Oct 2003

ESATAN v8.9

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ESATAN v8.9

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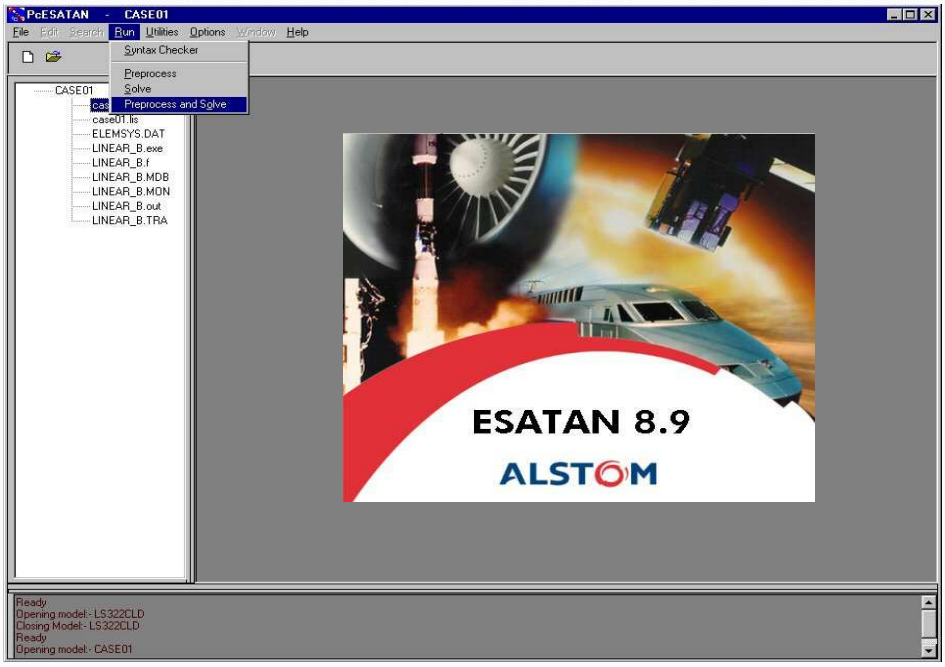

- State in the Field -

ESATAN v8.9

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- ESATAN v8.9
  - Released in June 2003
  - Now available on Linux
- Outstanding issues in v8.7
  - Apostrophe sign [’] in comments not supported
  - To comment the **`$INCLUDE (# $INCLUDE)`**
  - Subroutine in **`$EXTERNAL`** model not recognised
  - Reserved names not properly tested by ESATAN
  - Missing substitution data in predefined elements not tested

⇒ **All have been solved in ESATAN v8.9**

- State in the Field -

ESATAN v8.9 - New Developments

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- Pre-Processor Improvements

- Continuing Commitment to Development -

Pre-Processor Improvements

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- Improvements on processing data
  - very large models
  - large number of conductors

- Examples from test suite & user models
  - 40,000 nodes / 100,000 GLs - **8 times faster**
  - 2,800 nodes / 5,500 GLs / 310,000 GRs - **6 times faster**

- Pre-Processor recommanded against Syntax Checker -

ESATAN v8.9 - New Developments

ALSTOM

- Pre-Processor Improvements
- Thermal Solver Optimisation

- Continuing Commitment to Development -

SOLVFM Optimisation

- Improved band-width optimisation
- Improved algorithm
- Improved energy balance control
- ‘Unconnected Node’ support
- Near linear scalability

- SOLVFM Recommended Steady-State Solver -

New Thermal Solver SLCRNC

- Performs transient thermal analysis using Crank-Nicholson method
- Unique Temperature Rate of Change criterion DTROCA used for determining the maximum time step length to be used during a transient
- Arithmetic node optimisation with new control constant ARITH

- Transient Solution -

ESATAN v8.9 - New Developments

ALSTOM

- Pre-Processor Improvements
- Thermal Solver Optimisation
- Heat Balance Convergence Criteria

- Continuing Commitment to Development -

Heat Balance Convergence

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- Convergence can now be defined in terms of energy balance
  - INBALA (absolute nodal energy balance) vs ENBALA
  - INBALR (relative nodal energy balance) vs ENBALR
- Supported in steady state thermal solvers SOLVIT & SOLVFM

- Increased Analysis Control -

ESATAN v8.9 - New Developments

ALSTOM

- Pre-Processor Improvements
- Thermal Solver Optimisation
- Heat balance convergence
- Comma Separated Value format

- Continuing Commitment to Development -

PRNCSV Subroutine

ALSTOM

- New user-callable subroutine for outputting to Comma Separated Value

```
PRNCSV(ZLABEL,ZENTS,CNAME,ORDER,FILE)
```

- Output any nodal entities and conductors

PRNCSV (‘ ‘, ‘T’, CURRENT, ‘NODE’, ‘temperature.csv’)

- Plotting, Archiving, Database Import, etc. -

PRNCSV Subroutine

ALSTOM

```
$MODEL H_SECTION
#
    $MODEL BAR1, NOLIST
        $EXTERNAL NON_LINEAR_BAR
    $ENDMODEL BAR1
#
    $MODEL BAR2
        $REPEAT BAR1
    $ENDMODEL BAR2
#
$NODES
#
D100, T = 20.0, C = Density * Volume * INTRP1(T100, SpecificHeat, 1);
#
$CONDUCTORS
#
GL(100, BAR1:3) = U;       # Set in VARIABLES1
GL(100, BAR2:3) = U;
#
$CONSTANTS
$REAL
#
CrossSectionalArea = 0.025 * 0.025;
Density = 2.565E03;
Volume = 0.04 * 0.025 * 0.025;
DeltaY1 = 0.02;
DeltaY2 = 0.0125;
#
$CONTROL
#
TIMEND = 500.0;
OUTINT = 10.0;
DTIMEI = 1.0;
RELXCA = 0.01;
NLOOP = 100;
#
$ARRAYS
$REAL
#
Conductivity(2, 4) = -73.33, 200.0,   37.78, 356.3,
                      93.33, 580.0,  148.89, 845.0;
#
SpecificHeat(2, 4) = -73.33, 1.3E03,  37.78, 1.7E03,
                      93.33, 2.1E03, 148.89, 2.8E03;
#
$VARIABLES1
#
      QI:BAR2:1 = 0.0
      GR:BAR2:(1, 10, 2) = 0.0035
#
      GL(100, BAR1:3) = 1 /
     & (DeltaY1 / (CrossSectionalArea * INTRP1(T100, Conductivity, 1)) +
     &  DeltaY2 / (CrossSectionalArea * INTRP1(T:BAR1:3, BAR1:Conductivity, 1)))
#
      GL(100, BAR2:3) = 1 /
     & (DeltaY1 / (CrossSectionalArea * INTRP1(T100, Conductivity, 1)) +
     &  DeltaY2 / (CrossSectionalArea * INTRP1(T:BAR2:3, BAR2:Conductivity, 1)))
#
$EXECUTION
#
      CALL SLFWBK
#
$OUTPUTS
#
  CALL PRNCSV(' ', 'T', CURRENT, 'NODE', 'temp11.csv')
  CALL PRNCSV(' ', 'L, T', CURRENT, 'ENTITY', 'temp22.csv')
#
$ENDMODEL H_SECTION
```


```
$OUTPUTS
#
      CALL PRNCSV(' ', 'T', CURRENT, 'NODE', 'temp11.csv')
      CALL PRNCSV(' ', 'L, T', CURRENT, 'ENTITY', 'temp22.csv')
#
$ENDMODEL H_SECTION
```

- Plotting, Archiving, Database Import, etc. -

PRNCSV Subroutine

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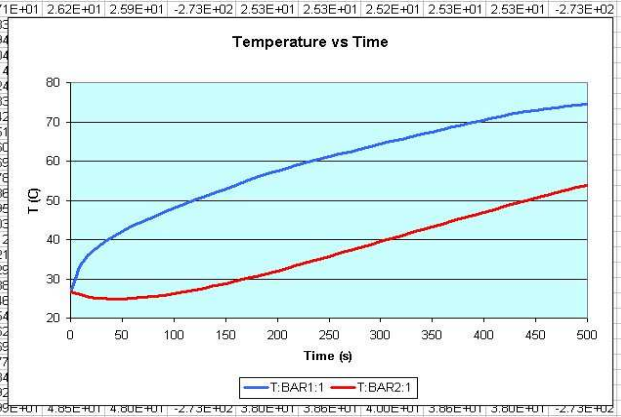
ESATAN v8.9.2; MODEL H_SECTION; TIME 16 OCTOBER 2003 15:43:03

TIME	T100	T:BAR1:1	T:BAR1:2	T:BAR1:3	T:BAR1:4	T:BAR1:5	T:BAR1:10	T:BAR2:1	T:BAR2:2	T:BAR2:3	T:BAR2:4	T:BAR2:5	T:BAR2:10
0	2.00E+01	2.67E+01	2.67E+01	2.67E+01	2.67E+01	2.67E+01	-2.73E+02	2.67E+01	2.67E+01	2.67E+01	2.67E+01	2.67E+01	-2.73E+02
10	2.38E+01	3.37E+01	2.86E+01	2.59E+01	2.60E+01	2.60E+01	-2.73E+02	2.59E+01	2.58E+01	2.52E+01	2.58E+01	2.60E+01	-2.73E+02
20	2.53E+01	3.66E+01	3.09E+01	2.71E+01	2.62E+01	2.59E+01	-2.73E+02	2.53E+01	2.53E+01	2.52E+01	2.53E+01	2.53E+01	-2.73E+02
30	2.61E+01	3.88E+01	3.27E+01	2.83									
40	2.69E+01	4.06E+01	3.43E+01	2.94									
50	2.75E+01	4.21E+01	3.57E+01	3.04									
60	2.82E+01	4.34E+01	3.69E+01	3.14									
70	2.88E+01	4.46E+01	3.81E+01	3.24									
80	2.95E+01	4.58E+01	3.92E+01	3.33									
90	3.02E+01	4.69E+01	4.02E+01	3.42									
100	3.08E+01	4.80E+01	4.12E+01	3.51									
110	3.15E+01	4.90E+01	4.22E+01	3.60									
120	3.22E+01	5.00E+01	4.32E+01	3.69									
130	3.30E+01	5.10E+01	4.41E+01	3.78									
140	3.37E+01	5.20E+01	4.50E+01	3.86									
150	3.44E+01	5.29E+01	4.59E+01	3.95									
160	3.52E+01	5.39E+01	4.69E+01	4.03									
170	3.60E+01	5.49E+01	4.78E+01	4.12									
180	3.67E+01	5.58E+01	4.87E+01	4.21									
190	3.75E+01	5.67E+01	4.96E+01	4.29									
200	3.83E+01	5.75E+01	5.04E+01	4.38									
210	3.91E+01	5.83E+01	5.12E+01	4.46									
220	3.99E+01	5.90E+01	5.20E+01	4.54									
230	4.07E+01	5.97E+01	5.27E+01	4.62									
240	4.14E+01	6.04E+01	5.35E+01	4.69									
250	4.22E+01	6.11E+01	5.42E+01	4.77									
260	4.30E+01	6.17E+01	5.49E+01	4.84									
270	4.37E+01	6.24E+01	5.56E+01	4.92									
280	4.45E+01	6.31E+01	5.63E+01	4.99									
290	4.52E+01	6.37E+01	5.70E+01	5.06E+01	4.93E+01	4.87E+01	-2.73E+02	3.87E+01	3.93E+01	4.08E+01	3.94E+01	3.88E+01	-2.73E+02
300	4.60E+01	6.43E+01	5.76E+01	5.13E+01	5.00E+01	4.94E+01	-2.73E+02	3.95E+01	4.01E+01	4.16E+01	4.01E+01	3.96E+01	-2.73E+02
430	5.51E+01	7.21E+01	6.59E+01	6.01E+01	5.88E+01	5.83E+01	-2.73E+02	4.91E+01	4.97E+01	5.11E+01	4.97E+01	4.92E+01	-2.73E+02
440	5.58E+01	7.25E+01	6.64E+01	6.07E+01	5.95E+01	5.90E+01	-2.73E+02	4.98E+01	5.04E+01	5.17E+01	5.04E+01	4.99E+01	-2.73E+02
450	5.65E+01	7.29E+01	6.70E+01	6.13E+01	6.01E+01	5.96E+01	-2.73E+02	5.05E+01	5.11E+01	5.24E+01	5.11E+01	5.06E+01	-2.73E+02
460	5.71E+01	7.33E+01	6.74E+01	6.19E+01	6.07E+01	6.02E+01	-2.73E+02	5.12E+01	5.18E+01	5.31E+01	5.18E+01	5.13E+01	-2.73E+02
470	5.77E+01	7.37E+01	6.79E+01	6.24E+01	6.13E+01	6.08E+01	-2.73E+02	5.19E+01	5.25E+01	5.38E+01	5.25E+01	5.20E+01	-2.73E+02
480	5.83E+01	7.40E+01	6.83E+01	6.29E+01	6.18E+01	6.14E+01	-2.73E+02	5.26E+01	5.31E+01	5.44E+01	5.32E+01	5.26E+01	-2.73E+02
490	5.89E+01	7.43E+01	6.87E+01	6.34E+01	6.23E+01	6.19E+01	-2.73E+02	5.32E+01	5.38E+01	5.51E+01	5.38E+01	5.33E+01	-2.73E+02
500	5.95E+01	7.46E+01	6.91E+01	6.39E+01	6.29E+01	6.24E+01	-2.73E+02	5.39E+01	5.44E+01	5.57E+01	5.45E+01	5.40E+01	-2.73E+02



- Plotting, Archiving, Database Import, etc. -

ESATAN v8.9 - New Developments

ALSTOM

- Pre-Processor Improvements
- Thermal Solver Optimisation
- Heat balance convergence
- Comma Separated Value format
- Model Name & Node functions

- Continuing Commitment to Development -

Model Name & Node Functions

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- *SUBMOD (ATTRIB)*

  returns model name of current model

```
$INITIAL
#
      CHARACTER * 20 SUBM
#
# to return 'MAIN:SUB1:SUB2'
#
      SUBM = SUBMOD('ALL')
#
# to return 'MAIN:SUB1'
#
      SUBM = SUBMOD('ROOT')
#
# to return 'SUB2'
#
      SUBM = SUBMOD('SUBMODEL')
#
```

- *SUBMDN (NODE, ATTRIB)*

  returns model name given the internal node number NODE

```
$VARIABLES2
#
      CHARACTER *20 SUBM
#
# to return 'MAIN:SUB1:SUB2'
#
      SUBM = SUBMDN(NCSGMN, 'ALL')
#
# to return 'MAIN:SUB1'
#
      SUBM = SUBMDN(NCSGMN, 'ROOT')
#
# to return 'SUB2'
#
      SUBM = SUBMDN(NCSGMN, 'SUBMODEL')
#
```

- Increased Modelling Flexibility -

Model Name & Node Functions

- *NODNUM (NODE)*
  returns the user node number given the internal node number NODE

```
$VARIABLES2
#
      INTEGER UNODE
#
# returns the user node number where
# CSG is minimal
#
      UNODE = NODNUM(NCSGMN)
#
```

- *INTNOD (CNAME, NODE)*
  returns internal node number given user node number NODE in model CNAME

```
$VARIABLES2
#
      INTEGER INODE
#
# returns the internal node number of D100
# in CURRENT model
#
      INODE = INTNOD(CURRENT, 100)
#
# returns the internal node number of D10
# in MAIN:SUB1:SUB2 submodel
#
      INODE = INTNOD(MAIN:SUB1:SUB2, 10)
#
```

- Increased Modelling Flexibility -

ESATAN v8.9 - New Developments

- Pre-Processor Improvements
- Thermal Solver Optimisation
- Heat balance convergence
- Comma Separated Value format
- Model Name & Node functions
- Zero Flow Solution

- Continuing Commitment to Development -

FHTS Zero Flow Solution

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- Handling analytically mass-flow links with zero flow rate
- Solution formulation adapted to treat low pressure drop case
  - $\Delta P <$ MINDP : default to 1.0E-03 Pa
  - All fluid solvers address MINDP

$\Rightarrow$ Overcomes problem of modelling closed branches

- Increased Modelling Flexibility -

ESATAN v8.9 - New Developments

ALSTOM

- Pre-Processor Improvements
- Thermal Solver Optimisation
- Heat balance convergence
- Comma Separated Value format
- Model Name & Node functions
- Zero Flow Solution
- Progress Monitoring File

- Continuing Commitment to Development -

Progress Monitoring File

- A progress file is automatically created containing current state of the analysis
  - modelname.MON
  - frequency of output is controlled by PRGFBK (default 10)
- File produced in Comma Separated Value
  - easy to import to programs such as Excel
- Data available Real time, SOLVER, TIMEN, TIMEN/TIMEND %, DTIMEU, STEPCT, LOOPCT and RELXCC
  - extra data available for FHTS model (such as RELXMC…)

Progress Monitoring File

Realtime	SOLVER	TIMEN	%	DTIMEU	STEPCT	LOOPCT	RELXCC
08:39:45	SOLVFM	0.00E+00	0	0.00E+00	0	10	50
08:39:45	SLFWBK	20	20	2	10	2	7.52E-12
08:39:45	SLFWBK	40	40	2	20	2	7.52E-12
08:39:45	SLFWBK	60	60	2	30	2	7.23E-12
08:39:45	SLFWBK	80	80	2	40	2	7.23E-12
08:39:45	SLFWBK	100	100	2	50	2	6.80E-12

- PROGHD and PROGRS new user-callable subroutines to print out extra data
  - PROGHD(UNIT) writes out column header
  - PROGRS(UNIT) writes out one line of data for each call

```
$INITIAL
#
      OPEN(UNIT=21, FILE='feedback.cvs')
#
      CALL PROGHD(21)
#
$VARIABLES1
#
      WRITE(21, *) Variable
#
$VARIABLES2
#
      CALL PROGRS(21)
#
```

- Increased Modelling Flexibility -

ESATAN v8.9 - New Developments

ALSTOM

- Pre-Processor Improvements
- Thermal Solver Optimisation
- Heat balance convergence
- Comma Separated Value format
- Model Name & Node functions
- Zero Flow Solution
- Progress Monitoring File
- Further Developments

- Continuing Commitment to Development -

Further Developments

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- Control Constant DTMAX is now used in conjunction with DTMIN throughout all transient solvers

- User Constants can now be defined with MORTRAN/ other User Constants in $CONSTANTS block
  - changes in the value of the first one will propagate to the second one

- Increased Modelling Flexibility -

ESATAN v8.9 - Summary

- Pre-Processor Improvements
- Thermal Solver Optimisation
- Heat balance convergence
- Comma Separated Value format
- Model Name & Node functions
- Zero Flow Solution
- Progress Monitoring File
- Further Developments

- Conclusion -

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