Drasil in a Nutshell

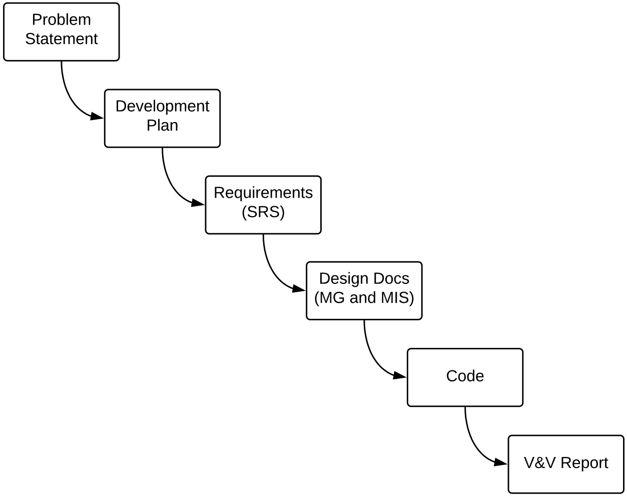
Spencer Smith, Jacques Carette

Computing and Software Department
Faculty of Engineering
McMaster University

Abstract

- **Goal** – Improve quality of $\{$SCS$\}$ (and other well understood software)
- **Idea** – Adapt ideas from SE
- **Document Driven Design**
  - Good – improves quality
  - Bad – “manual” approach is too much work
- **Solution**
  - Capture knowledge
  - Generate all things
  - Avoid duplication
  - Traceability
- **Showing great promise**
  - Significant work yet to do
  - Looking for examples/partners

“Faked” Rational Design Process



SWHS example at https://github.com/smiths/swhs

J_{tol} in SRS.pdf

Refname	**DD:sdf.tol**
Label	J_{tol}
Units	
Equation	$J_{tol} = \log\left(\log\left(\frac{1}{1-P_{btol}}\right)\frac{\left(\frac{a}{1000}\frac{b}{1000}\right)^{m-1}}{k\left((E*1000)\left(\frac{h}{1000}\right)^2\right)^m*LDF}\right)$
Description	J_{tol} is the stress distribution factor (Function) based on Pbtol P_{btol} is the tolerable probability of breakage a is the plate length (long dimension) b is the plate width (short dimension) m is the surface flaw parameter k is the surface flaw parameter E is the modulus of elasticity of glass h is the actual thickness LDF is the load duration factor

J_{tol} in SRS.tex

```
\noindent \begin{minipage}{\textwidth}
\begin{tabular}{p{0.2\textwidth} p{0.73\textwidth}}
\toprule \textbf{Refname} & \textbf{DD:sdf.tol}
\phantomsection
\label{DD:sdf.tol}
\\ \midrule \\
Label & $J_{tol}$
\\ \midrule \\
Units &
\\ \midrule \\
Equation & $J_{tol}$ = $\log\left(\log\left(\frac{1}{1-P_
    {btol}}\right)\frac{\left(\frac{a}{1000}\frac{b
    }{1000}\right)^{m-1}}{k\left(\left(E*1000\right)\left
    (\frac{h}{1000}\right)^{2}\right)^{m}*LDF}\right)$
\\ \midrule \\
Description & $J_{tol}$ is the stress distribution factor
      (Function) based on
               Pbtol\newline$P_{btol}$ is the tolerable
                   probability of breakage ...
\end{minipage}\\
```

J_{tol} in SRS.html

```
<a id="">
<div class="equation">
<em>J<sub>tol</sub></em> = log(log(<div class="fraction">
<span class="fup">
1
</span>
<span class="fdn">
1 &minus; <em>P<sub>btol</sub></em>
</span>
</div>)<div class="fraction">
<span class="fup">
(<div class="fraction">
<span class="fup">
<em>a</em>
</span>
<span class="fdn">
1000
</span>
</div><div class="fraction">
...
```

J_{tol} in Python

```
def calc_j_tol(inparams):
    j_tol = math.log((math.log(1.0 / (1.0 - inparams.
        pbtol))) * ((((inparams.a / 1000.0) * (inparams.b
         / 1000.0)) ** (inparams.m - 1.0)) / ((inparams.k
         * (((inparams.E * 1000.0) * ((inparams.h /
        1000.0) ** 2.0)) ** inparams.m)) * inparams.ldf))
        )
    return j_tol
```

J_{tol} in Java

```
public static double calc_j_tol(InputParameters inparams)
     {
        double j_tol = Math.log((Math.log(1.0 / (1.0 -
            inparams.pbtol))) * ((Math.pow((inparams.a /
            1000.0) * (inparams.b / 1000.0), inparams.m -
             1.0)) / ((inparams.k * (Math.pow((inparams.E
             * 1000.0) * (Math.pow(inparams.h / 1000.0,
            2.0)), inparams.m))) * inparams.ldf)));
        return j_tol;
    }
```

Code with Comments

```python
def func_B(inParams, J):
    # function 'func_B': risk of failure
    # parameter 'inParams':
    # parameter 'J': stress distribution factor (Function)

    return ((((2.86 * (10 ** (-(53)))) / ((inParams.a * inParams.b) **
      (7 - 1))) * ((((7.17 * (10 ** 7)) * 1000) *
      (inParams.h ** 2)) ** 7)) * ((3 / 60) ** (7 / 16))) *
      (math.exp(J))
```

Code with Logging

```
def func_B(inParams, J):
    # function 'func_B': risk of failure
    # parameter 'inParams':
    # parameter 'J': stress distribution factor (Function)

    outfile = open("log.txt", "w")
    print("function func_B(", end='', file=outfile)
    print(inParams, end='', file=outfile)
    print(", ", end='', file=outfile)
    print(J, end='', file=outfile)
    print(") called", file=outfile)
    outfile.close()

    return ((((2.86 * (10 ** (-(53)))) / ((inParams.a * inParams.b) **
      (7 - 1))) * ((((7.17 * (10 ** 7)) * 1000) *
      (inParams.h ** 2)) ** 7)) * ((3 / 60) ** (7 / 16))) *
      (math.exp(J))
```

J_{tol} in Drasil (Haskell)

```
tolStrDisFac_eq :: Expr
tolStrDisFac_eq = ln (ln (1 / (1 - (sy pb_tol)))
  * (((((sy plate_len)/1000.0) * ((sy plate_width)
     /1000.0)) $^ (sy sflawParamM - 1) /
    ((sy sflawParamK) * (((sy mod_elas * 1000.0) *
    (square ((sy min_thick)/1000.0))))) $^ (sy
       sflawParamM) * (sy lDurFac)))))
```

J_{tol} without Unit Conversion

```
tolStrDisFac_eq :: Expr
tolStrDisFac_eq = ln (ln (1 / (1 - (sy pb_tol)))
  * ((((sy plate_len) * (sy plate_width)) $^ (sy
      sflawParamM - 1) /
    ((sy sflawParamK) * ((sy mod_elas *
    (square (sy min_thick)))) $^ (sy sflawParamM) * (sy
        lDurFac)))))
```

Complete and Consistent

Symbol	Description	Units
A_C	Heating coil surface area	m^2
A_{in}	Surface area over which heat is transferred in	m^2
A_{out}	Surface area over which heat is transferred out	m^2
A_P	Phase change material surface area	m^2
C	Specific heat capacity	J/(kg·°C)
C^L	Specific heat capacity of a liquid	J/(kg·°C)
C^S	Specific heat capacity of a solid	J/(kg·°C)
C^V	Specific heat capacity of a vapour	J/(kg·°C)
C_W	Specific heat capacity of water	J/(kg·°C)
$C_P{}^L$	Specific heat capacity of PCM as a liquid	J/(kg·°C)
$C_P{}^S$	Specific heat capacity of PCM as a solid	J/(kg·°C)
D	Diameter of tank	m
E	Sensible heat	J
E_P	Change in heat energy in the PCM	J
E_W	Change in heat energy in the water	J
[illegible]	[illegible]	[illegible]

Complete and Consistent Cont'd

Assumptions

This section simplifies the original problem and helps in developing the theoretical model by filling in the missing information for the physical system. The numbers given in the square brackets refer to the Theoretical Models Section: Theoretical Models, General Definitions Section: General Definitions, Data Definitions Section: Data Definitions, Instance Models Section: Instance Models, Likely Changes Section: Likely Changes, or Unlikely Changes Section: Unlikely Changes, in which the respective assumption is used.

Thermal-Energy-Only: The only form of energy that is relevant for this problem is thermal energy. All other forms of energy, such as mechanical energy, are assumed to be negligible. TM: consThermE.

Heat-Transfer-Coeffs-Constant: All heat transfer coefficients are constant over time. GD: nwtnCooling.

Constant-Water-Temp-Across-Tank: The water in the tank is fully mixed, so the temperature of the water is the same throughout the entire tank. GD: rocTempSimp DD: ht_flux_P.

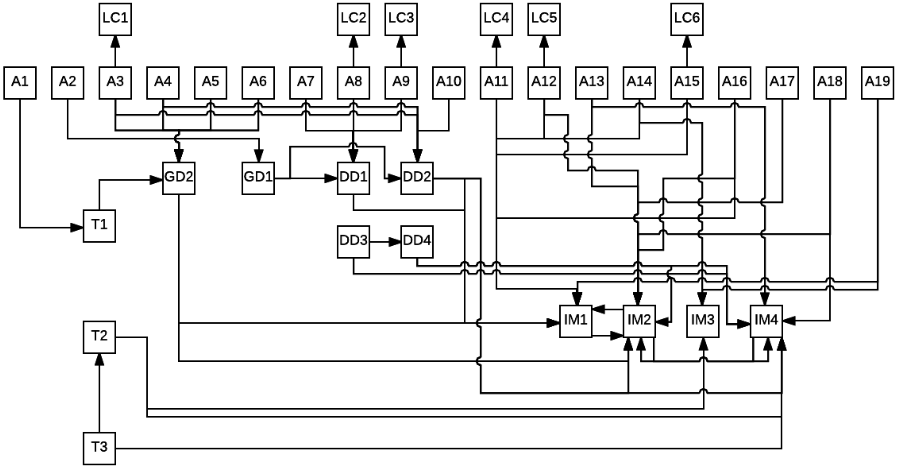
Temp-PCM-Constant-Across-Volume: The temperature of the phase change material is the same throughout the volume of PCM. GD: rocTempSimp LC: Uniform-Temperature-PCM DD: ht_flux_P.

Density-Water-PCM-Constant-over-Volume: The density of water and density of PCM have no spatial variation; that is, they are each constant over their entire volume. GD: rocTempSimp.

Specific-Heat-Energy-Constant-over-Volume: The specific heat capacity of water, specific heat capacity of PCM as a solid, and specific heat capacity of PCM as a liquid have no spatial variation; that is, they are each constant over their entire volume. GD: rocTempSimp.

Newton-Law-Convective-Cooling-Coil-Water: Newton's law of convective cooling applies between the heating coil and the water. DD: ht_flux_C.

Traceability Graph


LC1
LC2
LC3
LC4
LC5
LC6
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A11
A12
A13
A14
A15
A16
A17
A18
A19
GD2
GD1
DD1
DD2
T1
DD3
DD4
IM1
IM2
IM3
IM4
T2
T3