APPENDIX D
IMPLEMENTATION MODEL CODE

D.1 Scenario 1 Model Code

```
"total base workstation 1 cost (cBC1)"=
        "base workstations 1 (BW1)"*"cost per workstation 1 (cpW1)"
        ~       $
        ~       Total workstation cost base simulation.
        |

cost per base data set 4=
        "total base 1 cost (tBc1)"/"Base Data 1 (BD1)"
        ~
        ~               |

"cost per contractor 1 (cpC1)"=
        14000
        ~       $/Month
        ~       Monthly contractor cost.  This cost includes personnel and all realted \
                overhead.
        |

"cost per data set 1 (cD1)"=
        "total optimized 1 cost (tc1)"/"Data 1 (D1)"
        ~
        ~               |

"cost per employee 1 (cpE1)"=
        8000
        ~       $/Month
        ~       Monthly cost to sustan in-house employees.
        |

"cost per workstation 1 (cpW1)"=
        2000
        ~       $/Month
        ~       Monthly cost for the production workstations and supporting
infrastructure.
        |

"total base contractor 1cost (cBC1)"=
        "base contractors 1 (BC1)"*"cost per contractor 1 (cpC1)"
        ~       $
        ~       Total contractor cost base simulation.
        |
```

"total base employee 1 cost (cBC1)"=
	"base employees 1 (BE1)"*"cost per employee 1 (cpE1)"
	~	$
	~	Total cost of employee base simulation.
	|

"total workstation 1 cost (cW1)"=
	"cost per workstation 1 (cpW1)"*"Workstations 1 (W1)"
	~	$
	~	Total workstation monthly cost for optimized simulation.
	|

"total contractor 1cost (cC1)"=
	"Contractors 1(C1)"*"cost per contractor 1 (cpC1)"
	~	$
	~	Total cotractor cost of optimized model simulation.
	|

"total employee 1 cost (cE1)"=
	"cost per employee 1 (cpE1)"*"Employees 1 (E1)"
	~	$
	~	Total employee coat of optimized simulation.
	|

"total optimized 1 cost (tc1)"=
	"total contractor 1cost (cC1)"+"total employee 1 cost (cE1)"+"total workstation 1 cost (cW1)"
	~	$
	~	Total optimized cost.
	|

"technical efficiency 1 (TE1)"=
	"total base 1 cost (tBc1)"/"total optimized 1 cost (tc1)"
	~	dmnl
	~	TE
	|

"total base 1 cost (tBc1)"=
	"total base contractor 1cost (cBC1)"+"total base employee 1 cost (cBC1)"+"total base workstation 1 cost (cBC1)"
	~	$
	~	Total cost of base simulation.
	|

"improvement factor (if1)"=

```
        1-"technical efficiency 1 (TE1)"
        ~
        ~               |

"Aged Base Data 1 (AD1)"= INTEG (
        "base data 1 decomposition rate a (BDR1a)"+"base data 1 decomposition rate b
(BDR1b)"\
                +"base data 1 decomposition rate c (BDR1c)",
                0)
        ~       cells
        ~               |

"base contractors 1 (BC1)"=
        IF THEN ELSE("data 1 production requirement (DPN1)"=0 , 0 ,519 )
        ~       contractors
        ~               |

"Base Data 1 (BD1)"= INTEG (
        "base data 1 production rate (BDPR1)"-"base data 1 decomposition rate a
(BDR1a)"-"base data 1 decomposition rate b (BDR1b)"\
                -"base data 1 decomposition rate c (BDR1c)",
                1)
        ~       cells
        ~               |

"base data 1 decomposition rate a (BDR1a)"=
        STEP(0.02*"Base Data 1 (BD1)", 12 )
        ~       cells/Month
        ~       BDDR1a shows the decomposition rate for data that requires maintenance
\
                after 12 months.  25% of the BD1 decomposes at 12 month rate.  (.02 is \
                derived from .25 percent decomposition / 12 months)
        |

"base data 1 decomposition rate b (BDR1b)"=
        STEP( 0.02*"Base Data 1 (BD1)" , 24 )
        ~       cells/Month
        ~       BDDR1b shows the decomposition rate for data that requires maintenance
\
                after 24 months.  50% of the BD1 decomposes at 24 month rate.
        |

"base data 1 decomposition rate c (BDR1c)"=
        STEP(0.0052*"Base Data 1 (BD1)", 48)
        ~       cells/Month
```

~ BDDR1c shows the decomposition rate for data that requires maintenance \
after 48 months. 25% of the BD1 decomposes at 48 month rate.
|

"base data 1 production employees (BEP1)"=
IF THEN ELSE("data 1 production requirement (DPN1)" = 0,0 , "base employees 1 (BE1)"
)
~ employees
~ |

"base data 1 production rate (BDPR1)"=
("data 1 production standard (PS1)"*"base data 1 production employees (BEP1)"^"employee 1 production exponent (eep1)"\
)*
("base data 1 production workstations (BWP1)"^"workstation 1 production exponent (ewp1)"\
)+"contractors 1 production standard (CPS1)"
*"base contractors 1 (BC1)"
~
~ |

"base data 1 production workstations (BWP1)"=
IF THEN ELSE("data 1 production requirement (DPN1)" = 0,0 , "base workstations 1 (BW1)"
)
~ workstations
~ |

"base employees 1 (BE1)"=
778
~ employees
~ |

"base workstations 1 (BW1)"=
778
~ workstations
~ |

"change in contractors 1(dC1)"=
("desired contractors data 1 (C1*)"-"Contractors 1(C1)")/"contractor 1 adjustment time (Cat1)"
~ contractors/Month
~ This variable is used as part of the hill-climbing optimization struture \
to adjust the level being optimized.

|

"data 1 production rate (DPR1)"=
"data 1 production standard (PS1)"*("data 1 production employees (EP1)"^"employee 1 production exponent (eep1)"\
)*"data 1 production workstations (WP1)"
^"workstation 1 production exponent (ewp1)"+"data 1 production contractors (CP1)" *"contractors 1 production standard (CPS1)"
~ cells/Month
~ Data production rate is the amount of new cells produced during each \ period. These cells are completed by both in-house employees and \ contractor support.
|

"data 1 production contractors (CP1)"=
IF THEN ELSE("data 1 production requirement (DPN1)"=0 , 0 ,"Contractors 1(C1)")
~
~ |

"data 1 production function (Dp1)"=
"data 1 theoritical production (DTP1)"+"data 1 theoritical maintenance value (DTM1)"
~ cells
~ This variable is used to describe the production activities and their \ relationship with the level variable being optimized.
|

"data 1 theoritical production (DTP1)"=
"data 1 production rate (DPR1)"
~
~ |

"data 1 theoritical maintenance value (DTM1)"=
IF THEN ELSE("data 1 production rate (DPR1)"<1,"data 1 maintenance standard (MS1)"*(\
"Employees 1 (E1)"^"employee 1 production exponent (eep1)")*("Workstations 1 (W1)"^\
"workstation 1 production exponent (ewp1)") , "data type 1 maintenance rate (DMR1)"\
)
~
~ |

"desired workstations 1 (W1*)"=
"Workstations 1 (W1)"*"relative production (Dp1*/Dp1)"

~ workstations
~ This variable is an artifact required by the hill-climbing optimization \
algorithm. It is used to search for theworkstations optimal level.
|

"change in workstations 1 (dW1)"=
("desired workstations 1 (W1*)"-"Workstations 1 (W1)")/"workstation 1 adjustment time (Wat1)"
~ workstations/Month
~ This variable is used as part of the hill-climbing optimization struture \
to adjust the level being optimized.
|

"Data 1 Maintenance Queue (DM1)"= INTEG (
("data 1 decomposition rate a (DDR1a)"+"data 1 decomposition rate b (DDR1b)"+"data 1 decomposition rate c (DDR1c)"\
-"data type 1 maintenance rate (DMR1)"
),
0)
~ cells
~ Data maintenance queue shows the amount of data that has significantly \
aged to require maintenance to be useful.
|

"Data 1 (D1)"= INTEG (
"data 1 production rate (DPR1)"+"data type 1 maintenance rate (DMR1)"-"data 1 decomposition rate a (DDR1a)"\
-"data 1 decomposition rate b (DDR1b)"
-"data 1 decomposition rate c (DDR1c)",
1)
~ cells
~ Data 1 reflects the number of "good" cells af data available. It is the \
sum of the data production rate and the data maintenance rate, minus the \
data decomposition rates.
|

"data 1 production workstations (WP1)"=
IF THEN ELSE("data 1 production requirement (DPN1)"=0 ,0 ,"Workstations 1 (W1)"-"data 1 maintenance workstations (WM1)"
)
~ workstations
~ This variable is used to calculate how many workstations are avialble for \
production once the data maintenance function has been satisfied.
|

"data 1 maintenance employees (EM1)"=

IF THEN ELSE("Data 1 Maintenance Queue (DM1)">1, MIN(("Data 1 Maintenance Queue (DM1)"\
/"data 1 maintenance standard (MS1)"
), "Employees 1 (E1)"), 0)
~ employees
~ Provides the number of employees required to perform the data maintenance \
function. If DM1>1, then employees will be assigned to data maintenance \
as this function has priority over production. EXPLAINTAION OF UNITS: \
DM1/MS1 = cells/1/cells/month = months. It is implied that the equation \
is multipled by 1 employee/month and an equalizer to provied the unit of \
employees.
|

"workstation 1 adjustment time (Wat1)"=
6
~ Month
~ The adjustment time variable is the time that it would take to place the \
varibale in a state of equilibrium at its present rate of change.
|

"data 1 maintenance workstations (WM1)"=
IF THEN ELSE("Data 1 Maintenance Queue (DM1)">1, MIN(("Data 1 Maintenance Queue (DM1)"
/"data 1 maintenance standard (MS1)")
,"Workstations 1 (W1)") , 0)
~ workstations
~ Maintenance workstations reflects the total number of workstations used to \
perform data maintenance. EXPLAINTAION OF UNITS: DM1/MS1 = \
cells/1/cells/month = months. It is implied that the equation is \
multipled by 1 workstation/month and an equalizer to provied the unit of \
workstations.
|

"Workstations 1 (W1)"= INTEG (
"change in workstations 1 (dW1)",
"Employees 1 (E1)")
~ workstations
~ The optimal number of workstations. When workstation exponent = employee \
exponent, Workstations = Employees.
|

"data type 1 maintenance rate (DMR1)"=
("data 1 maintenance employees (EM1)"^"employee 1 production exponent (eep1)")*("data 1 maintenance workstations (WM1)"\
^"workstation 1 production exponent (ewp1)"
)*("data 1 maintenance standard (MS1)"
)
~ cells/Month
~ Data maintenance rate is the rate at which cells in the data maintenance \ queue are maintained. For data 1, maintaining the aged cells is the top \ priority for the in-house employees.
|

"data 1 production employees (EP1)"=
IF THEN ELSE("data 1 production requirement (DPN1)"=0 ,0 ,"Employees 1 (E1)"-"data 1 maintenance employees (EM1)"\
)
~ employees
~ This variable is used to calculate how many employees are avialble for \ production once the data maintenance function has been satisfied.
|

"relative production (Dp1*/Dp1)"=
"data 1 production goal (Dp1*)"/"data 1 production function (Dp1)"
~ dmnl
~ Artificial variable used to show the ratio of number of cells required \ versus the number of cells being produced.
|

"desired employees 1 (E1*)"=
"Employees 1 (E1)"*"relative production (Dp1*/Dp1)"
~ employees
~ This variable is an artifact required by the hill-climbing optimization \ algorithm. It is used to search for the employee optimal level.
|

"desired contractors data 1 (C1*)"=
"Contractors 1(C1)"*"relative new production DPN1/DPR1"
~ contractors
~ This variable is an artifact required by the hill-climbing optimization \ algorithm. It is used to search for the contractor optimal level.
|

"relative new production DPN1/DPR1"=
IF THEN ELSE("data 1 production rate (DPR1)"<1 , 0 ,"data 1 production requirement (DPN1)"\
/"data 1 production rate (DPR1)")

~ dmnl
~ Artificial variable used to show the ratio of number of cells required \
versus the number of cells being produced.
|

"Contractors 1(C1)"= INTEG (
("change in contractors 1(dC1)"),
20)
~ contractors
~ Contractors is the number of optimal number or contractors required to \
augment in-house employees.
|

"data 1 production requirement (DPN1)"=
IF THEN ELSE("data 1 population requirement (DR1)">=100, 100 ,"data 1 population requirement (DR1)"\
)
~ cells
~ The production requirement sets the number of new celsl to be produced \
during a given time period.
|

"contractor 1 adjustment time (Cat1)"=
2
~ per month
~ The adjustment time variable is the time that it would take to place the \
varibale in a state of equilibrium at its present rate of change.
|

"contractors 1 production standard (CPS1)"=
0.07273
~ cells/Month
~ The contractor weight heps determing what the contractor contribution to \
production is. CPS1 = 2,200 hours/cell, thus .07273 cells/month
|

"data 1 population requirement (DR1)"=
MAX(12000-"Data 1 (D1)"-"Data 1 Maintenance Queue (DM1)", 0)
~ cells
~ The population requirement calculates and reports the number of remaining \
cells to be completed. It also sets the lower bound of "0" when all of \
the new cells are completed.
|

"employee 1 adjustment time (Eat1)"=

4
~ per month
~ The adjustment time variable is the time that it would take to place the \
varibale in a state of equilibrium at its present rate of change.
|

"data 1 maintenance required (DMR1)"=
"Data 1 Maintenance Queue (DM1)"
~ cells
~ The data maintenance requirement shows the number of cells that must be \
maintained during a given time period.
|

"data 1 production goal (Dp1*)"=
"data 1 production requirement (DPN1)"+"data 1 maintenance required (DMR1)"
~ cells
~ The production goal reflects the total peroduction requirement new cells + \
maintained cells per unit time.
|

"employee 1 production exponent (eep1)"=
0.5
~ dmnl
~ The employee exponent shows the contribution of the workstation to \
production. When production/maintenance depends on an equal \
employee-to-workstation interaction, this variable will have a value of 5. \
When the employee plays a less important role than the workstation (e.g. \
automated change detection, automated feature extraction) the workstation \
exponent > employee exponent.
|

"workstation 1 production exponent (ewp1)"=
0.5
~ dmnl
~ The workstation exponent shows the contribution of the workstation to \
production. When production/maintenance depends on an equal \
employee-to-workstation interaction, this variable will have a value of 5. \
Whe the workstation plays a more important role (e.g. automated change \
detection, automated feature extraction) the workstation exponent > \
employee exponent.
|

"change in employees 1 (dE1)"=

("desired employees 1 (E1*)"-"Employees 1 (E1)")/"employee 1 adjustment time (Eat1)"
~ employees/Month
~ This variable is used as part of the hill-climbing optimization struture \
to adjust the level being optimized.
|

"data 1 maintenance standard (MS1)"=
RANDOM NORMAL(0.133 , 0.229 , 0.16 , 0.03 , 0)
~ months
~ Data maintenance standard is the amount of time (in months) that it takes \
to maintan a cell of data. This is a normally distributed random \
variable.Max= 700 hrs/cell= .229 cells.month; Min=1,200 hrs/cell = .133 \
cells/month; Mean= 1,000 hrs/cell=.16 cells/month.
|

"data 1 production standard (PS1)"=
RANDOM NORMAL(0.067 ,0.089 ,0.08 ,0.005 ,0)
~ cells/Month
~ The production standard shows how many cells can be completes per month by \
one employee. Max =1,800 hrs/cell = .089 cells/month/employee; Min=2,400 \
hrs/cell =.067 cells/month; Mean= 2,000 hrs/cell = .08 cells /month
|

"Employees 1 (E1)"= INTEG (
"change in employees 1 (dE1)",
30)
~ employees
~ Employees is the number of optimal in-house employees requred to perform \
the given tasks.
|

"data 1 decomposition rate a (DDR1a)"=
STEP(0.02*"Data 1 (D1)", 12)
~ cells/Month
~ DDR1a shows the decomposition rate for data that requires maintenance \
after 12 months. 25% of the D1 decomposes at 12 month rate. (.02 is \
derived from .25 percent decomposition / 12 months)
|

"data 1 decomposition rate b (DDR1b)"=
STEP(0.02*"Data 1 (D1)" , 24)
~ cells/Month

```
        ~       DDR1b shows the decomposition rate for data that requires maintenance \
                after 24 months.  50% of the D1 decomposes at 24 month rate.
        |

"data 1 decomposition rate c (DDR1c)"=
        STEP(0.0052*"Data 1 (D1)", 48)
        ~       cells/Month
        ~       DDR1c shows the decomposition rate for data that requires maintenance \
                after 48 months.  25% of the DC1 decomposes at 48 month rate.
        |

********************************************************
        .Control
********************************************************~
                Simulation Control Parameters
        |

FINAL TIME  = 600
        ~       Month
        ~       The final time for the simulation.
        |

INITIAL TIME  = 0
        ~       Month
        ~       The initial time for the simulation.
        |

SAVEPER  = 1
        ~       Month
        ~       The frequency with which output is stored.
        |

TIME STEP  = 1
        ~       Month
        ~       The time step for the simulation.
        |
```

D.2 Scenario 2 Model Code

"Aged Base Data 2 (AD2)"= INTEG (
"base data 2 decomposition rate a (BDR2a)"+"base data 2 decomposition rate b (BDR2b)"\
,
0)
~ cells
~ |

"Base Data 2 (BD2)"= INTEG (
"base data 2 production rate (BDPR2)"-"base data 2 decomposition rate a (BDR2a)"-"base data 2 decomposition rate b (BDR2b)"
,
1)
~ cells
~ |

"cost per contractor 2 (cpC2)"=
14000
~ $/Month
~ Monthly contractor cost. This cost includes personnel and all realted \
overhead.
|

"base contractors 2 (BC2)"=
IF THEN ELSE("data 2 production requirement (DPN2)"=0 , 0 ,201.51)
~ contractors
~ |

"cost per employee 2 (cpE2)"=
8000
~ $/Month
~ Monthly cost to sustan in-house employees.
|

"cost per workstation 2 (cpW2)"=
2000
~ $/Month
~ Monthly cost for the production workstations and supporting infrastructure.
|

"total optimized 2 cost (tc2)"=
"total contractor 2 cost (cC2)"+"total employee 2 cost (cE2)"+"total workstation 2 cost (cW2)"
~ $

~ Total optimized cost.
|

"total workstation 2 cost (cW2)"=
"cost per workstation 2 (cpW2)"*"Workstations 2 (W2)"
~ $
~ Total workstation monthly cost for optimized simulation.
|

"base data 2 production employees (BEP2)"=
IF THEN ELSE("data 2 production requirement (DPN2)" = 0,"data 2 special employees (SE2)"\
, "base employees 2 (BE2)"-"data 2 special employees (SE2)"
)
~ employees
~ |

"base data 2 production rate (BDPR2)"=
"data 2 production standard (PS2)"*"base data 2 production employees (BEP2)"^"employee 2 production exponent (eep2)"\
*"base data 2 production workstations (BWP2)"^"workstation 2 production exponent (ewp2)"\
+"contractor 2 production standard (CPS2)"*"base contractors 2 (BC2)"
~
~ |

"base data 2 production workstations (BWP2)"=
IF THEN ELSE("data 2 production requirement (DPN2)" = 0,"data 2 special workstations (SW2)"\
, "base workstations 2 (BW2)"
-"data 2 special workstations (SW2)")
~ workstations
~ |

"total base employee 2 cost (cBC2)"=
"base employees 2 (BE2)"*"cost per employee 2 (cpE2)"
~ $
~ Total cost of employee base simulation.
|

"total base workstation 2 cost (cBW2)"=
"base workstations 2 (BW2)"*"cost per workstation 2 (cpW2)"
~ $
~ Total workstation cost base simulation.
|

"total contractor 2 cost (cC2)"=
	"Contractors 2 (C2)"*"cost per contractor 2 (cpC2)"
	~	$
	~	Total cotractor cost of optimized model simulation.
	|

"total employee 2 cost (cE2)"=
	"cost per employee 2 (cpE2)"*"Employees 2 (E2)"
	~	$
	~	Total employee coat of optimized simulation.
	|

"improvement factor (if2)"=
	1-"technical efficiency 2 (TE2)"
	~
	~		|

"cost per base data set 2 (cBD2)"=
	"total base 2 cost (tBc2)"/"Base Data 2 (BD2)"
	~
	~		|

"total base contractor 2 cost (cBC2)"=
	"base contractors 2 (BC2)"*"cost per contractor 2 (cpC2)"
	~	$
	~	Total contractor cost base simulation.
	|

"technical efficiency 2 (TE2)"=
	"total base 2 cost (tBc2)"/"total optimized 2 cost (tc2)"
	~	dmnl
	~	TE
	|

"total base 2 cost (tBc2)"=
	"total base contractor 2 cost (cBC2)"+"total base employee 2 cost (cBC2)"+"total base workstation 2 cost (cBW2)"
	~	$
	~	Total cost of base simulation.
	|

"cost per data set 2 (cD2)"=
	"total optimized 2 cost (tc2)"/"Data 2 (D2)"
	~
	~		|

"base data 2 decomposition rate a (BDR2a)"=
STEP(0.0417*"Base Data 2 (BD2)", 12)
~ cells/Month
~ BDDR2a shows the decomposition rate for data that requires maintenance \
after 12 months. 50% of the BD2 decomposes at 12 month rate. 50% of the \
BD2 decomposes at 12 month rate. (.0417 is derived from 50% percent \
decomposition / 12 months.
|

"base data 2 decomposition rate b (BDR2b)"=
STEP(0.0208*"Base Data 2 (BD2)" , 24)
~ cells/Month
~ BDDR2b shows the decomposition rate for data that requires maintenance \
after 60 months. 50% of the BD2 decomposes at 24 month rate. 50% of the \
BD2 decomposes at 12 month rate. (.0417 is derived from 50% percent \
decomposition / 12 months.
|

"base employees 2 (BE2)"=
202
~ employees
~ |

"base workstations 2 (BW2)"=
202
~ workstations
~ |

"data 2 production contractors (CP2)"=
IF THEN ELSE("data 2 production requirement (DPN2)"=0,0,"Contractors 2 (C2)")
~
~ |

"desired contractors data 2 (C2*)"=
"Contractors 2 (C2)"*"relative contractor 2 production (RCP2)"
~
~ |

"data 2 production function (Dp2)"=
"data 2 theoretical production rate (DTP2)"+"data 2 theoretical maintenance rate (DTM2)"\

+"data 2 theoretical special rate (DTS2)"
~ cells
~ This variable is used to describe the production activities and their \
relationship with the level variable being optimized.
|

"data 2 theoretical maintenance rate (DTM2)"=
IF THEN ELSE("data 2 production rate (DPR2)"=0 ,"data 2 maintenance standard (MS2)"*\
("Employees 2 (E2)"^"employee 2 exponent (eem2)"
)*("Workstations 2 (W2)"^"maintenance workstation 2 exponent (ewm2)")+"contractor 2 maintenaince standard (CMS2)"\
*"data 2 maintenance contractors (CM2)" , "data type 2 maintenance rate (DMR2)")
~
~ |

"data 2 theoretical production rate (DTP2)"=
"data 2 production rate (DPR2)"
~
~ |

"data 2 theoretical special rate (DTS2)"=
"special data 2 production rate (SPR2)"
~
~ |

"data 2 production rate (DPR2)"=
"data 2 production standard (PS2)"*("data 2 production employees (EP2)"^"employee 2 production exponent (eep2)"\
)*"data 2 production workstations (WP2)"
^"workstation 2 production exponent (ewp2)"+"data 2 production contractors (CP2)"*"contractor 2 production standard (CPS2)"
~ cells/Month
~ Data production rate is the amount of new cells produced during each \
period. These cells are completed by both in-house employees and \
contractor support.
|

"data 2 maintenance contractors (CM2)"=
IF THEN ELSE("data 2 population requirement (DN2)"<100 , "Contractors 2 (C2)"-("data 2 population requirement (DN2)"\
/"contractor 2 production standard (CPS2)") ,0)
~
~ Provides the number of contractors required to perform the data \
maintenance function. If DN2=0, then contractors will be reassigned to \

data maintenance function. EXPLAINTION OF UNITS: DM1/MS1 = \
cells/1/cells/month = months. It is implied that the equation is \
multipled by 1 employee/month and an equalizer to provied the unit of \
employees.
|

"relative contractor 2 production (RCP2)"=
IF THEN ELSE("data 2 production requirement (DPN2)">0 ,"data 2 production requirement (DPN2)"\
/"data 2 theoretical production rate (DTP2)", "data 2 maintenance required (DMN2)"/\
"data 2 theoretical maintenance rate (DTM2)")
~
~ |

"contractor 2 maintenaince standard (CMS2)"=
0.32
~ cells/Month
~ CMS2=500 hours/cell, thus .32 cells/month/contractor can be maintained.
|

"contractor 2 production standard (CPS2)"=
0.2133
~ cells/Month
~ CPS2 = 750 hours/cell, thus .2133 cells/month/employee are produced
|

"change in contractors 2 (dC2)"=
("desired contractors data 2 (C2*)"-"Contractors 2 (C2)")/"contractor 2 adjustment time (Cat2)"
~
~ |

"Contractors 2 (C2)"= INTEG (
"change in contractors 2 (dC2)",
50)
~ contractors
~ Contractors is the number of optimal number or contractors required to \
augment in-house employees.
|

"contractor 2 adjustment time (Cat2)"=
2
~
~ |

"data type 2 maintenance rate (DMR2)"=
("data 2 maintenance employees (EM2)"^"employee 2 exponent (eem2)")*("data 2 maintenance workstations (WM2)"\
^"maintenance workstation 2 exponent (ewm2)"
)*("data 2 maintenance standard (MS2)"
)+"data 2 maintenance contractors (CM2)"*"contractor 2 maintenaince standard (CMS2)"
~ cells/Month
~ Data maintenance rate is the rate at which cells in the data maintenance \
queue are maintained. For data 3, maintaining the aged cells is the top \
priority for the in-house employees.
|

"Data 2 (D2)"= INTEG (
"data 2 production rate (DPR2)"+"data type 2 maintenance rate (DMR2)"-"data 2 decomposition rate a (DDR2a)"\
-"data 2 decomposition rate b (DDR2b)",
1)
~ cells
~ Data 3 reflects the number of "good" cells af data available. It is the \
sum of the data production rate and the data maintenance rate, minus the \
data decomposition rates.
|

"Data 2 Maintenance Queue (DM2)"= INTEG (
"data 2 decomposition rate a (DDR2a)"+"data 2 decomposition rate b (DDR2b)"-"data type 2 maintenance rate (DMR2)"\
,
0)
~ cells
~ Data maintenance queue shows the amount of data that has significantly \
aged to require maintenance to be useful.
|

"data 2 decomposition rate a (DDR2a)"=
STEP(0.0417*"Data 2 (D2)" , 12)
~ cells/Month
~ DDR2a shows the decomposition rate for data that requires maintenance \
after 12 months. 50% of the D2 decomposes at 12 month rate. 50% of the \
D2 decomposes at 12 month rate. (.0417 is derived from 50% percent \
decomposition / 12 months.
|

"data 2 maintenance employees (EM2)"=

IF THEN ELSE("Data 2 Maintenance Queue (DM2)">0, MIN(("Data 2 Maintenance Queue (DM2)"\
/"data 2 maintenance standard (MS2)"
) , "Employees 2 (E2)"-"data 2 special employees (SE2)"), 0)
~ employees
~ Provides the number of employees required to perform the data maintenance \
function. If DM1>1, then employees will be assigned to data maintenance \
as this function has priority over production. EXPLAINTION OF UNITS: \
DM1/MS1 = cells/1/cells/month = months. It is implied that the equation \
is multipled by 1 employee/month and an equalizer to provied the unit of \
employees.
|

"data 2 maintenance workstations (WM2)"=
IF THEN ELSE("Data 2 Maintenance Queue (DM2)">0, MIN(("Data 2 Maintenance Queue (DM2)"\
/"data 2 maintenance standard (MS2)"
) , "Workstations 2 (W2)"-"data 2 special workstations (SW2)"), 0)
~ workstations
~ Maintenance workstations reflects the total number of workstations used to \
perform data maintenance. EXPLAINTION OF UNITS: DM1/MS1 = \
cells/1/cells/month = months. It is implied that the equation is \
multipled by 1 workstation/month and an equalizer to provied the unit of \
workstations.
|

"employee 2 production exponent (eep2)"=
0.5
~
~ |

"data 2 special workstations (SW2)"=
"Special Data 2 Requirement (SN2)"/"special data 2 production standard (SPS2)"
~
~ |

"data 2 production employees (EP2)"=
IF THEN ELSE("data 2 production requirement (DPN2)"=0,0, "Employees 2 (E2)"-"data 2 maintenance employees (EM2)"\
-"data 2 special employees (SE2)")
~ employees
~ This variable is used to calculate how many employees are avialble for \

production once the data maintenance function has been satisfied.
|

"data 2 production goal (Dp2*)"=
"data 2 production requirement (DPN2)"+"data 2 maintenance required (DMN2)"+"Special Data 2 Requirement (SN2)"
~ cells
~ The production goal reflects the total peroduction requirement new cells + \
maintained cells per unit time.
|

"data 2 special employees (SE2)"=
"Special Data 2 Requirement (SN2)"/"special data 2 production standard (SPS2)"
~
~ |

"relative production (Dp2*/Dp2)"=
"data 2 production goal (Dp2*)"/"data 2 production function (Dp2)"
~ dmnl
~ Artificial variable used to show the ratio of number of cells required \
versus the number of cells being produced.
|

"special data 2 production rate (SPR2)"=
("data 2 special employees (SE2)"^"employee 2 special exponent (ees2)")*("data 2 special workstations (SW2)"\
^"workstation 3 special exponent (ews2)")*"special data 2 production standard (SPS2)"
~
~ |

"employee 2 special exponent (ees2)"=
0.3
~
~ |

"data 2 production workstations (WP2)"=
IF THEN ELSE("data 2 production requirement (DPN2)"=0,0 ,"Workstations 2 (W2)"-"data 2 maintenance workstations (WM2)"\
-"data 2 special workstations (SW2)"
)
~ workstations
~ This variable is used to calculate how many workstations are avialble for \
production once the data maintenance function has been satisfied.
|

"workstation 3 special exponent (ews2)"=
0.7
~
~ |

"special data 2 production standard (SPS2)"=
3.2
~ cells/Month
~ SPS2= 50 hours/cell, or 3.2 cells/month
|

"special data 2 requirement rate (SNR2)"=
6
~
~ |

"Special Data 2 Requirement (SN2)"= INTEG (
"special data 2 requirement rate (SNR2)"-"special data 2 production rate (SPR2)",
0)
~
~ |

"workstation 2 adjustment time (Wat2)"=
6
~ Month
~ The adjustment time variable is the time that it would take to place the \
varibale in a state of equilibrium at its present rate of change.
|

"change in workstations 2 (dW2)"=
("desired workstations 2 (W2*)"-"Workstations 2 (W2)")/"workstation 2 adjustment time (Wat2)"
~ workstations/Month
~ This variable is used as part of the hill-climbing optimization struture \
to adjust the level being optimized.
|

"Workstations 2 (W2)"= INTEG (
"change in workstations 2 (dW2)",
50)
~ workstations
~ The optimal number of workstations. When workstation exponent = employee \
exponent, Workstations = Employees.
|

"desired workstations 2 (W2*)"=
"Workstations 2 (W2)"*"relative production (Dp2*/Dp2)"
~ workstations
~ This variable is an artifact required by the hill-climbing optimization \
algorithm. It is used to search for theworkstations optimal level.
|

"workstation 2 production exponent (ewp2)"=
0.5
~ dmnl
~ The workstation exponent shows the contribution of the workstation to \
production. When production/maintenance depends on an equal \
employee-to-workstation interaction, this variable will have a value of 5. \
Whe the workstation plays a more important role (e.g. automated change \
detection, automated feature extraction) the workstation exponent > \
employee exponent.
|

"desired employees 2 (E2*)"=
"Employees 2 (E2)"*"relative production (Dp2*/Dp2)"
~ employees
~ This variable is an artifact required by the hill-climbing optimization \
algorithm. It is used to search for the employee optimal level.
|

"data 2 production requirement (DPN2)"=
IF THEN ELSE("data 2 population requirement (DN2)">=100, 100 ,"data 2 population requirement (DN2)"\
)
~ cells
~ The production requirement sets the number of new celsl to be produced \
during a given time period.
|

"data 2 population requirement (DN2)"=
MAX(12000-"Data 2 (D2)"-"Data 2 Maintenance Queue (DM2)", 0)
~ cells
~ The population requirement calculates and reports the number of remaining \
cells to be completed. It also sets the lower bound of "0" when all of \
the new cells are completed.
|

"employee 2 adjustment time (Eat2)"=
4

~ Month
~ The adjustment time variable is the time that it would take to place the \
varibale in a state of equilibrium at its present rate of change.
|

"data 2 maintenance required (DMN2)"=
"Data 2 Maintenance Queue (DM2)"
~ cells
~ The data maintenance requirement shows the number of cells that must be
\
maintained during a given time period.
|

"employee 2 exponent (eem2)"=
0.5
~ dmnl
~ The employee exponent shows the contribution of the workstation to \
production. When production/maintenance depends on an equal \
employee-to-workstation interaction, this variable will have a value of 5. \
When the employee plays a less important role than the workstation (e.g. \
automated change detection, automated feature extraction) the workstation
\
exponent > employee exponent.
|

"maintenance workstation 2 exponent (ewm2)"=
0.5
~ dmnl
~ The workstation exponent shows the contribution of the workstation to \
production. When production/maintenance depends on an equal \
employee-to-workstation interaction, this variable will have a value of 5. \
Whe the workstation plays a more important role (e.g. automated change \
detection, automated feature extraction) the workstation exponent > \
employee exponent.
|

"change in employees 2 (dE2)"=
("desired employees 2 (E2*)"-"Employees 2 (E2)")/"employee 2 adjustment time
(Eat2)"
~ employees/Month
~ This variable is used as part of the hill-climbing optimization struture \
to adjust the level being optimized.
|

"data 2 maintenance standard (MS2)"=
RANDOM NORMAL(0.29 ,0.8 ,0.4 , 0.05 , 0)

```
        ~       months
        ~       Data maintenance standard is the amount of time (in months) that it takes \
                to maintan a cell of data.  This is a normally distributed random \
                variable.Min= 550 hrs/cell= .29 cells.month; Max=200 hrs/cell = .8 \
                cells/month; Mean= 400 hrs/cell=.4 cells/month.
        |

"data 2 production standard (PS2)"=
        RANDOM NORMAL( 0.213 , 0.4324 , 0.2857 , 0.03 , 0 )
        ~       cells/Month
        ~       The production standard shows how many cells can be completes per
month by \
                one employee.   Max =370 hrs/cell = .4324 cells/month/employee;
Min=750 \
                hrs/cell = .213 cells/month; Mean= 560 hrs/cell = .2857 cells /month
        |

"Employees 2 (E2)"= INTEG (
        "change in employees 2 (dE2)",
                50)
        ~       employees
        ~       Employees is the number of optimal in-house employees requred to
perform \
                the given tasks.
        |

"data 2 decomposition rate b (DDR2b)"=
        STEP( 0.0208*"Data 2 (D2)" , 24)
        ~       cells/Month
        ~       DDR2b shows the decomposition rate for data that requires maintenance \
                after24 months.  50% of the D2 decomposes at 24 month rate.   50% of the
\
                D2 decomposes at 24 month rate.  (.0208  is derived from 50%  percent \
                decomposition / 24 months.
        |

********************************************************
        .Control
********************************************************~
                Simulation Control Parameters
        |

FINAL TIME  = 600
        ~       Month
        ~       The final time for the simulation.
        |
```

INITIAL TIME = 0
~ Month
~ The initial time for the simulation.
|

SAVEPER = 1
~ Month
~ The frequency with which output is stored.
|

TIME STEP = 1
~ Month
~ The time step for the simulation.
|

D.3 Scenario 3 Model Code

```
"Aged Base Data 3 (AD3)"= INTEG (
        "base data 3 decomposition rate a (BDR3a)",
                0)
        ~       cells
        ~               |

"Base Data 3 (BD3)"= INTEG (
        "base data 3 production rate (BDPR3)"-"base data 3 decomposition rate a
(BDR3a)",
                1)
        ~       cells
        ~               |

"total workstation cost (cW3)"=
        "cost per workstation 3 (cpW3)"*"Workstations 3 (W3)"
        ~       $
        ~       Total workstation monthly cost for optimized simulation.
        |

"base data 3 production employees (BEP3)"=
        IF THEN ELSE("data 3 production requirement (DPN3)" = 0, "data 3 special
employees (SE3)"\
                , "base employees 3 (BE3)"-"data 3 special employees (SE3)"
         )
        ~       employees
        ~               |

"base data 3 production rate (BDPR3)"=
        "data 3 production standard (PS3)"*"base data 3 production employees
(BEP3)"^"employee 3 production exponent (eep3)"\
                *"base data 3 production workstations (BWP3)"^"workstation 3
production exponent (ewp3)"
        ~       cells/Month
        ~               |

"base data 3 production workstations (BWP3)"=
        IF THEN ELSE("data 3 production requirement (DPN3)" = 0,"data 3 special
workstations (SW3)"\
                , "base workstations 3 (BW3)"
        -"data 3 special workstations (SW3)" )
        ~       workstations
        ~               |

"total base workstation 3 cost (cBW3)"=
```

```
        "base workstations 3 (BW3)"*"cost per workstation 3 (cpW3)"
        ~       $
        ~       Total workstation cost base simulation.
        |

"total employee 3 cost (cE3)"=
        "cost per employee 3 (cpE3)"*"Employees 3 (E3)"
        ~       $
        ~       Total employee coat of optimized simulation.
        |

"total optimized 3 cost (tc3)"=
        "total employee 3 cost (cE3)"+"total workstation cost (cW3)"
        ~       $
        ~       Total optimized cost.
        |

"cost per employee 3 (cpE3)"=
        8000
        ~       $/Month
        ~       Monthly cost to sustan in-house employees.
        |

"cost per base data set 3 (cBD3)"=
        "total base 3 cost (tBc3)"/"Base Data 3 (BD3)"
        ~
        ~               |

"cost per data set 3 (cD3)"=
        "total optimized 3 cost (tc3)"/"Data 3 (D3)"
        ~
        ~               |

"total base 3 cost (tBc3)"=
        "total base employee 3 cost (cBE3)"+"total base workstation 3 cost (cBW3)"
        ~       $
        ~       Total cost of base simulation.
        |

"cost per workstation 3 (cpW3)"=
        3500
        ~       $/Month
        ~       Monthly cost for the production workstations and supporting
infrastructure.
        |
```

```
"technical efficiency 3 (TE3)"=
        "total base 3 cost (tBc3)"/"total optimized 3 cost (tc3)"
        ~       dmnl
        ~       TE
        |

"total base employee 3 cost (cBE3)"=
        "base employees 3 (BE3)"*"cost per employee 3 (cpE3)"
        ~       $
        ~       Total cost of employee base simulation.
        |

"improvement factor (if3)"=
        1-"technical efficiency 3 (TE3)"
        ~
        ~               |

"base data 3 decomposition rate a (BDR3a)"=
        STEP( 0.005*"Base Data 3 (BD3)" , 60)
        ~       cells/Month
        ~       DDR3a shows the decomposition rate for data that requires maintenance \
                after 60 months.  30% of the D3 decomposes at 60 month rate.
        |

"base employees 3 (BE3)"=
        104.54
        ~       employees
        ~               |

"base workstations 3 (BW3)"=
        314
        ~       workstations
        ~               |

"data 3 maintenance employees (EM3)"=
        IF THEN ELSE( "Data 3 Maintenance Queue (DM3)">0, MIN(  ("Data 3
Maintenance Queue (DM3)"\
                /"data 3 maintenance standard (MS3)"
         ) , "Employees 3 (E3)"-"data 3 special employees (SE3)"  ), 0)
        ~       employees
        ~       Provides the number of employees required to perform the data
maintenance \
                function.  If DM1>1, then employees will be assigned to data maintenance
\
                as this function has priority over production.  EXPLAINTION OF UNITS:
\
```

DM1/MS1 = cells/1/cells/month = months. It is implied that the equation \
is multipled by 1 employee/month and an equalizer to provied the unit of \
employees.
|

"data 3 maintenance workstations (WM3)"=
IF THEN ELSE("Data 3 Maintenance Queue (DM3)">0, MIN(("Data 3 Maintenance Queue (DM3)"\
/"data 3 maintenance standard (MS3)"
) , "Workstations 3 (W3)"-"data 3 special workstations (SW3)"), 0)
~ workstations
~ Maintenance workstations reflects the total number of workstations used to \
perform data maintenance. EXPLAINTION OF UNITS: DM1/MS1 = \
cells/1/cells/month = months. It is implied that the equation is \
multipled by 1 workstation/month and an equalizer to provied the unit of \
workstations.
|

"data 3 theoritical maintenance value (DTM3)"=
IF THEN ELSE("data 3 production rate (DPR3)"=0 ,"data 3 maintenance standard (MS3)"*\
("Employees 3 (E3)"^"employee 3 maintenance exponent (eem3)"
)*("Workstations 3 (W3)"^"workstation 3 maintenance exponent (ewm3)") , "data type 3 maintenance rate (DMR3)"\
)
~
~ |

"employee 3 production exponent (eep3)"=
0.2
~
~ |

"Data 3 (D3)"= INTEG (
"data 3 production rate (DPR3)"+"data type 3 maintenance rate (DMR3)"-"data 3 decomposition rate a (DDR3a)"\
,
1)
~ cells
~ Data 3 reflects the number of "good" cells af data available. It is the \
sum of the data production rate and the data maintenance rate, minus the \
data decomposition rates.
|

"data 3 production function (Dp3)"=

"data 3 production rate (DPR3)"+"data 3 theoritical maintenance value (DTM3)"+"special data 3 production rate (SPR3)"
~ cells
~ This variable is used to describe the production activities and their \ relationship with the level variable being optimized.
|

"data 3 production rate (DPR3)"=
"data 3 production standard (PS3)"*("data 3 production employees (EP3)"^"employee 3 production exponent (eep3)"\
)*"data 3 production workstations (WP3)"
^"workstation 3 production exponent (ewp3)"
~ cells/Month
~ Data production rate is the amount of new cells produced during each \ period. These cells are completed by both in-house employees and \ contractor support.
|

"data 3 special workstations (SW3)"=
"Special Data 3 Requirement (SN3)"/"special data 3 production standard (SPS3)"
~
~ |

"data 3 production employees (EP3)"=
IF THEN ELSE("data 3 production requirement (DPN3)"=0,0, "Employees 3 (E3)"-"data 3 maintenance employees (EM3)"\
-"data 3 special employees (SE3)")
~ employees
~ This variable is used to calculate how many employees are avialble for \ production once the data maintenance function has been satisfied.
|

"data 3 production goal (Dp3*)"=
"data 3 production requirement (DPN3)"+"data 3 maintenance required (DMN3)"+"Special Data 3 Requirement (SN3)"
~ cells
~ The production goal reflects the total peroduction requirement new cells + \
maintained cells per unit time.
|

"data 3 special employees (SE3)"=
"Special Data 3 Requirement (SN3)"/"special data 3 production standard (SPS3)"
~
~ |

```
"relative production (Dp3*/Dp3)"=
        "data 3 production goal (Dp3*)"/"data 3 production function (Dp3)"
        ~       dmnl
        ~       Artificial variable used to show the ratio of number of cells required \
                versus the number of cells being produced.
        |

"special data 3 production rate (SPR3)"=
        ("data 3 special employees (SE3)"^"employee 3 special exponent (ees3)")*("data
3 special workstations (SW3)"\
                ^"workstation 3 special exponent (ews3)")*"special data 3 production
standard (SPS3)"
        ~
        ~               |

"employee 3 special exponent (ees3)"=
        0.3
        ~
        ~               |

"data 3 production workstations (WP3)"=
        IF THEN ELSE( "data 3 production requirement (DPN3)"=0,0 ,"Workstations 3
(W3)"-"data 3 maintenance workstations (WM3)"\
                -"data 3 special workstations (SW3)"
         )
        ~       workstations
        ~       This variable is used to calculate how many workstations are avialble for \
                production once the data maintenance function has been satisfied.
        |

"workstation 3 special exponent (ews3)"=
        0.7
        ~
        ~               |

"data type 3 maintenance rate (DMR3)"=
        ("data 3 maintenance employees (EM3)"^"employee 3 maintenance exponent
(eem3)")*("data 3 maintenance workstations (WM3)"\
                ^"workstation 3 maintenance exponent (ewm3)"
        )*("data 3 maintenance standard (MS3)"
        )
        ~       cells/Month
        ~       Data maintenance rate is the rate at which cells in the data maintenance \
                queue are maintained.  For data 3, maintaining the aged cells is the top \
                priority for the in-house employees.
        |
```

```
"special data 3 production standard (SPS3)"=
        6.4
        ~       cells/Month/employee
        ~       SPS3= 25 hours/cell, thus 6.4 cells/momth.employee can be produced.
        |

"special data 3 requirement rate (SNR3)"=
        10
        ~       cells/Month
        ~       Projected special cells monthly requirement.
        |

"Special Data 3 Requirement (SN3)"= INTEG (
        "special data 3 requirement rate (SNR3)"-"special data 3 production rate (SPR3)",
                0)
        ~
        ~               |

"workstation 3 adjustment time (Wat3)"=
        12
        ~       Month
        ~       The adjustment time variable is the time that it would take to place the \
                varibale in a state of equilibrium at its present rate of change.
        |

"change in workstations 3 (dW3)"=
        ("desired workstations 3 (W3*)"-"Workstations 3 (W3)")/"workstation 3
adjustment time (Wat3)"
        ~       workstations/Month
        ~       This variable is used as part of the hill-climbing optimization struture \
                to adjust the level being optimized.
        |

"Workstations 3 (W3)"= INTEG (
        "change in workstations 3 (dW3)",
                30)
        ~       workstations
        ~       The optimal number of workstations.  When workstation exponent =
employee \
                exponent, Workstations = Employees.
        |

"desired workstations 3 (W3*)"=
        "Workstations 3 (W3)"*"relative production (Dp3*/Dp3)"
        ~       workstations
```

~ This variable is an artifact required by the hill-climbing optimization \
algorithm. It is used to search for theworkstations optimal level.
|

"workstation 3 production exponent (ewp3)"=
0.8
~ dmnl
~ The workstation exponent shows the contribution of the workstation to \
production. When production/maintenance depends on an equal \
employee-to-workstation interaction, this variable will have a value of 5. \
Whe the workstation plays a more important role (e.g. automated change \
detection, automated feature extraction) the workstation exponent > \
employee exponent.
|

"Data 3 Maintenance Queue (DM3)"= INTEG (
"data 3 decomposition rate a (DDR3a)"-"data type 3 maintenance rate (DMR3)",
0)
~ cells
~ Data maintenance queue shows the amount of data that has significantly \
aged to require maintenance to be useful.
|

"desired employees 1 (E1*)"=
"Employees 3 (E3)"*"relative production (Dp3*/Dp3)"
~ employees
~ This variable is an artifact required by the hill-climbing optimization \
algorithm. It is used to search for the employee optimal level.
|

"data 3 production requirement (DPN3)"=
IF THEN ELSE("data 3 population requirement (DR3)">=100, 100 ,"data 3 population requirement (DR3)"\
)
~ cells
~ The production requirement sets the number of new celsl to be produced \
during a given time period.
|

"data 3 population requirement (DR3)"=
MAX(12000-"Data 3 (D3)"-"Data 3 Maintenance Queue (DM3)", 0)
~ cells
~ The population requirement calculates and reports the number of remaining \
cells to be completed. It also sets the lower bound of "0" when all of \
the new cells are completed.

```
	|

"employee 3 adjustment time (Eat3)"=
	6
	~	Month
	~	The adjustment time variable is the time that it would take to place the \
		varibale in a state of equilibrium at its present rate of change.
	|

"data 3 maintenance required (DMN3)"=
	"Data 3 Maintenance Queue (DM3)"
	~	cells
	~	The data maintenance requirement shows the number of cells that must be
\
		maintained during a given time period.
	|

"employee 3 maintenance exponent (eem3)"=
	0.1
	~	dmnl
	~	The employee exponent shows the contribution of the workstation to \
		production.  When production/maintenance depends on an equal \
		employee-to-workstation interaction, this variable will have a value of 5.  \
		When  the employee plays a less important role than the workstation (e.g. \
		automated change detection, automated feature extraction) the workstation
\
		exponent > employee exponent.
	|

"workstation 3 maintenance exponent (ewm3)"=
	0.9
	~	dmnl
	~	The workstation exponent shows the contribution of the workstation to \
		production.  When production/maintenance depends on an equal \
		employee-to-workstation interaction, this variable will have a value of 5.  \
		Whe  the workstation plays a more important role (e.g. automated change \
		detection, automated feature extraction) the workstation exponent > \
		employee exponent.
	|

"change in employees 3 (dE3)"=
	("desired employees 1 (E1*)"-"Employees 3 (E3)")/"employee 3 adjustment time
(Eat3)"
	~	employees/Month
	~	This variable is used as part of the hill-climbing optimization struture \
		to adjust the level being optimized.
```

```
        |

"data 3 maintenance standard (MS3)"=
        RANDOM NORMAL( 0.7111 ,1.6 , 0.8 ,0.8 ,0 )
        ~       cells/Month/employee
        ~       Data maintenance standard is the amount of time (in months) that it takes \
                to maintan a cell of data.  This is a normally distributed random \
                variable.Max= 100 hrs/cell= 1.6 cells.month; Min=225 hrs/cell = .7111 \
                cells/month; Mean=200 hrs/cell=.8 cells/month.
        |

"data 3 production standard (PS3)"=
        RANDOM NORMAL(0.356, 0.533 , 0.4 , 0.08 ,0 )
        ~       cells/Month/employee
        ~       The production standard shows how many cells can be completes per
month by \
                one employee.  Max =300 hrs/cell = .533 cells/month/employee; Min=450
\
                hrs/cell = .356 cells/month; Mean= 400 hrs/cell = .4 cells /month
        |

"Employees 3 (E3)"= INTEG (
        "change in employees 3 (dE3)",
                10)
        ~       employees
        ~       Employees is the number of optimal in-house employees requred to
perform \
                the given tasks.
        |

"data 3 decomposition rate a (DDR3a)"=
        STEP( 0.005*"Data 3 (D3)" , 60)
        ~       cells/Month
        ~       DDR3a shows the decomposition rate for data that requires maintenance \
                after 60 months.  30% of the D3 decomposes at 60 month rate.
        |

**********************************************************
        .Control
**********************************************************~
                Simulation Control Parameters
        |

FINAL TIME  = 600
        ~       Month
        ~       The final time for the simulation.
```

|

INITIAL TIME = 0
~ Month
~ The initial time for the simulation.
|

SAVEPER = 1
~ Month
~ The frequency with which output is stored.
|

TIME STEP = 1
~ Month
~ The time step for the simulation.
|

D.4 Scenario 4 Model Code

```
"cost per base data set 4 (cBD4)"=
        "total base 4 cost (tBC4)"/"Base Data 4 (BD4)"
        ~
        ~               |

"cost per data set 4 (cD4)"=
        "total optimized 4 cost (tc4)"/"Data 4 (D4)"
        ~
        ~               |

"technical efficiency 4 (TE4)"=
        "total base 4 cost (tBC4)"/"total optimized 4 cost (tc4)"
        ~       dmnl
        ~       TE
        |

"Aged Base Data 4 (AD4)"= INTEG (
        "base data 4 decomposition rate a (BDR4a)"+"base data 4 decomposition rate b
(BDR4b)"\
                +"base data 4 decomposition rate c (BDR4c)",
                0)
        ~       cells
        ~               |

"base contractors 4 (BC4)"=
        IF THEN ELSE("data 4 production requirement (DPN4)"=0 , 0 ,259.2 )
        ~       contractors
        ~               |

"Base Data 4 (BD4)"= INTEG (
        "base data 4 production rate (BDPR4)"-"base data 4 decomposition rate a
(BDR4a)"-"base data 4 decomposition rate b (BDR4b)"\
                -"base data 4 decomposition rate c (BDR4c)",
                1)
        ~       cells
        ~               |

"base data 4 decomposition rate a (BDR4a)"=
        STEP(0.0092*"Base Data 4 (BD4)" , 36)
        ~       cells/Month
        ~               |

"base data 4 decomposition rate b (BDR4b)"=
        STEP( 0.0056*"Base Data 4 (BD4)" ,72)
```

~ cells/Month
~ |

"base data 4 decomposition rate c (BDR4c)"=
STEP(0.0028*"Base Data 4 (BD4)" , 108)
~ cells/Month
~ |

"base data 4 production employees (BEP4)"=
IF THEN ELSE("data 4 production requirement (DPN4)" = 0, "data 4 special employees (SE4)"\
, "base employees 4 (BE4)"-"data 4 special employees (SE4)"
)
~ employees
~ |

"base data 4 production rate (BDPR4)"=
("data 4 production standard (PS4)"*"base data 4 production employees (BEP4)"^"employee 4 production exponent (eep4)"\
)*("base data 4 production workstations (BWP4)"^"workstation 4 production exponent (ewp4)"\
)+"contractor 4 production standard (CPS4)"*"base contractors 4 (BC4)"
~
~ |

"base data 4 production workstations (BWP4)"=
IF THEN ELSE("data 4 production requirement (DPN4)" = 0,"data 4 special workstations (SW4)"\
, "base workstations 4 (BW4)"-"data 4 special workstations (SW4)")
~ workstations
~ |

"base employees 4 (BE4)"=
269.57
~ employees
~ |

"base workstations 4 (BW4)"=
518.4
~ workstations
~ |

"total base workstation 4 cost (cBW3)"=
"base workstations 4 (BW4)"*"cost per workstation 4 (cpW4)"
~ $
~ Total workstation cost base simulation.

```
        |

"total contractor 4 cost (cC4)"=
        "Contractors 4 (C4)"*"cost per contractor 4 (cCp4)"
        ~       $
        ~       Total cotractor cost of optimized model simulation.
        |

"total employee 4 cost (cE4)"=
        "cost per employee 4 (cpE4)"*"Employees 4 (E4)"
        ~       $
        ~       Total employee coat of optimized simulation.
        |

"total optimized 4 cost (tc4)"=
        "total contractor 4 cost (cC4)"+"total employee 4 cost (cE4)"+"total workstation 4
cost (cW4)"
        ~       $
        ~       Total optimized cost.
        |

"total workstation 4 cost (cW4)"=
        "cost per workstation 4 (cpW4)"*"Workstations 4 (W4)"
        ~       $
        ~       Total workstation monthly cost for optimized simulation.
        |

"improvement factor (if4)"=
        1-"technical efficiency 4 (TE4)"
        ~
        ~               |

"cost per contractor 4 (cCp4)"=
        14000
        ~       $/Month
        ~       Monthly contractor cost.  This cost includes personnel and all realted \
                overhead.
        |

"cost per employee 4 (cpE4)"=
        8000
        ~       $/Month
        ~       Monthly cost to sustan in-house employees.
        |

"cost per workstation 4 (cpW4)"=
```

```
        2000
        ~       $/Month
        ~       Monthly cost for the production workstations and supporting
infrastructure.
        |

"total base contractor 4 cost (cBC4)"=
        "base contractors 4 (BC4)"*"cost per contractor 4 (cCp4)"
        ~       $
        ~       Total contractor cost base simulation.
        |

"total base 4 cost (tBC4)"=
        "total base contractor 4 cost (cBC4)"+"total base employee 4 cost (cBC4)"+"total
base workstation 4 cost (cBW3)"
        ~       $
        ~       Total cost of base simulation.
        |

"total base employee 4 cost (cBC4)"=
        "base employees 4 (BE4)"*"cost per employee 4 (cpE4)"
        ~       $
        ~       Total cost of employee base simulation.
        |

"Data 4 Maintenance Queue (DM4)"= INTEG (
        "data 4 decomposition rate a (DDR4a)"+"data 4 decomposition rate b
(DDR4b)"+"data 4 decomposition rate c (DDR4c)"\
                -"data type 4 maintenance rate (DMR4)",
                0)
        ~       cells
        ~       Data maintenance queue shows the amount of data that has significantly \
                aged to require maintenance to be useful.
        |

"data 4 decomposition rate c (DDR4c)"=
        STEP( 0.0028*"Data 4 (D4)" , 108)
        ~       cells/Month
        ~       DDR4c shows the decomposition rate for data that requires maintenance \
                after 108 months.  30% of the D4 decomposes at 108 month rate.   (.0028
\
                is derived from 30%  percent decomposition / 108 months.
        |

"Data 4 (D4)"= INTEG (
```

"data 4 production rate (DPR4)"+"data type 4 maintenance rate (DMR4)"-"data 4 decomposition rate a (DDR4a)"\
-"data 4 decomposition rate b (DDR4b)"-"data 4 decomposition rate c (DDR4c)",
1)
~ cells
~ Data 3 reflects the number of "good" cells af data available. It is the \ sum of the data production rate and the data maintenance rate, minus the \ data decomposition rates.
|

"data 4 production contractors (CP4)"=
IF THEN ELSE("data 4 production requirement (DPN4)"=0,0,"Contractors 4 (C4)")
~
~ |

"desired contractors data 4 (C4*)"=
"Contractors 4 (C4)"*"relative contractor production (RCP4)"
~
~ |

"data 4 production function (Dp4)"=
"data 4 theoretical production rate (DTP4)"+"data 4 theoretical maintenance rate (DTM4)"\
+"data 4 theoretical special rate (DTS4)"
~ cells
~ This variable is used to describe the production activities and their \ relationship with the level variable being optimized.
|

"data 4 theoretical maintenance rate (DTM4)"=
IF THEN ELSE("data 4 production rate (DPR4)"=0 ,"data 4 maintenance standard (MS4)"*\
("Employees 4 (E4)"^"employee 4 maintenance exponent (eem4)"
)*("Workstations 4 (W4)"^"maintenance workstation 4 exponent (ewm4)")+"contractor 4 maintenaince standard (CMS4)"\
*"data 4 maintenance contractors (CM4)" , "data type 4 maintenance rate (DMR4)")
~
~ |

"data 4 theoretical production rate (DTP4)"=
"data 4 production rate (DPR4)"
~
~ |

"data 4 theoretical special rate (DTS4)"=
"special data 4 production rate (SPR4)"
~
~ |

"data 4 production rate (DPR4)"=
"data 4 production standard (PS4)"*("data 4 production employees (EP4)"^"employee 4 production exponent (eep4)"\
)*"data 4 production workstations (WP4)"
^"workstation 4 production exponent (ewp4)"+"data 4 production contractors (CP4)"*"contractor 4 production standard (CPS4)"
~ cells/Month
~ Data production rate is the amount of new cells produced during each \
period. These cells are completed by both in-house employees and \
contractor support.
|

"data 4 maintenance contractors (CM4)"=
IF THEN ELSE("data 4 population requirement (DN4)"<100 , "Contractors 4 (C4)"-("data 4 population requirement (DN4)"\
/"contractor 4 production standard (CPS4)") ,0)
~
~ Provides the number of contractors required to perform the data \
maintenance function. If DN2=0, then contractors will be reassigned to \
data maintenance function. EXPLAINTION OF UNITS: DM1/MS1 = \
cells/1/cells/month = months. It is implied that the equation is \
multipled by 1 employee/month and an equalizer to provied the unit of \
employees.
|

"relative contractor production (RCP4)"=
IF THEN ELSE("data 4 production requirement (DPN4)">0 ,"data 4 production requirement (DPN4)"\
/"data 4 theoretical production rate (DTP4)", "data 4 maintenance required (DMN4)"/\
"data 4 theoretical maintenance rate (DTM4)")
~
~ |

"contractor 4 maintenaince standard (CMS4)"=
0.246
~ cells/Month/employee
~ CMS4= 650 hours/cell or ..246 cells/month/employee
|

"contractor 4 production standard (CPS4)"=
0.123
~ cells/Month
~ contractor standard 1,300 hours per cell or .123 cells per month.
|

"change in contractors 4 (dC4)"=
("desired contractors data 4 (C4*)"-"Contractors 4 (C4)")/"contractor 4 adjustment time (Cat4)"
~
~ |

"Contractors 4 (C4)"= INTEG (
"change in contractors 4 (dC4)",
50)
~ contractors
~ Contractors is the number of optimal number or contractors required to \
augment in-house employees.
|

"contractor 4 adjustment time (Cat4)"=
2
~ months
~ |

"data type 4 maintenance rate (DMR4)"=
("data 4 maintenance employees (EM4)"^"employee 4 maintenance exponent (eem4)")*("data 4 maintenance workstations (WM4)"\
^"maintenance workstation 4 exponent (ewm4)"
)*("data 4 maintenance standard (MS4)"
)+"data 4 maintenance contractors (CM4)"*"contractor 4 maintenaince standard (CMS4)"
~ cells/Month
~ Data maintenance rate is the rate at which cells in the data maintenance \
queue are maintained. For data 3, maintaining the aged cells is the top \
priority for the in-house employees.
|

"data 4 decomposition rate a (DDR4a)"=
STEP(0.0092*"Data 4 (D4)" , 36)
~ cells/Month
~ DDR4a shows the decomposition rate for data that requires maintenance \
after 36 months. 30% of the D2 decomposes at 36 month rate. (.0092 is \
derived from 30% percent decomposition / 36 months.
|

"data 4 maintenance employees (EM4)"=
IF THEN ELSE("Data 4 Maintenance Queue (DM4)">0, MIN(("Data 4 Maintenance Queue (DM4)"\
/"data 4 maintenance standard (MS4)"
) , "Employees 4 (E4)"-"data 4 special employees (SE4)"), 0)
~ employees
~ Provides the number of employees required to perform the data maintenance \
function. If DM1>1, then employees will be assigned to data maintenance \
as this function has priority over production. EXPLAINTION OF UNITS: \
DM1/MS1 = cells/1/cells/month = months. It is implied that the equation \
is multipled by 1 employee/month and an equalizer to provied the unit of \
employees.
|

"data 4 maintenance workstations (WM4)"=
IF THEN ELSE("Data 4 Maintenance Queue (DM4)">0, MIN(("Data 4 Maintenance Queue (DM4)"\
/"data 4 maintenance standard (MS4)"
) , "Workstations 4 (W4)"-"data 4 special workstations (SW4)"), 0)
~ workstations
~ Maintenance workstations reflects the total number of workstations used to \
perform data maintenance. EXPLAINTION OF UNITS: DM1/MS1 = \
cells/1/cells/month = months. It is implied that the equation is \
multipled by 1 workstation/month and an equalizer to provied the unit of \
workstations.
|

"employee 4 production exponent (eep4)"=
0.3
~
~ |

"data 4 special workstations (SW4)"=
"Special Data 4 Requirement (SN4)"/"special data 4 production standard (SPS4)"
~
~ |

"data 4 production employees (EP4)"=
IF THEN ELSE("data 4 production requirement (DPN4)"=0,0, "Employees 4 (E4)"-"data 4 maintenance employees (EM4)"\
-"data 4 special employees (SE4)")
~ employees

~ This variable is used to calculate how many employees are avialble for \
production once the data maintenance function has been satisfied.
|

"data 4 production goal (Dp4*)"=
"data 4 production requirement (DPN4)"+"data 4 maintenance required (DMN4)"+"Special Data 4 Requirement (SN4)"
~ cells
~ The production goal reflects the total peroduction requirement new cells + \
maintained cells per unit time.
|

"data 4 special employees (SE4)"=
"Special Data 4 Requirement (SN4)"/"special data 4 production standard (SPS4)"
~
~ |

"relative production (Dp4*/Dp4)"=
"data 4 production goal (Dp4*)"/"data 4 production function (Dp4)"
~ dmnl
~ Artificial variable used to show the ratio of number of cells required \
versus the number of cells being produced.
|

"special data 4 production rate (SPR4)"=
("data 4 special employees (SE4)"^"employee 4 special exponent (ees4)")*("data 4 special workstations (SW4)"\
^"workstation 4 special exponent (ews4)")*"special data 4 production standard (SPS4)"
~
~ |

"employee 4 special exponent (ees4)"=
0.3
~
~ |

"data 4 production workstations (WP4)"=
IF THEN ELSE("data 4 production requirement (DPN4)"=0,0 ,"Workstations 4 (W4)"-"data 4 maintenance workstations (WM4)"\
-"data 4 special workstations (SW4)"
)
~ workstations
~ This variable is used to calculate how many workstations are avialble for \
production once the data maintenance function has been satisfied.

```
	|

"workstation 4 special exponent (ews4)"=
	0.7
	~
	~		|

"special data 4 production standard (SPS4)"=
	6.4
	~	cells/Month
	~	The production standard reflects the number of cells tthat can be produced
\
		per month.  The variable is randomly distributed with a Max = 10  hrs/cell
\
		= 16 cells/month  ; Min=50 hrs/cell = 3.2 cells/month; Mean= 25 hrs/cell \
		=6.4 cells/month
	|

"special data 4 requirement rate (SNR4)"=
	14
	~
	~		|

"Special Data 4 Requirement (SN4)"= INTEG (
	"special data 4 requirement rate (SNR4)"-"special data 4 production rate (SPR4)",
		0)
	~
	~		|

"workstation 4 adjustment time (Wat4)"=
	12
	~	Month
	~	The adjustment time variable is the time that it would take to place the \
		varibale in a state of equilibrium at its present rate of change.
	|

"change in workstations 4 (dW4)"=
	("desired workstations 2 (W2*)"-"Workstations 4 (W4)")/"workstation 4
adjustment time (Wat4)"
	~	workstations/Month
	~	This variable is used as part of the hill-climbing optimization struture \
		to adjust the level being optimized.
	|

"Workstations 4 (W4)"= INTEG (
	"change in workstations 4 (dW4)",
```

100)
~ workstations
~ The optimal number of workstations. When workstation exponent = employee \
exponent, Workstations = Employees.
|

"desired workstations 2 (W2*)"=
"Workstations 4 (W4)"*"relative production (Dp4*/Dp4)"
~ workstations
~ This variable is an artifact required by the hill-climbing optimization \
algorithm. It is used to search for theworkstations optimal level.
|

"workstation 4 production exponent (ewp4)"=
0.7
~ dmnl
~ The workstation exponent shows the contribution of the workstation to \
production. When production/maintenance depends on an equal \
employee-to-workstation interaction, this variable will have a value of 5. \
Whe the workstation plays a more important role (e.g. automated change \
detection, automated feature extraction) the workstation exponent > \
employee exponent.
|

"desired employees 4 (E4*)"=
"Employees 4 (E4)"*"relative production (Dp4*/Dp4)"
~ employees
~ This variable is an artifact required by the hill-climbing optimization \
algorithm. It is used to search for the employee optimal level.
|

"data 4 production requirement (DPN4)"=
IF THEN ELSE("data 4 population requirement (DN4)">=100, 100 ,"data 4 population requirement (DN4)"\
)
~ cells
~ The production requirement sets the number of new celsl to be produced \
during a given time period.
|

"data 4 population requirement (DN4)"=
MAX(12000-"Data 4 (D4)"-"Data 4 Maintenance Queue (DM4)", 0)
~ cells
~ The population requirement calculates and reports the number of remaining \

cells to be completed. It also sets the lower bound of "0" when all of \
the new cells are completed.
|

"employee 4 adjustment time (Eat4)"=
6
~ Month
~ The adjustment time variable is the time that it would take to place the \
varibale in a state of equilibrium at its present rate of change.
|

"data 4 maintenance required (DMN4)"=
"Data 4 Maintenance Queue (DM4)"
~ cells
~ The data maintenance requirement shows the number of cells that must be \
maintained during a given time period.
|

"employee 4 maintenance exponent (eem4)"=
0.2
~ dmnl
~ The employee exponent shows the contribution of the workstation to \
production. When production/maintenance depends on an equal \
employee-to-workstation interaction, this variable will have a value of 5. \
When the employee plays a less important role than the workstation (e.g. \
automated change detection, automated feature extraction) the workstation \
exponent > employee exponent.
|

"maintenance workstation 4 exponent (ewm4)"=
0.8
~ dmnl
~ The workstation exponent shows the contribution of the workstation to \
production. When production/maintenance depends on an equal \
employee-to-workstation interaction, this variable will have a value of 5. \
Whe the workstation plays a more important role (e.g. automated change \
detection, automated feature extraction) the workstation exponent > \
employee exponent.
|

"change in employees 4 (dE4)"=
("desired employees 4 (E4*)"-"Employees 4 (E4)")/"employee 4 adjustment time (Eat4)"
~ employees/Month

~ This variable is used as part of the hill-climbing optimization struture \
to adjust the level being optimized.
|

"data 4 maintenance standard (MS4)"=
RANDOM NORMAL(0.29 ,0.8 , 0.4 , 0.1 , 0)
~ cells/Month
~ Data maintenance standard is the amount of time (in months) that it takes \
to maintan a cell of data. This is a normally distributed random \
variable.Min= 550 hrs/cell= .29 cells.month; Max=200 hrs/cell = .8 \
cells/month; Mean= 400 hrs/cell=.4 cells/month.
|

"data 4 production standard (PS4)"=
RANDOM NORMAL(0.133 , 0.213 , 0.16 , 0.05 , 0)
~ cells/Month
~ The production standard shows how many cells can be completes per month by \
one employee. Max =750 hrs/cell = .213 cells/month/employee; Min=1,200 \
hrs/cell = .133 cells/month; Mean= 1,000 hrs/cell = .16 cells /month
|

"Employees 4 (E4)"= INTEG (
"change in employees 4 (dE4)",
52)
~ employees
~ Employees is the number of optimal in-house employees requred to perform \
the given tasks.
|

"data 4 decomposition rate b (DDR4b)"=
STEP(0.0056*"Data 4 (D4)" ,72)
~ cells/Month
~ DDR4b shows the decomposition rate for data that requires maintenance \
after 72 months. 40% of the D4 decomposes at 72 month rate. (.0056 is \
derived from 40% percent decomposition / 72 months.
|

****
.Control
**********~
Simulation Control Parameters
|

FINAL TIME = 240
~ Month
~ The final time for the simulation.
|

INITIAL TIME = 0
~ Month
~ The initial time for the simulation.
|

SAVEPER = 1
~ Month
~ The frequency with which output is stored.
|

TIME STEP = 1
~ Month
~ The time step for the simulation.
|