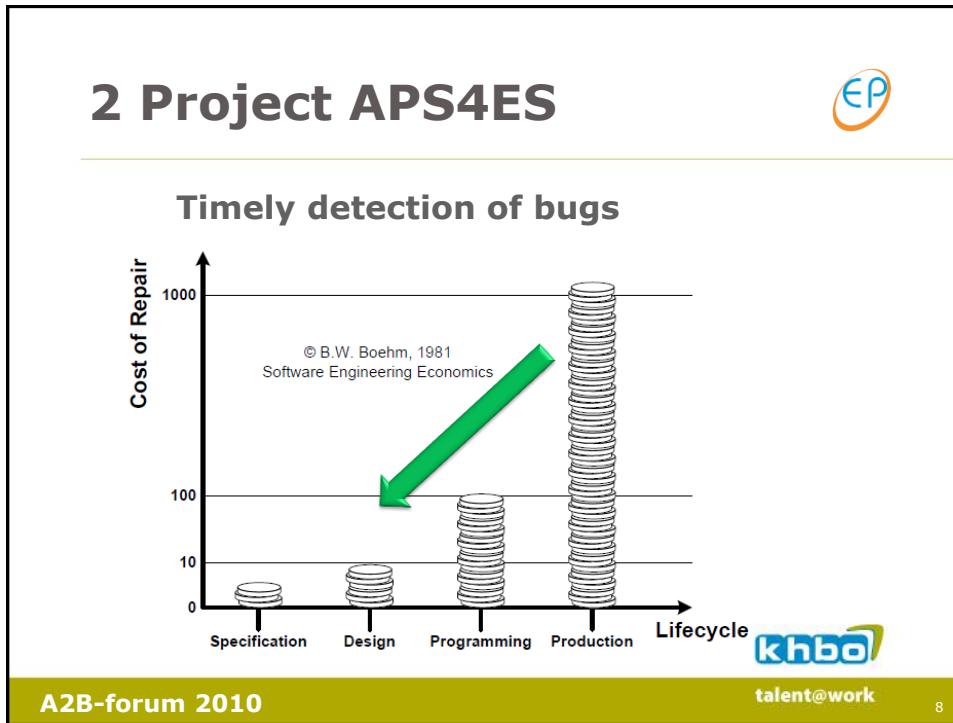
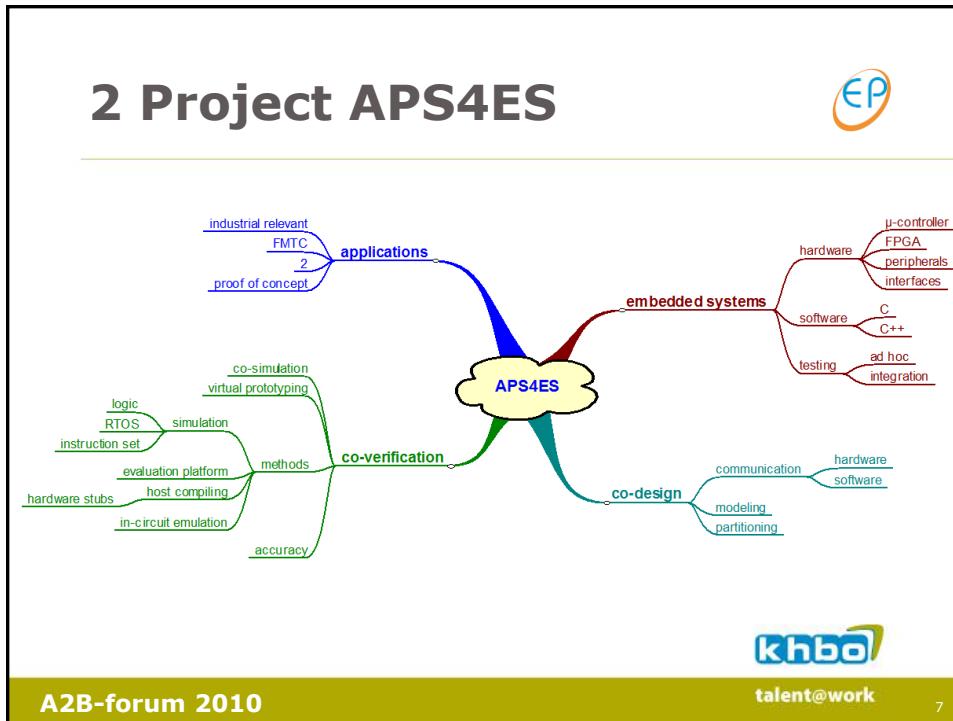
4. General contact

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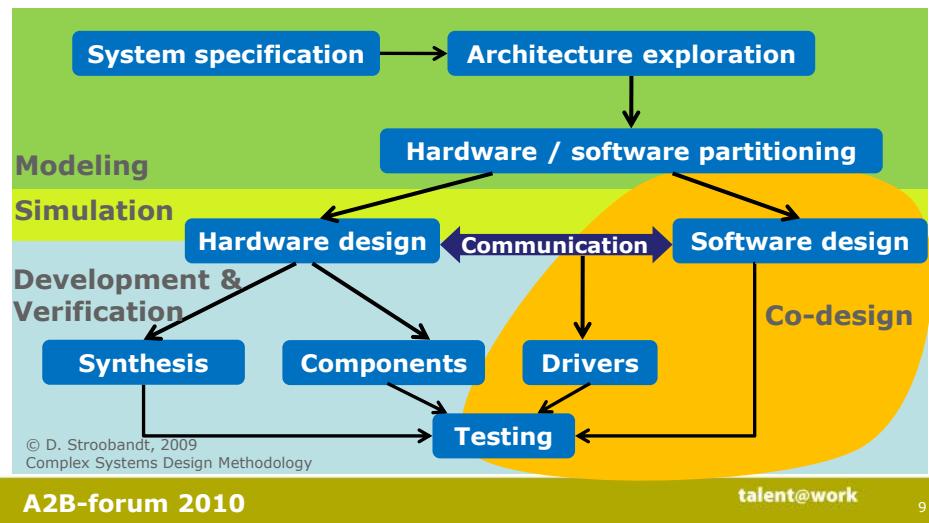


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## 2.1 APS4ES: Co-design



## 2.2 APS4ES: Goals



### Goals:



- Two proof of concept applications

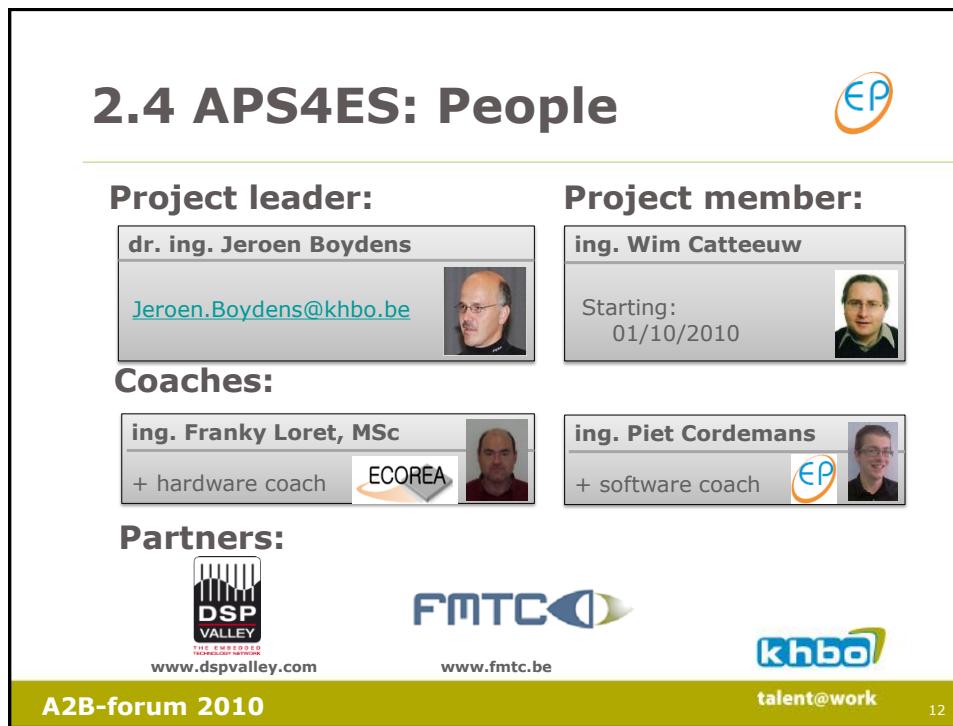
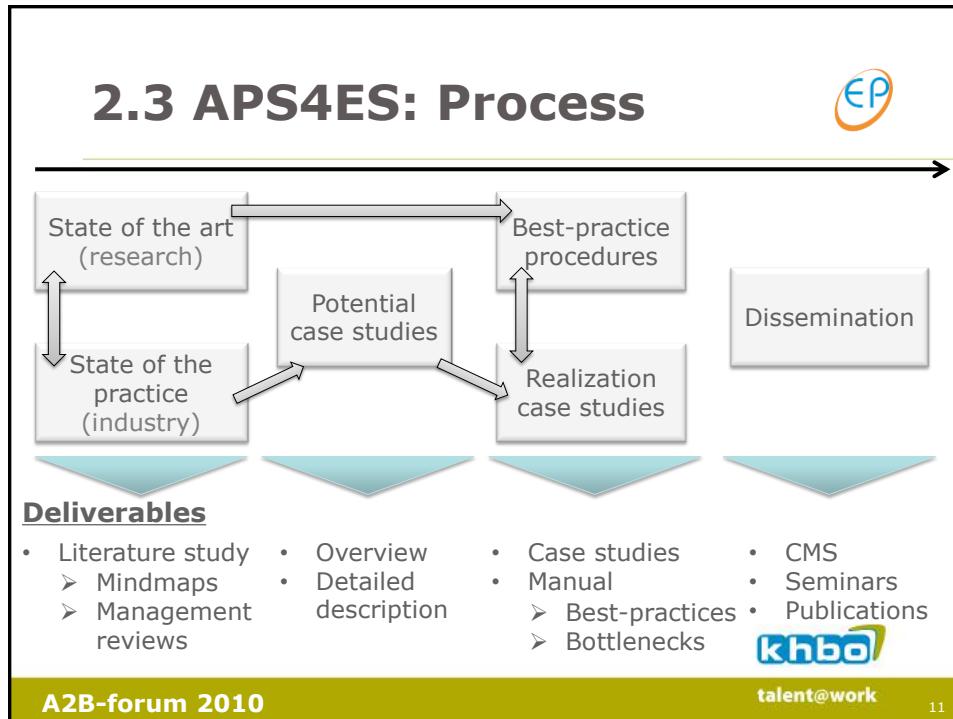
For example:

1. badminton robot controller
2. stereo vision system (cfr. badminton robot)
3. smart wireless camera
4. autonomous vibration sensor (low power)
5. wireless remote control (safety & low power)
6. object localization unit.
7. service tool for connector monitoring.
8. active damper of vibrations

- Best practice manual

➤ Support for professional bachelor courses





## 2.5 APS4ES: Resources



### EP Content Management System (CMS)

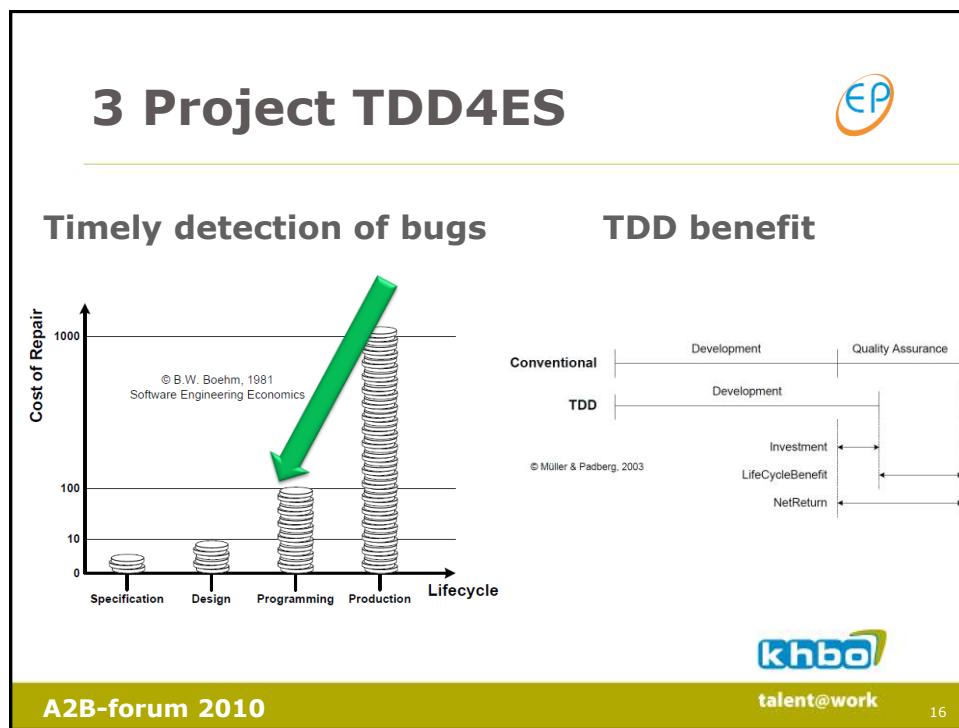
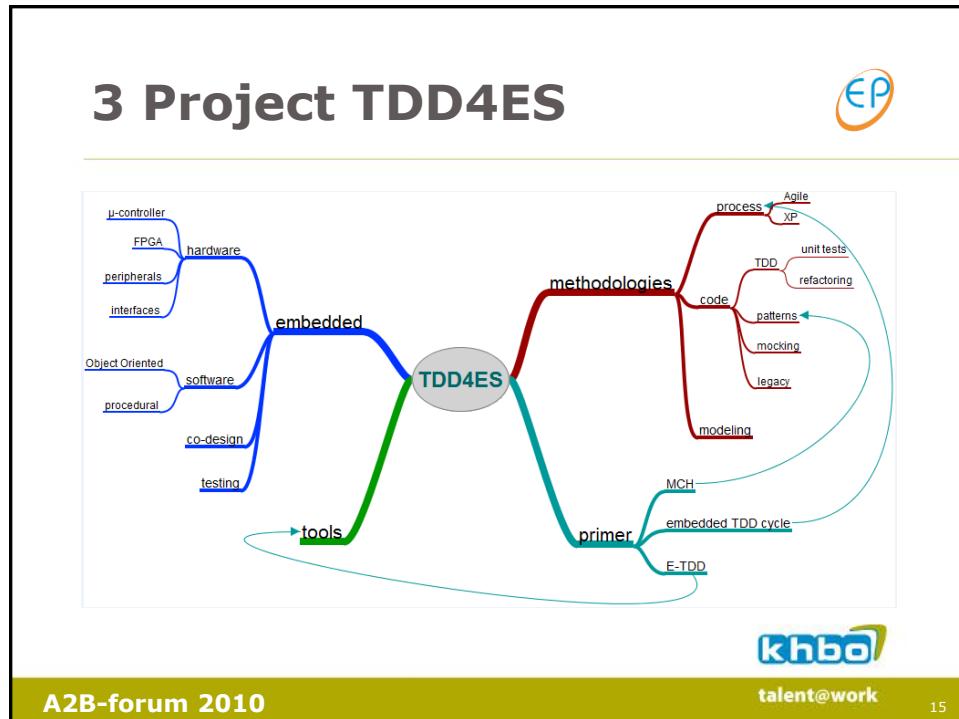
<http://ep.khbo.be>

## Content



- presented by S. Van Landschoot*
1. EP Research group
  2. Project APS4ES
  3. Project TDD4ES
    1. Test-Driven Development
    2. Embedded Strategies
    3. Case studies
    4. New project: DP4CES
    5. People
    6. Resources
  4. General contact

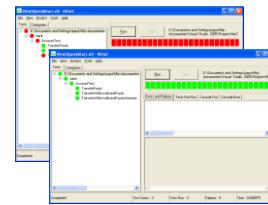
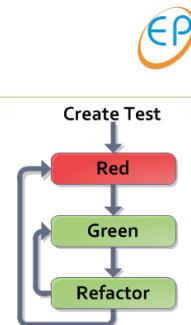




## 3.1 TDD4ES: TDD

### Test-Driven Development

1. Write failing test
  - New behavior
  - Minimal skeleton to get through compilation
2. Write code to pass test
  - Minimal implementation
3. Refactor
  - No new behavior
  - Clean code
  - Keep tests passing



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### Embedded constraints

1. Memory footprint
2. Slow programming cycle

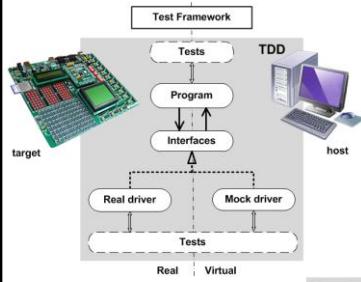
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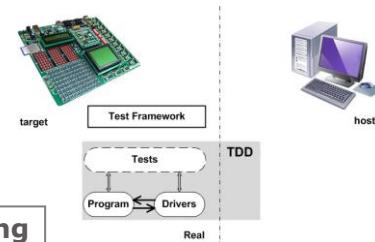
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## 3.2 TDD4ES: Strategies

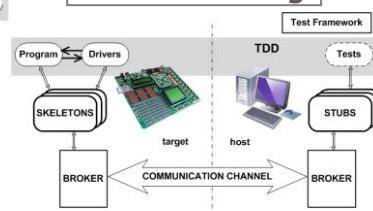
### Test on host



### Test on target



### Remote testing



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### 3.3 TDD4ES: Case studies



#### Proof of concept



- Temperature sensor application
- ARM7TDMI development board
- Workshop

#### Industrial case



- Loom control system
- NIOS II softprocessor
- Motor emulation



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### 3.4 New project: DP4CES



**DP4CES**  
Design Patterns for Concurrent Embedded Software  
IWT Tetra Proposal

**Problem statement**

Embedded systems  
Hardware constraints  
Moore's Law  
Amdahl's Law  
Active Object

**Literature**

**Goals**

Prof. E. Sheppard  
ISOM  
Prof. Y. Belotti  
DISTINET  
FRTCDI

**Partners**

**Process**

**Proof of concept**

**Industrial Case**

**Project planning**

**User Committee**

01/10/2011 – 30/09/2013 <http://ep.khbo.be/DP4CES> talent@work

- Design patterns
- Concurrent embedded software
- IWT Tetra proposal
- User committee

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## 3.5 TDD4ES: People



**Project leader:**

dr. ing. Jeroen Boydens

[Jeroen.Boydens@khbo.be](mailto:Jeroen.Boydens@khbo.be)

**Project members:**

ing. Piet Cordemans

ing. Sille Van Landschoot

**Scientific partners:**

KATHOLEKE UNIVERSITEIT  
LEUVEN

prof. dr. ir. Eric Steegmans

+ SOM  
research group



prof. dr. ir. Yolande Berbers

+ DISTRINET  
research group



**User committee:**

tesco  
testing your software

[www.tesco.be](http://www.tesco.be)

marelec  
INDUSTRY PARTNER

[www.marelec.com](http://www.marelec.com)

• VAN DE WIELE

[www.vandewiele.com](http://www.vandewiele.com)

sirris

[www.sirris.be](http://www.sirris.be)

E.D.&A.  
TESTING CONSULTANTS

[www.edna.eu](http://www.edna.eu)

DSP  
VALLEY

[www.dspvalley.com](http://www.dspvalley.com)

Summa

[www.summa.be](http://www.summa.be)

televic

Provider of reliable interaction

[www.televic.com](http://www.televic.com)

Newtec

INDUSTRIELE CONTROLE

[www.newtec.eu](http://www.newtec.eu)

FMTc

[www.fmtc.be](http://www.fmtc.be)

Q-STAR

The Correct Test Company

[www.qstar.be](http://www.qstar.be)

UNITRON

GROUP

[www.unitron.be](http://www.unitron.be)

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## 3.6 TDD4ES: Resources



### EP Content Management System (CMS)

<http://ep.khbo.be>



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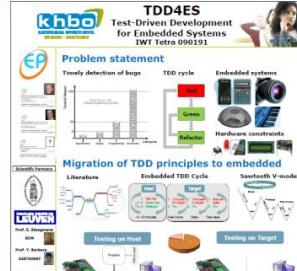
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Test-Driven Development for Embedded Software



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## 4 General contact



dr. ing. Jeroen Boydens

Jeroen.Boydens@khbo.be

Tel. +32 59 569018



The screenshot shows the EP (Erlangen-Nürnberg Programming Research Group) website. It includes sections for research interests (e.g., functional programming, type theory, logic), publications, and a contact form.

### Food for thought:



*"If you want more effective programmers, you will discover that they should not waste their time debugging, they should not introduce the bugs to start with."*

Edsger Dijkstra, The Humble Programmer (1972)



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