Measuring Function Point from Requirements/Design Specification - A Case Study of Joint Work between Osaka University and Hitachi Co.

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Graduate School of Engineering Science, Osaka University
Graduate School of Information Science, Nara Institute of Science and Technology
Japan
Osaka Univ./ NAIST
Osaka University

70 years history
10 schools
900 million $ budget
2500 faculty members
13,000 undergraduate students
7,000 graduate students
3 computer related departments
Osaka Univ. SE Lab

3 faculty members
- Inoue, K. Slicing, Analysis
- Kusumoto, S. Metrics, Measurement
- Matsushita, M. Process, Environment

3 Ph.D. candidates, 13 master students, 5 undergraduate students

50,000$ budget annual
Research Focus of Osaka SE Lab.

Program Analysis and Slicing
- Pascal base slicing system, Java alias analysis system, Combining dynamic and static analysis

Software Metrics and Measurement
- Function point analysis, Object oriented program measurement, Clone detection

Software process and development environment
- Process modeling, Quality assurance framework, Versioning file system
NAIST

9 years history
3 schools
90million $ budget
200 faculty members
1000 graduate students
2 computer science departments
NAIST SE Lab.

4 faculty members
- Inoue, K. (adjunct)
- Matsumoto, K. Usability, Software quality
- Shima, K. Reliability model
- Monden, A Bug analysis, Software watermarking

6 Ph.D. students, 8 master students
60,000 $ budget annual
Research Focus of NAIST SE Lab.

Usability of Computer Systems
- Analysis of human activities (eye, brain wave …), Tracking system on Unix and Windows

Bug Analysis for Large Legacy System
- Bug prediction based on complexity measures

Reliability Modeling
- Multi version software, Reliability growth model
Research Focus of Osaka SE Lab.

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Function point analysis (FPA):

Measures functionality of application software

Issues:

- FPA involves analyzer’s judgment -> instability of analysis results

- High deployment cost to overall organization
Hitachi: Business System Development Division

- Introducing FPA to various software development projects
- An object-oriented requirement analysis system REQUARIO has been used during the requirements analysis phase.
  
  - Use REQUARIO document for FPA
  - Automated analysis
Function Point Analysis

FPA: Specification or design documents

- Data functions
  - Internal and external data requirements
- Transactional Functions
  - Represent the functionality provided to the user for the processing of data by an application
Data Functions

• Internal Logical File (ILF) is...
  - user identifiable group of data.
  - maintained within the application boundary.

• External Interface File (EIF) is...
  - user identifiable group of data.
  - not maintained by the application being counted.

• Each ILF or EIF has a functional complexity based on the number of data element types (DETs) and record element types (RETs).
  - DET is a unique user recognizable, nonrecursive field on the ILF or EIF.
  - RET is a user recognizable subgroup of data elements within an ILF or EIF.
Transactional Functions

- **External input (EI):**
  - Processes data or control information that comes from outside the application's boundary.

- **External output (EO):**
  - An elementary process that generates data or control information sent outside the application's boundary.

- **External inquiry (EQ):**
  - An external inquiry is an elementary process made up of an input-output combination that results in data retrieval.

- Each EI, EO or EQ also has a functional complexity based on the number of file types referenced (FTRs) and data element types (DETs).
  - **FTR is**
    - An internal logical file read or maintained by a function type
    - An external interface file read by a function type.
REQUARIO

• REQUARIO is a CASE tool for visually analyzing requirements developed in Hitachi.

• Features:
  – Use-cases (objects + events) are visually represented.
  – Users can easily develop and review the use-cases.
  – Use-cases are automatically translated into the object, UML use-case and sequence diagrams.
Example of REQUARIO Use-Case
Collaboration Goals

• Hitachi:
  - Obtain a function point measurement tool for REQUARIO
  - Industrial strength tool

• Osaka University:
  - Understand industrial problems
  - Publish papers with background of industrial needs
Overview of collaboration

• Duration:
  – 2 years (June, 1997〜May, 1999)

• Fund from Hitachi to University
  – 20,000 $ / annual

• Staff:
  – Hitachi: 2 engineers (part time).
  – Osaka University: 4 persons (2 students, Inoue, Kusumoto)

• Meeting:
  – Meeting (every two months)
  – Day-by-day communication (via e-mail/phone/fax)
<table>
<thead>
<tr>
<th>Osaka University</th>
<th>Hitachi Ltd.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Explanation</strong></td>
<td>• Explanation</td>
</tr>
<tr>
<td>• Learning</td>
<td>- Software development</td>
</tr>
<tr>
<td>• Proposal of detailed FP measurement rules</td>
<td>- REQUARIO</td>
</tr>
<tr>
<td></td>
<td>- Function Point</td>
</tr>
<tr>
<td>• Revision of the rules</td>
<td>• Application of the rules to small example</td>
</tr>
<tr>
<td>• Design of measurement tool</td>
<td></td>
</tr>
</tbody>
</table>

*Progress (1997.6-1997.12)*
# Progress (1998.1-1999.5)

<table>
<thead>
<tr>
<th>Osaka University</th>
<th>Hitachi Ltd.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development of prototype system.</td>
<td>• Exhibition at ICSE’98 expo in Kyoto.</td>
</tr>
<tr>
<td></td>
<td>• Case study</td>
</tr>
<tr>
<td>• Extension of prototype system.</td>
<td></td>
</tr>
<tr>
<td>• Exhibition at ICSE99 poster&amp;research demo in Los Angeles</td>
<td></td>
</tr>
</tbody>
</table>
Measurement Tool

Developed with Visual C++ on Windows95/98
Program size: about 14000 lines

Function point counting: IFPUG counting manual version 4.0.

[Diagram showing Requirement Specification by REQUARIO leading to Counting Tool, which then outputs Function points, Data functions, and Transactional functions.]
Counting Rules

Internal Logical File

External Input
Example of screen

<table>
<thead>
<tr>
<th>Function type</th>
<th>Complexity</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ILF</td>
<td>1 x 7 = 7</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>0 x 10 = 0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0 x 15 = 0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>EIF</td>
<td>1 x 5 = 5</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>0 x 7 = 0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0 x 10 = 0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>EI</td>
<td>3 x 3 = 9</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>0 x 4 = 0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0 x 6 = 0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>EO</td>
<td>2 x 4 = 8</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>0 x 5 = 0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0 x 7 = 0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>EQ</td>
<td>5 x 3 = 15</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>0 x 4 = 0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0 x 6 = 0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15</td>
</tr>
</tbody>
</table>

Unadjusted function point: 44

Sum of system characteristics: 0

Final adjusted function point: 28.80
### Example of screen

<table>
<thead>
<tr>
<th>Sender character</th>
<th>Receiver character</th>
<th>Relation character</th>
<th>Message</th>
<th>FTR</th>
<th>DET</th>
<th>Function type</th>
<th>Complexity</th>
</tr>
</thead>
<tbody>
<tr>
<td>receptionist</td>
<td>DB of stock shortage</td>
<td>---</td>
<td>registration</td>
<td>1</td>
<td>4</td>
<td>EI</td>
<td>Low</td>
</tr>
<tr>
<td>receptionist</td>
<td>DB of load</td>
<td>---</td>
<td>retrieval</td>
<td>1</td>
<td>1</td>
<td>EI</td>
<td>Low</td>
</tr>
<tr>
<td>receptionist</td>
<td>DB of stock shortage</td>
<td>---</td>
<td>retrieval</td>
<td>1</td>
<td>1</td>
<td>EI</td>
<td>Low</td>
</tr>
<tr>
<td>DB of load</td>
<td>receptionist</td>
<td>---</td>
<td>flag of stock sit.</td>
<td>1</td>
<td>1</td>
<td>EO</td>
<td>Low</td>
</tr>
<tr>
<td>DB of stock shortage</td>
<td>receptionist</td>
<td>---</td>
<td>flag of delivery</td>
<td>1</td>
<td>1</td>
<td>EO</td>
<td>Low</td>
</tr>
<tr>
<td>receptionist</td>
<td>DB of stock shortage</td>
<td>indication for delivery</td>
<td>elimination</td>
<td>1</td>
<td>0</td>
<td>EO</td>
<td>Low</td>
</tr>
<tr>
<td>receptionist</td>
<td>DB of load</td>
<td>indication for delivery</td>
<td>renewal</td>
<td>1</td>
<td>0</td>
<td>EO</td>
<td>Low</td>
</tr>
<tr>
<td>receptionist</td>
<td>DB of stock shortage</td>
<td>indication for delivery</td>
<td>DB of load, DB of stock</td>
<td>making</td>
<td>2</td>
<td>EO</td>
<td>Low</td>
</tr>
<tr>
<td>receptionist</td>
<td>DB of load</td>
<td>indication for delivery</td>
<td>DB of load, DB of stock</td>
<td>making</td>
<td>2</td>
<td>EO</td>
<td>Low</td>
</tr>
<tr>
<td>receptionist</td>
<td>deliveryman</td>
<td>document of stock ..</td>
<td>stock shortage</td>
<td>0</td>
<td>4</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>receptionist</td>
<td>receptionist</td>
<td>---</td>
<td>renewal of stock</td>
<td>0</td>
<td>0</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>receptionist</td>
<td>receptionist</td>
<td>---</td>
<td>renewal of load</td>
<td>0</td>
<td>0</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>receptionist</td>
<td>receptionist</td>
<td>---</td>
<td>making</td>
<td>0</td>
<td>0</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>receptionist</td>
<td>receptionist</td>
<td>---</td>
<td>flag of stock sit.</td>
<td>0</td>
<td>1</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>receptionist</td>
<td>receptionist</td>
<td>---</td>
<td>flag of delivery</td>
<td>0</td>
<td>5</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>receptionist</td>
<td>receptionist</td>
<td>---</td>
<td>registration of ..</td>
<td>0</td>
<td>0</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>receptionist</td>
<td>receptionist</td>
<td>---</td>
<td>document of load</td>
<td>0</td>
<td>0</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>receptionist</td>
<td>warehouseman</td>
<td>indication for delivery</td>
<td>indication for ..</td>
<td>0</td>
<td>0</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>receptionist</td>
<td>receptionist</td>
<td>---</td>
<td>renewal of load</td>
<td>0</td>
<td>0</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>receptionist</td>
<td>receptionist</td>
<td>---</td>
<td>making</td>
<td>0</td>
<td>0</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>receptionist</td>
<td>receptionist</td>
<td>---</td>
<td>flag of stock sit.</td>
<td>0</td>
<td>1</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>receptionist</td>
<td>receptionist</td>
<td>---</td>
<td>flag of delivery</td>
<td>0</td>
<td>1</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>deliveryman</td>
<td>receptionist</td>
<td>request of delivery</td>
<td>request of delivery</td>
<td>0</td>
<td>4</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>
Case study

Applied the tool:

(1) Purchase processing system
(2) Order processing system
(3) Stock control system

We have compared the FP values:

- Function point analysis specialist of Hitachi
- Our tool
Comparison

P : Purchase processing system
O : Order processing system
S : Stock control system

<table>
<thead>
<tr>
<th></th>
<th>Function point analysis specialist</th>
<th>Our tool</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P</td>
<td>O</td>
</tr>
<tr>
<td>Data function</td>
<td>14</td>
<td>29</td>
</tr>
<tr>
<td>Transactional function</td>
<td>18</td>
<td>63</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
<td>92</td>
</tr>
</tbody>
</table>

No significant difference between two analysis results  (specialist counts not described transaction functions)
Results of collaboration

- Research papers
  - International conference: 2
  - Domestic conference: 3
  - Journal paper: 1
  - Master thesis: 1
  - Bachelor thesis: 2

- Exhibited tool at ICSE’98 & ICSE’99
- Hitachi applied for several patents and might integrate the FP tool into REQUARIO.
Lessons learned

• Students were very motivated.
  • find research theme easily.
  • get the information of the actual software development at the company.

• It was useful to train students.
  • required some results based on tight schedule
  • learning several manners

• Papers based on actual data and experience interest industry people
Derived Research Project

Function point measurement for UML
design specification

Collaboration with
Hitachi System Engineering, Ltd.
(subsidiary company of Hitachi)

Applied a government research fund
120,000 $ budget
Collaboration Issues

• Start with small problems
  Do not set ambitious goals at beginning
• Not consulting, equal research partner
  Share ideas and labors
• Do not expect short term success
  Long term relation, Good human relation

• Find publishable theme from university side
  Money is a secondary issue