Measuring the Progress of Projects Using the Time Dependence of Code Changes

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Tracking the Progress of Projects

Managers track projects through:

Manually compiled progress reports
Meetings with developers
Software as a Construction Project

Each change provides structure which other changes can build on
Approach: Establishing Time Dependence Between Changes

```
function f1()
{
    ............
    ............
    ............
    ............
}
```

```
function f2()
{
    variable var1
    ............
    ............
    ............
    ............
}
```

```
function f1()
{
    variable var1
    ............
    call function f2()
    ............
}
```

Time 0  Time 1  Time 2
Approach: Establishing Time Dependence Between Changes
Approach: Establishing Time Dependence Between Changes

C1   C2   C3    C4
C5   C6   C7
C8  C9  C10  C11

Period1

Period2

Period3
Approach: built-on-new, built-on-old and independent changes

<table>
<thead>
<tr>
<th>Built-on-new</th>
<th>Built-on-old</th>
<th>Independent</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1 C2 C3 C4</td>
<td>C5 C6 C7</td>
<td>C8 C9 C10 C11</td>
</tr>
<tr>
<td>Time Dependent</td>
<td>Time Dependent</td>
<td>Time Dependent</td>
</tr>
<tr>
<td>Period 1</td>
<td></td>
<td>Period 3</td>
</tr>
<tr>
<td>Built-on-old</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time Dependent</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Graphical representation with nodes and dependencies.
Categories of Changes

- Built-on-New
  - Bug Fix (BN)
  - Enhancement (EN)

- Independent
  - Bug Fix (BI)
  - Enhancement (EI)

- Built-on-Old
  - Bug Fix (BO)
  - Enhancement (EO)

Bug Fix (B)  Enhancement (E)
Case Study

PostgreSQL

1997-2007

FreeBSD

1994-2005
The average plateaus when moving to periods longer than two quarters
Q1 How does the Time Dependence of Changes Vary?

Just-in-time or Delayed?
Q1: How does the Time Dependence of Changes Vary?

**PostgreSQL**

![Graph showing time dependence of changes for PostgreSQL]

**FreeBSD**

![Graph showing time dependence of changes for FreeBSD]
PostgreSQL

Built-on-New

FreeBSD

Built-on-New
Built-on-Old
Q2: What is the Impact of Independent Changes?

Skyscrapers or Urban Sprawl
Q2: What is the Impact of Independent Changes?
PostgreSQL

FreeBSD
Q3: Is the Distribution of Time Dependence Similar for the Regular Development and Bug Fix Processes?

same floor or different floors?

Construction or Renovation?
Q3: Is the Distribution of Time Dependence Similar for Regular Development and Bug Fix Processes?

<table>
<thead>
<tr>
<th></th>
<th>PostgreSQL</th>
<th>FreeBSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Built-on-New</td>
<td>0.87</td>
<td>0.81</td>
</tr>
<tr>
<td>Built-on-Old</td>
<td>0.90</td>
<td>0.91</td>
</tr>
<tr>
<td>Independent</td>
<td>0.84</td>
<td>0.90</td>
</tr>
</tbody>
</table>

Correlations between bug fix and enhancement changes
Same or Different Floors?

PostgreSQL and FreeBSD
Q4: Is building on new code risky?

Risks of Construction?
Q4: Is Building on Recent Changes Risky?

Correlation is 0.91 for FreeBSD
Q4: Is Building on Recent Changes Risky?

Correlation is 0.65 for PostgreSQL
Is Building on New Code Risky?

Yes

Building on new code is risky
Conclusion

PostgreSQL

Built-on-New

Fewer independent changes

FreeBSD

Built-on-New
Built-on-Old

More independent changes
Conclusion

Regular Development and Bug Fix

On same change periods

Building on New Code

Risky and leads to bugs