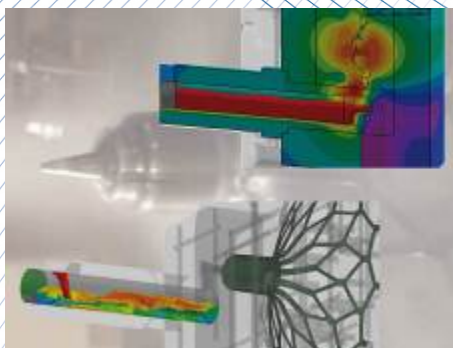


# ProCAST 2013.0

## Release Notes & Installation Guide



Shot Sleeve Modeling in  
High Pressure Die Casting



Low Pressure, Investment  
and Gravity Casting



Ingot and Continuous Casting

*Images courtesy of: Casati & CMS, Mofopress, Vulcan SFM*



# ProCAST 2013.0

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## RELEASE NOTES & INSTALLATION GUIDE

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January 2013

CL/PRCA/12/01/00/A



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## MESSAGE

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Dear Customer,

We are pleased to provide you with the ProCAST 2013.0<sup>1</sup> release.

We are delivering one CD containing **ProCAST 2013.0** (scalar<sup>2</sup> and parallel solvers for Windows (32<sup>3</sup>/64) and Linux (64) systems) and one DVD containing **Visual-Cast 8.6** version (the environment).

Those new versions have undergone improved product functionalities and contain also new features. Please refer to the present release notes and to their respective on-line user manual for more details about all new capabilities and corrections. In particular, we strongly recommend reading the **ProCAST What's New/Version 2013.0 or VE 8.6 Release Notes** sections which detail all. These Release Notes only highlight a few specific developments.

A major element of this version is the completion of the new pre-processing **Visual-Cast**<sup>4</sup> which provides a set-up of process conditions on CAD geometry and not anymore on mesh only. This gives access to the advantage of adapting the meshing to the simulation needs without resetting the boundary conditions. It also introduces a new generic process workflow for guiding user. It includes filtering and data check using updated public databases for casting process oriented set-up.

The second generation of the modeler, **Visual-Mesh** improves robustness ,shell and 3D Tet mesh quality and a new boundary layer method was introduced as well as "undo delete" capability. Also a step-by-step process wizard is introduced.

**Visual-Viewer** performances in volume manipulation and movies generation are enhanced and the exporting capability was enriched.

This version introduces the NIYAMA criterion to enlarge porosity prediction, FREESFBALL and WALLF in function of time, blow phase for die casting and pouring cup control for gravity casting. A major development concerns the fluid flow solver<sup>5</sup> with the introduction of a new discretization method, so-called Edge-Based FE Method (EBFEM) and a new linear solver based on the algebraic multigrid (AMG), widely used in CFD. The discretization of the continuum partial differential equations into discrete linear equations is faster when using the EBFEM approach. The AMG solution of the resultant linear system is faster when using AMG solver compared to the PETSC solvers. So, EBFEM and AMG solver together speed up the solver considerably and improved the robustness.

Note that the delivery of version 2013.0/8.6 does not necessarily require a new FlexLM license file. Normally your recent code has been delivered already with the 2013 key features. If this is not the case, contact your local ESI support representative in order to get the updated password.

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<sup>1</sup> Last version including the installation of the Manager, MeshCAST and PreCAST.

<sup>2</sup> Last version including the scalar code.

<sup>3</sup> Last version including the 32bit platform.

<sup>4</sup> A new pre-CAFÉ and the TTT/CCT models will be introduced in next release. Inverse modeling, phase field, and optimization via CDS script editor as well as foaming are not available.

<sup>5</sup> For DMP code only.

You will find at the end of this Release Notes a section called **Survey**. In advance we thank you for your precious collaboration which will hopefully help us improve our software and our services.

We wish you a lot of success with the ProCAST 2013.0 and Visual-Cast 8.6 releases. If you have any questions or need further assistance, please do not hesitate to contact your local support team.

In the meantime, the ESI Group's casting team remains sincerely yours.

**ESI GROUP CASTING TEAM**

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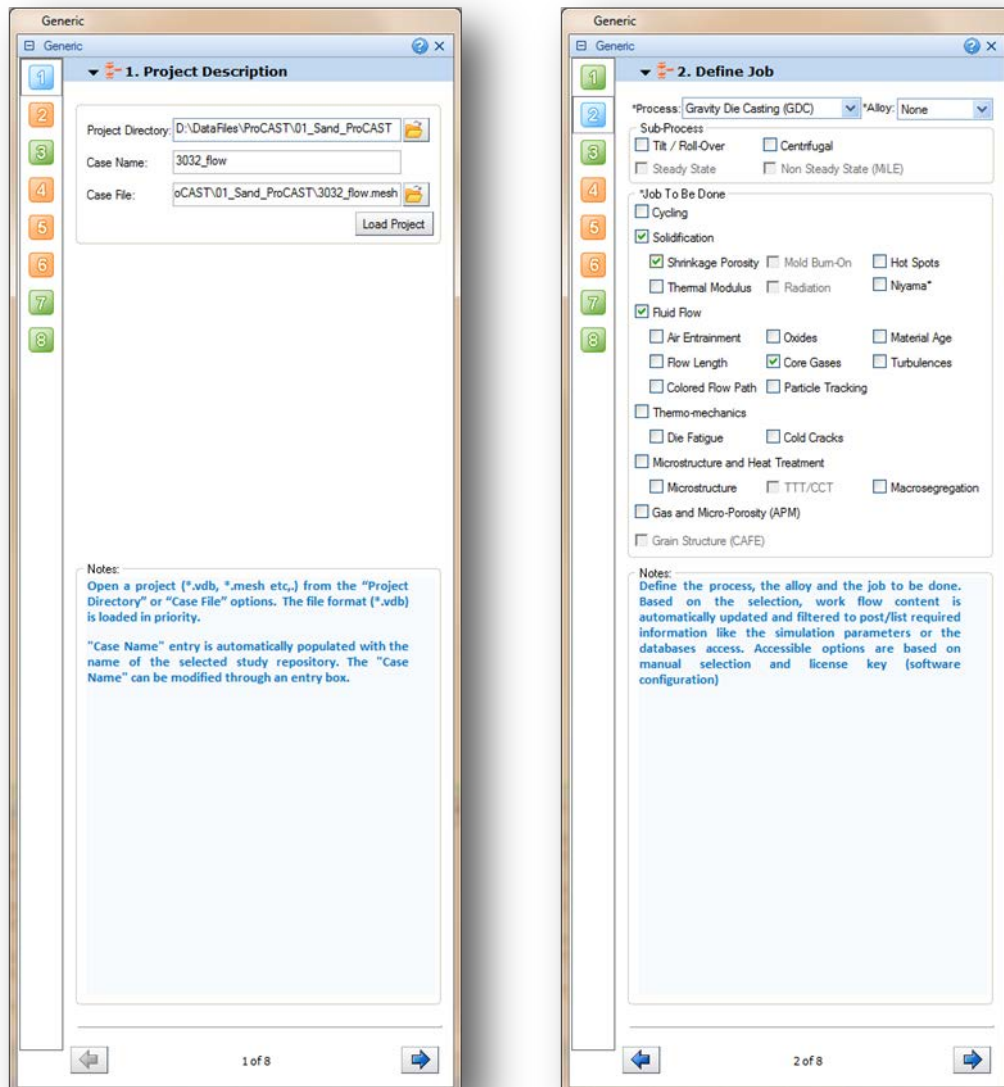
# WHAT'S NEW

**Visual-Cast** is the single integrated environment for all your Casting needs. The pre-processor helps in model set-up, aided by definition of physics on topology. Visual-Cast is also linked to Thermodynamic Databases for the automatic determination of the material properties. **Visual-Mesh** is a complete meshing tool for ProCAST and QuikCAST which supports CAD import, 2D and 3D meshing of linear and quadratic elements. **Visual-Viewer** is the visualization and plotting tool that helps in analyzing **ProCAST** and **QuikCAST** result data within a uniform interface. It performs automated tasks and generates customized reports, thereby increasing engineer productivity.

# VISUAL-CAST

Visual-Cast is the new-generation pre-processing tool with a state-of-the-art multi-window / multi-model environment that caters to the requirements of the CAE community. It has an intuitive and sleek user interface with Windows look and feel and enables you to group your data into pages. You can set-up your models on CAD and not only on surface mesh, as is commonly done. You can re-run complete saved sessions without losing any data.

## Generic Workflow



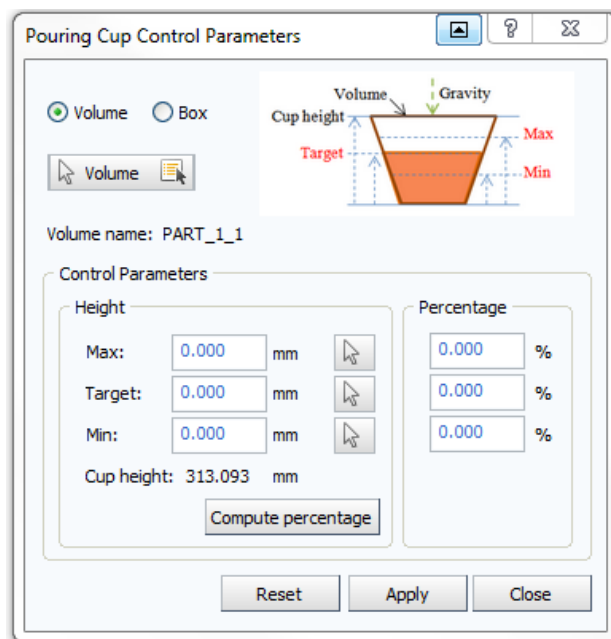
- Generic workflow automates the model setup through a set of blocks.
- Entry through Workflow->Generic.
- Color coding of blocks for easy identification of status– **Blue: Current block**, **Green: Completed block**, **Orange: Ready block** and Grey: Not ready block
- The step-by-step workflow guides user for going through the different necessary steps for complete model set-up
- License key with process and alloy selection at STEP 2 filter and activate the accessible options for the analysis
- Microstructure option with cast iron will pop up a wizard to select foundry practices like inoculation method and mold hardness.
- All the steps have tips and automatic checking.

## Easy Access Toolbar



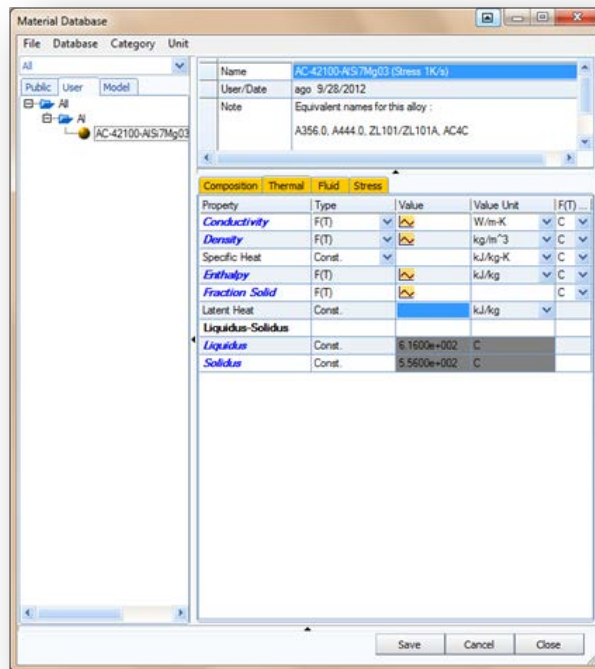
- New toolbar for easy access of workflow
- Same options are accessible through the Cast Menu

## Pouring Cup Controls



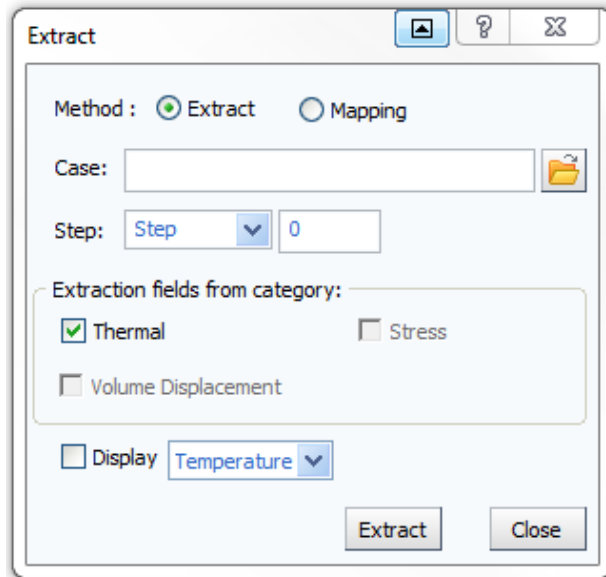
- This allows entering a min and max bound for the visible filling level to control pouring rate following foundry practice.
- Right click on alloy volume name in volume manager to access this panel.

## Material Database Editor Enhancements



- Properties generated by 'Computherm' are **highlighted in blue color**.
- Notes will have information about the 'Computherm' algorithm used for generating material properties.
- Composition value entry messages are made simple.

## Extract / Mapping Updates



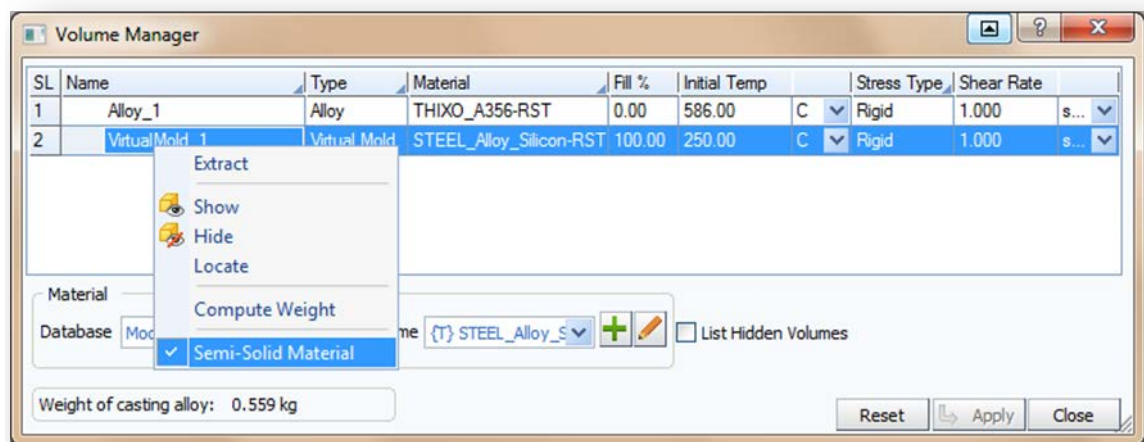
- Support for stress and domain displacements.
- Option to enter "Time" for extraction.
- File-> Append to add Material/Volume and Delete Material/Volume directly from the explorer with a right click

## Blow Phase for Cycling

Property	Value		Temp	Time
H. T Coeff	1.0000e+003	W/m^2-K	C	sec
Air Coeff	1.0000e+001	W/m^2-K		
Air Temp	2.5000e+001	C		
Spray Coeff	1.0000e+004	W/m^2-K		
Spray Temp	5.4000e+001	C		
Blow Coeff		W/m^2-K		
Blow Temp		C		
Attach until ejection	No			
<b>Time Details</b>				
Mold Open	0.0000e+000	sec		
Mold Close	0.0000e+000			
Spray Start	0.0000e+000			
Spray End	0.0000e+000			
Blow Start				
Blow End				

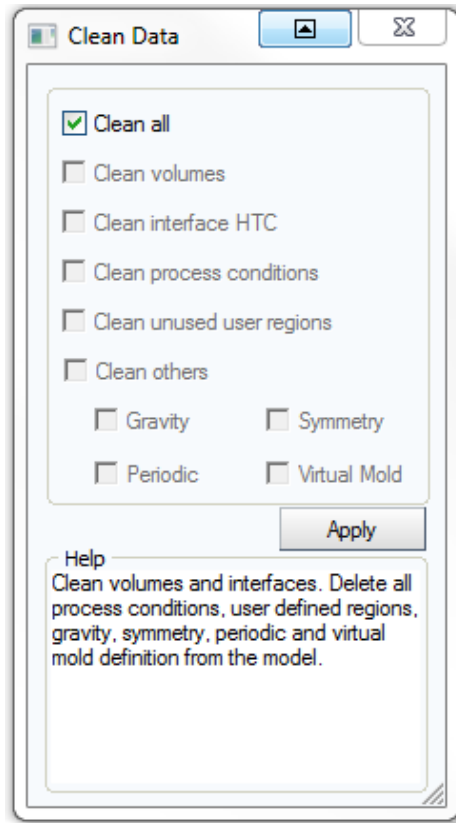
- Blow phase is added at die combo interface level similar to spray phase.
- Time details are rearranged as Mold Open / Mold Close / Spray Start / Spray End / Blow Start / Blow End
- TBBLOW and TEBLOW simulation parameters are also added between TESPRA and TCLOSE in Simulation parameters panel.
- As for Spray, if Blow Start and Blow End are defined in interface and through TBBLOW TEBLOW, value from interface will be used.

## Semi-Solid Modeling (SSM)



- Semi-Solid modeling support.
- Volume manger enhanced to accept Critical Shear Rate values for each volume.
- Right click on volume name will post option "Semi-Solid Material". On selecting this, a new row for "Shear Rate" gets added.

## Clean Data



- Clean selected set-up
- Accessible through the Cast Menu

## Other Updates

- Progression bar for virtual mold computation status is introduced for tracking the status.
- Progression bar for mapping / extraction computation status is introduced for tracking the status.
- Database type and name selection list width is increased for a clear visibility of type and name.
- In weight calculator, volume is also shown along with weight.
- Gravity GUI is automatically posted if the loaded file does not have gravity definition. Automatic posting happens when switching from Visual-Mesh to Visual-Cast. It ensures that the gravity definition is not missed.
- Free surface balance (FREESFBAL) and free surface velocity at the wall mold (WALLF) simulation parameters based on time can now be defined.

- APM tab is added in simulation parameters GUI.
- Simulation parameters are modified to take care the following
  - If MICRO=1 and MICCPL=0, then THERMAL is forced to 2
  - If MICRO=1 and MICCPL=1, then THERMAL is forced to 1
  - If FADING = 0 then MGTREAT is forced to 0
- Data Checks Panel is simplified.
- Start simulation panel is enhanced with capabilities to copy standard files from installation folder to project folder. Ex. to copy user function files.
- Assign volume and Momentum source process conditions can now be defined through explorer.
- When you change the units of the FS curve in the material database, the units of the Liquidus and Solidus are updated automatically
- Anisotropic properties (conductivity) are supported in material database.
- HTC is supported as a function of time/temperature in die combo interface.
- NIYAMA (default value 0.90: activated) is added in simulation parameters GUI under thermal category.
- Gravity vector definition GUI is automatically posted on loading any file, if there is no gravity already defined.
- Extract / Mapping for pyramid elements are now supported.
- Predefined set of Simulation Parameters has been updated for taking care of: Default, Core Blowing, Curved Continuous Casting, Gravity Die Casting, Gravity Sand Casting, High Pressure Die Casting, Investment Casting, Lost Foam Casting, Low Pressure Die Casting, Semi-Solid Casting and Straight Continuous casting
- Create specific pre.-define set of Simulation Parameters from File/Save as in Program Files (x86)\ESI Group\Visual-Environment\8.5\COMMON\Resources\VisualCast\RunParam
  - Open the file and edit the name on the first line TITLE ---> Default
- Public Databases have been updated as follows: Update of material and folder names, correction of inconsistencies, update of some material properties, creation of new material like wool and concrete, update of comments, introduction of density curve with expansion for Cast Iron category, introduction of new BCs and iHTC standard values
- Quadratization of linear tet mesh is supported (10-node tetrahedral)
- Constraint conditions for stress calculation can be function of time.



## Bug Fixes

- Sectors with overlapping regions over the symmetry planes in rotational symmetry definition can now be defined.
- Issues in resolving wall process condition when other process conditions defined on the same nodes are now fixed.
- Region definition GUI inconsistencies with other GUIs with respect to apply are now resolved.
- Unit of area in process condition manager is made consistent with defined model units.
- Inlet user region via circle option was selecting the nodes on the symmetrical / periodic plane.
- If an APM model loaded through d.dat and p.dat, solver was not running. This is resolved.
- A material property computed in Kelvin from 'Computherm' was being displayed in Celsius. This inconsistency is addressed.
- Issues in virtual mold depth calculations on volumes are resolved. It is advised to have 3D elements in the volumes before computing depth for virtual mold.
- User function input for material properties, particularly for stress was missed. Now it is added.
- When hexa elements are split to tetra, volume computation was going wrong. This is fixed.
- When process condition database is updated using the velocity or the ladle calculators, update is now done properly along gravity direction.
- Converting enclosures to volume was not properly computing volumes. Now this is fixed.

## Known Issues

- Time and time step may not exactly match for filling case when compared to old PreCAST / ProCAST solved problems. But, results and the filling pattern have no issues.
- Solver identification is done by the values set in COMMON\Resources\VisualEnvironment\VisualEnvFactorySettings.ini file. Ex: Under "Visual-CAST-Settings" block by default "ProCAST Solver Versions=20091, 20100, 20110, 20130" are specified. In such a case, Visual-Cast automatically takes 20130 first. Application checks if this environment variable "ProCAST20130" is defined. If not, it goes to 20110

(ProCAST20110) and so on. In this version, avoid choosing solver path through GUI.

- Solver should not be run with the p.dat file open.
- Refreshing issues may arise in Plot Editor in Material/Interface/Process Condition database. So close the dialog & open it again is recommended.
- It is not advised to define regions on CAD surface if CAD and FE are detached.
- All property values from database are stored in SI units. Therefore values entered in user-defined units are shown in SI units when reopened the database. User can however select their unit system to enter and view values.
- After loading Visual-Cast 8.0 vdb files from a folder which doesn't contain p.dat, go to "Simulation Parameter" panel and re-define simulation parameters. Ex: Select Pre- Defined Set to re-define parameters.
- Hostfile options are not supported from 'Start Simulation' panel.
- For NCOIN interfaces, appropriate In-Plane and Perimeter tolerance should be specified in 'Create New Interface' panel.
- Re-compute of volumes should be avoided if virtual mold is defined. If volume has to be re-computed, delete and re-define virtual mold.
- Thermodynamic computation may take longer time in some cases and computation may not converge.

## Limitations

- Following are yet to be supported in d.dat reading.
  - 2D Model - Loading will terminate in this case.
  - Extract of initial condition - Will continue to load, so it can be extract manually after loading such files using "Extract/Mapping" right click menu on volumes in explorer.
  - Reading d.dat ProCAST version below 2008.1 - Will continue to load. It allows checking and making necessary changes if required in GUI.
- CAFÉ, TTT/CCT and FOAMING is not yet supported in this version. Will be supported in coming versions.
- It is recommended to use workflow with single model.

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## ProCAST SOLVER 2013.0 UPDATES

### Niyama (Ny)

- Niyama criterion (Ny) is widely used in metal casting. Values are evaluated at a specified temperature (or fraction solid) near the end of solidification.

$$Ny = G / \sqrt{\dot{T}}$$

- $G$  is temperature gradient
- $\sqrt{\dot{T}}$  is cooling rate
- Niyama is used to predict feeding-related shrinkage micro-porosity caused by shallow temperature gradients.
- *It is expected* expects shrinkage porosity to form in regions with Ny below some threshold values.

Limitations:

- Threshold Ny value below which shrinkage porosity forms is generally unknown (other than for steel), and can be sensitive to the type of alloy being cast, as well as to casting conditions (e.g., sand mold vs. permanent mold, application of pressure, etc.).
- Ny does not provide actual amount of shrinkage porosity that forms, other than in a qualitative fashion (i.e., the lower Ny is, the more shrinkage porosity expected).
- Input: Simulation parameter NIYAMA [0, 1] corresponding to the fraction of solid where regular Niyama is calculated.
  - Recommended and default value is 0.9.

### Discretization Method: Edge-based Finite Element Method

- A new FEM discretization method is introduced and is referred to as edge-based FEM (EBFEM) and has been made popular by Rainald Lohner<sup>6</sup>.
- EBFEM and the classical FEM differ only in the way variable properties are approximated and in the way the advection operator is discretized.

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<sup>6</sup> 1. Rainald Lohner, Applied CFD Techniques: an introduction based on finite element methods, Wiley & Sons, 2001.

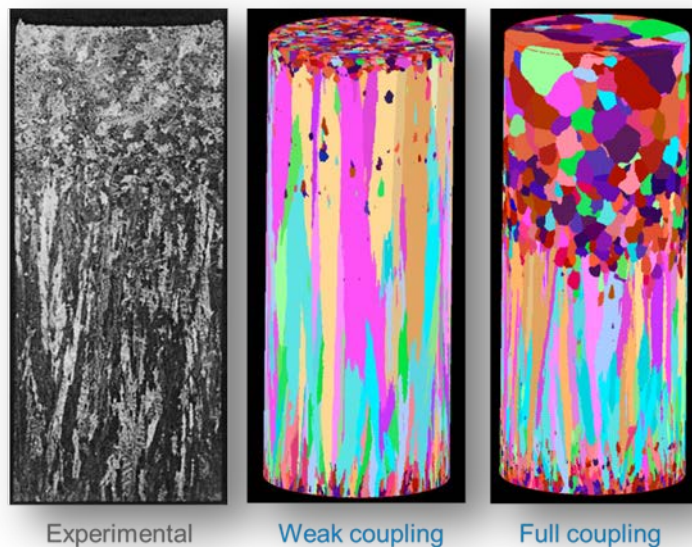
- The EBFEM approach has been implemented for the following systems of Partial Differential Equations (PDEs):
  - Conservation of momentum solved for the velocities U, V and W.
  - Conservation of mass solved for the pressure P.
  - Conservation of energy solved for either temperature T or enthalpy H.
  - Turbulence kinetic energy (K) and turbulence rate of dissipation (E).
- EBFEM discretizes the advection operator using upwinding schemes with limiters to achieve higher-order accuracy, which demonstrated to give better filling behavior in certain cases. In particular, the hanging flow and premature filling of pouring cup anomalies appear to be better controlled.
- EBFEM approach for free-surface is not yet activated by default (2013.5) as it requires smaller time steps (consequently longer simulation time). This model should be activated only if the free-surface behavior obtained using the default advection algorithm is unsatisfactory. Activate it with NMETHODF set to 1 prefixp.dat.
- This new EBFEM procedure is activated by setting "NMETHOD 2" in the simulation parameter (new default value). To go back to the classical FEM solver we need to set "NMETHOD 0".
- EBFEM is only available within the DMP code.
- The following physics are not updated for the EBFEM solver. In such cases, the ProCAST code deselects the EBFEM solver and reverts to the classical FEM solver and writes a warning message to the prefixp.out file.
  - Anisotropy
  - Accordion
  - Periodic BC
  - Gas models
  - Junction
  - Macrosegregation
- NMETHOD 2 works in combination with AMSOLVER 255 and only for the DMP code. If serial code is use the solver options for AMGSOLVER and NEMTEHOD will be set automatically to 0.

## Linear Solver : Algebraic Multi-Grid (AMG)

- A new linear solver adapted by ESI based on the algebraic multi-grid (AMG) was introduced to build highly efficient and robust linear solver.
- AMG solver is faster (up to 50% as model size is increasing) than PETSC.
- AMG is a popular linear solver used by many prominent CFD software packages such as ANSYS-FLUENT, ANSYS-CFX, and ESI-ACE+.
- AMG is activated with AMGSOLVER set to 255 and is only available within the DMP code.
- Currently the following physics are not supported by the AMGSOLVER.
  - Burning Foam: When burning foam is detected, the code internally picks the PETSC solver even if the user has specified AMGSOLVER. A suitable warning message is printed in prefixp.out.
  - MLDUPDT: If  $MLDUPDT > 1$ , the AMGSOLVER is replaced by the PETSC solver with suitable warning message printed to the prefixp.out.
  - Temperature PDE system when using the classical FEM scheme (NMETHOD = 0). Even if the user specifies AMG solver, internally the code resets it to PETSC solver and a suitable warning message is printed to prefixp.out.
  - Accordion
  - Periodic BC

## CAFE Solver: Revisited Full Coupling Mode

- While the weak coupling approach is generally adequate for the prediction of grain selection (e.g. grain selector), it remains limited for the description of the columnar to equiaxed transition (CET) and stray grain formation in SX turbine blades (e.g. undesired grains nucleating in platforms) as shown on the below example<sup>7</sup>.



- The full coupling scheme is revisited by coupling and calculating enthalpy with the ProCAST heat flow solver, the grain fraction with CAFÉ and the fraction of solid and the temperature for the enthalpy given by ProCAST with a new microsegregation model from MetalLib and all this at every FE node.
- The computation time may be an issue to apply the full coupling scheme to very large cases.

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<sup>7</sup> C.-A. Gandin, ISIJ, (40) 2000, p. 971

## Other Updates

- Pyramid elements are supported
- Strain output is introduced
- Improve MUMPS direct solver capability for advanced stress calculation. MUMPS solver is more robust code in case of bad mesh quality but it requires higher RAM.
- Control pouring cup with a minimum and maximum bound for the visible filling level to adjust pouring rate following foundry practice.
- Simulation parameters FREESFBALL and WALLF could now be set in function of the time for a better handling of shot sleeve simulation with a moving piston.
- A blow phase is added in die combo to take into account of air blowing after spraying phase in permanent mold.
- The effect of local acceleration orientation on porosity location in closed mushy pockets was introduced in POROS 1 in case of vertical centrifugal casting process.
- The User Function IHTC (interface heat transfer coefficient) can now be defined as the function of fluid pressure or contact pressure, or as the function of both pressures.

When using this user function is set as a function of pressure, GAPMOD has to be set as 0.

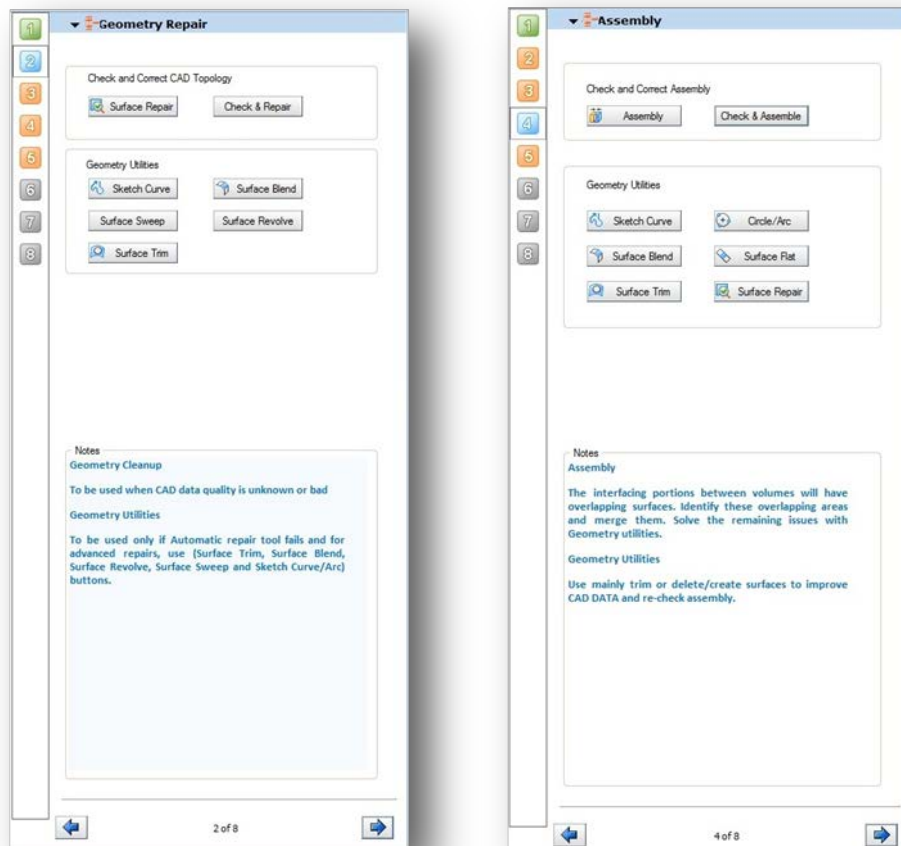
- In order to more efficiently map/extract stress data, gauss point to gauss point correspondence is coded in the mapping shared library of ProCAST.
- Problem of convergence in stress MiLE approach for Continuous Casting is fixed and DMP speed up is improved.
- Improvements in solver performance and stability are obtained with new versions of PETSC and Platform MPI 8.2.1.
- Contact algorithm does not support 10 node tet element.

## Bug Fixes

- Fill Ratio difference between initial and first step is fixed.
- GATEFS resetting is fixed.
- Handling a case with more than 5 inlets is now possible.
- ...

## VISUAL-MESH

### Meshing Workflow



- Generic workflow automates the model meshing through a set of blocks.
- Entry through Workflow->Generic.
- The step-by-step workflow guides you to go through the different necessary steps for complete model meshing.
- All the steps have tips and automatic checking.



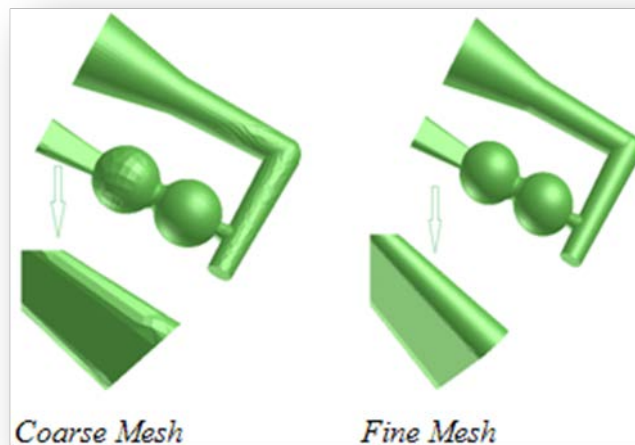
## Mesh Visibility

- The selection type in display control is set to Element.
- The buttons "Complementary CAD and FE display", "Show CAD only" and "Show Mesh Only" work based on volumes now.

### Export

#### STL:

- Option is provided to export each volume as separate STL file.
- Mesh connectivity across connected surfaces are retained now.
- Different mesh resolutions are provided while exporting CAD.



#### Pro-CAST files:

- Exporting displayed elements only, is supported for .sm and .mesh files.

#### Export CAD to STL (QuikCAST)

- A customized process which runs surface mesh process (Except Assembly and Boolean) and export each volume as separate STL file for QuikCAST work flow has been supported.

## Geometry

### Basic Shapes

- In Box and Cylinder GUIs, 'By Point' method, determining axis and position from a single clicked point is supported.
- Cone and Sphere creation is supported.

### Surface

#### CleanUp

- In 'Small Hole' removal, after holes are identified based on given radius, some of them can be deselected / re-selected now.

#### Mid Surface

- Simplified surfaces (surfaces which do not match with underlying geometry, resulting due to split, delete-edge or simplification operations) are supported now for mid-planeing and surface extension.

#### Extend

- Simplified surfaces are supported now for surface extension.

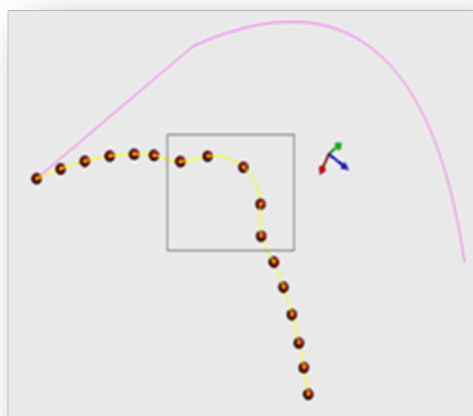
### Assembly & Boolean

- Undo-All is supported now to restore initial situation.

### Curve

#### Curve Edit

- A new GUI to edit existing circles, arcs, poly lines and spline curves is provided.



### **Curve Drop**

- Simple GUI based (Command) session generation is supported now.
- Edges of surfaces are allowed to be selected for drop.

## **2D Mesh**

### **2D**

Enclosure meshed features are accessible from 2D Mesh menu.

#### **Grow:**

- Simple GUI based (Command) session generation is supported.
- Option to select 2D elements as target is supported, with both Upto and Upto-Middle types.

#### **Check Surface Mesh:**

- Two tolerance schemes, Fine and Coarse, are provided, to properly clean STL and FE quality mesh types.

### **Boundary**

#### **Layered Elements:**

- A new option 'Layered Elements' is provided to identify the interior edges of the element which are connected to boundary nodes (for Flow Check).

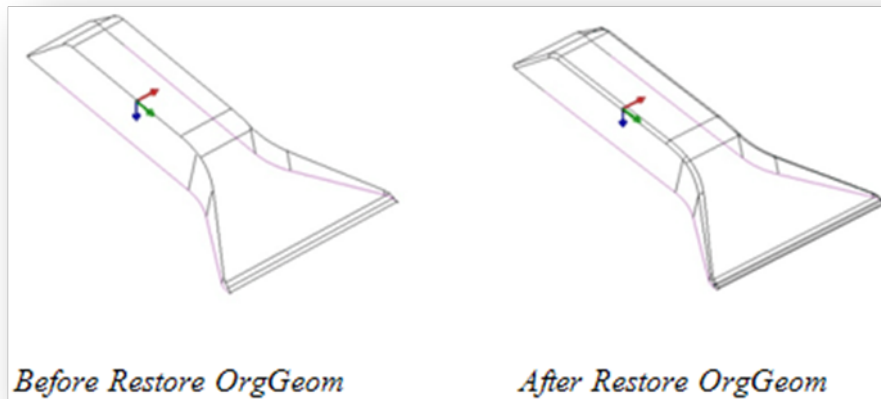
### **Shelling**

- Shell by Boolean and 3D Layered mesh algorithms are modified to improve mesh quality.
- For easy identification, elements of "All Other" group are drawn with specific color.

## Topo Mesh

### Restore Org. Geom.

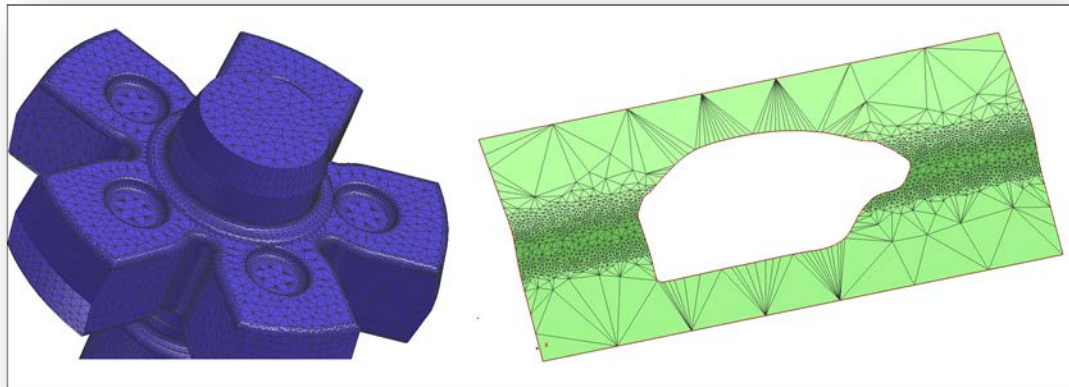
- A new option "Restore Org. Geom" is provided to restore original geometry of simplified surfaces.



- An option "Stitch to Adjacent FE" is provided

### Chordal Deviation Mesh

- For geometry shading display, Chordal deviation based seeding and meshing is supported.



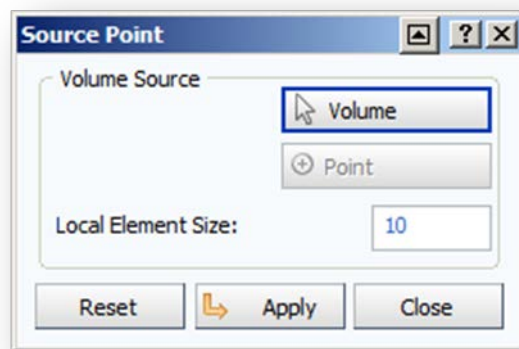
## 3D Mesh

### By Node

- A new option to create 5-noded Pyramid element is provided.

### Tetra Mesh

- Uniform method of Tetra mesh creation has been modified to improve mesh quality.
- In Gradual method of tetra mesh GUI, source point definition and maximum element size options are provided to improve mesh transition and better control over element size.
- Using the Source Point dialog, you can refine or coarsen tetrahedral elements within a volume by providing a specific size near a specified point in the volume to accurately simulate the fluid conditions near that region.



- Quadratization of linear tet mesh is supported

### Boundary Layer

- A new method in boundary layers generation is supported, which takes source point and maximum element size options. And allows you to create boundary layers on desired faces.

## Volume

Volume computation algorithm has been modified to handle different cases. Cavity inside Cavity has been supported.

### Volume Options

- A new dialog is provided to group different options to control volume computation and volume display.



### Volume Element Size Manager

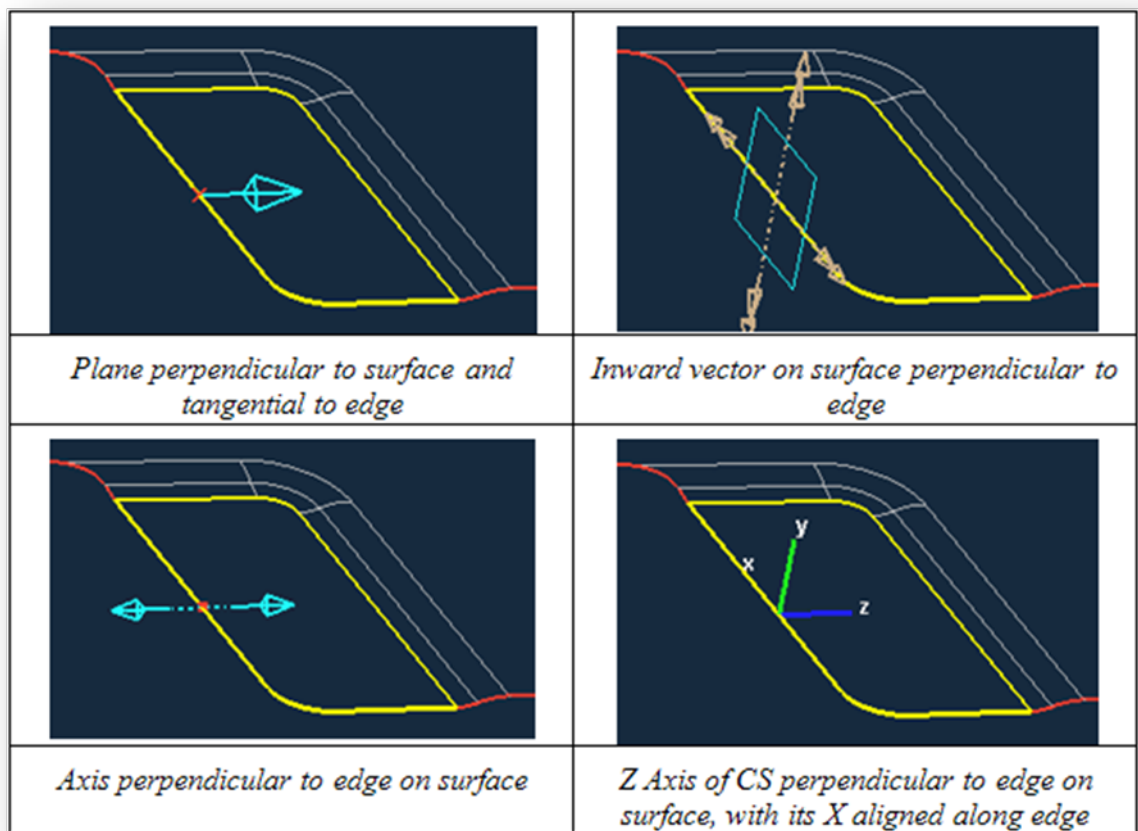
- New columns "Max. Element Size", "Transition Factor" and "Shape Factor" are added in Volume Element Size Manager.

ID	Name	Element Size	Max Element Size	Transition Factor	Shape Factor	Surface/2D Elms(Solid Elms)
1	PART_1_1	13.3652	10	1	2	0/60(0)
2	PART_1_2	13.3652	10	1	2	0/60(0)
3	PART_1_3	12.3393	10	1	2	0/222(0)

## General

### Vector Panel

- In 'Ent. Normal' method:
  - In 'Curve / Edge Tangent' option, you are allowed to pick edges of element.
  - A new option, 'Edge Plane' is provided to define edge plane, perpendicular to surface/element, by clicking on the edge.



- Volumes can be directly converted from linear to quadratic.

## Bug Fixes

- In STL import, color card is now ignored in ASCII format.
- In assembly, deletion of surfaces due to split failure is fixed.
- Volume folder is correctly updated for display status.

## Known Issues

- Volume computation on very large models consumes significant time.
- Chordal deviation meshing not yet supported for surfaces with deleted edges, normally resulting after simplification.
- Dialog posting through workflow may cause a crash due to repeated posting.
- COINC interfaces identified during .mesh or d.dat loading should be converted to EQUIV interfaces before any volume manipulations. Ex. Before calling "Compute Volume".



---

# VISUAL-VIEWER

## Enhancements

- Significant improvement in the performance of animation for solidification problems in ProCAST models.
- Improvement in performance in multi-window scenarios. Working experience with multiple windows is improved.
- View manipulations like rotate, zoom, pan are improved.
- Export functionality is enhanced. Now you can export porosity or stress or both in M01 format. Sysweld, Abaqus, Ansys and Generic formats are supported.
- Hotspots can be calculated in the application itself.
- Strain tensor display is supported.

## Bug Fixes

- Display Pipe was badly set. When it was made OFF, Pipe would be displayed. This is corrected.
- Double click on the spectrum was not posting the spectrum GUI for a copied window. This is fixed.
- Total steps displayed in calculation monitoring during solver re-run was wrong. This is now corrected.
- When importing curves at two different times, it was not possible to display the curves on a new page the second time. This is addressed.
- In Calculation Monitor, under the label 'Time Step', step number was shown. This inconsistency is addressed.
- Porosity was exported with wrong units in MO1. This is fixed.

## Known Issues

- Updating APM results during solver run may sometimes crash the application.
- If you select 'View'>Home Page when a model is active, the Contour dialog still remains. If you select a different result, when the model is displayed, the contour colors will not be correct.

Work around: This can be corrected by selecting the result again or by posting the Spectrum dialog.

- Loading a model does not fit the model to the window. User has to explicitly fit the model.
- If more than one Principal stress is selected for display as vectors, its maximum value will not be displayed properly in the legend.
- If units are changed in the cut-off mode, contours will not be displayed properly. You are advised to change it in the snapshot mode and then switch to cut-off mode.

## Limitations

- Template does not support calculated particles, free surface / point XY-plotting.
- Entity Selector may become inactive in some situations. To activate it again, activate the model window and press Escape key.
- Volume of porosity computation is linked to the mesh size; consequently this is an approximated value.
- For QuikCAST models, tilt and explode cannot be applied simultaneously.
- Exporting the evolution curves plotted has a problem. If the curve names are not present in the "Page/File View" tab, then exporting two or more curves by pressing Control key and right clicking will give error.
- Stress tensors are not displayed on mold.
- To view solver calculation status in "Calculation Monitoring" GUI, the solver path must have solver version number. Ex. 2013.0 or 2011.0, etc.

---

# INSTALLATION GUIDE

---

## SOFTWARE INSTALLATION ON WINDOWS

---

### Installation of the Software

Insert the CD-ROM into the disc drive. Follow the procedure described below depending if autorun is enabled on your computer.

#### **Autorun is enabled on your computer**

The ProCAST installation should start automatically.

The InstallShield Wizard dialog box is displayed and then you should simply follow the instructions.

#### **Autorun is disabled on your computer**

Open a Windows Explorer window, click on your CD-ROM drive icon.

Double click on the Setup.exe file, located in the ProCAST20130\_Windows directory, to start the software installation.

*The InstallShield Wizard dialog box is displayed and then you should simply follow the instructions.*

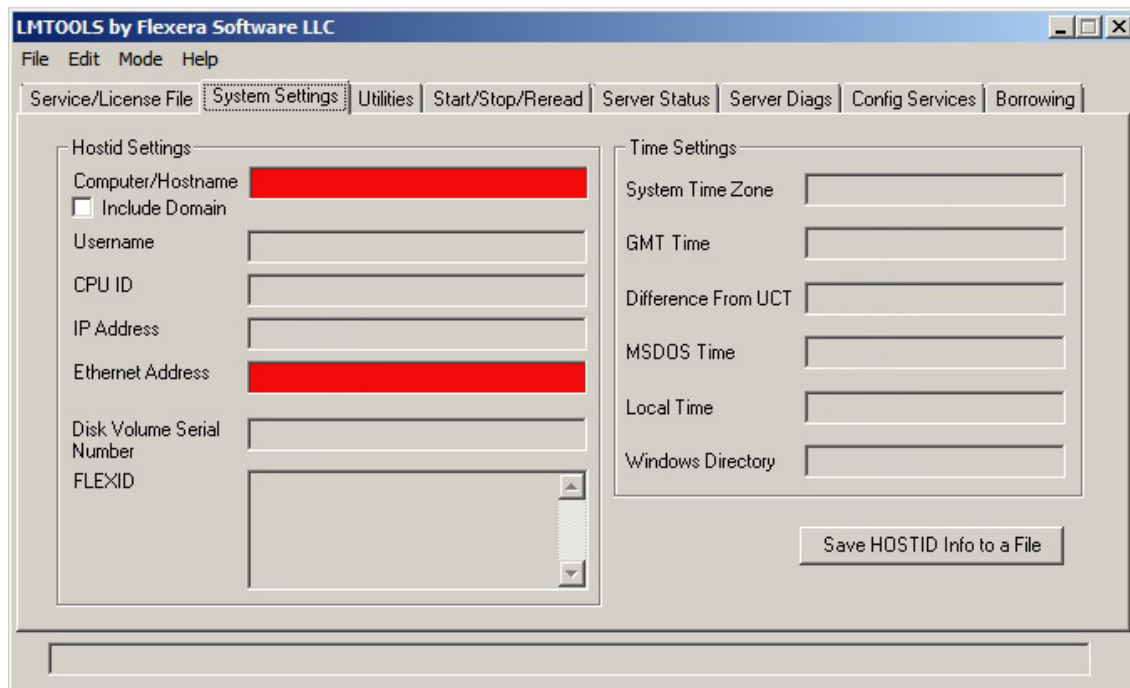
When the software installation is completed, the ProCAST product will be available in the Start/Programs/ESI group menu or in the ESI Group icon folder on the desktop.

### Installation of the License

Before starting the license installation you should obtain a valid license file. Note that the ProCAST software is version protected and compiled with FLEXnet™ version 11.9.0. License files delivered for the previous ProCAST versions are not valid with this version of the software, except if your license does already contain the 2013 label.

System information must be retrieved before you can request your FLEXnet™ license files if required:

- For each PC machine that will be running ProCAST, execute `c:\flexlm\lmtools.exe`
- Select **System Settings** tab
- Send all the information on the left part (**Hostid Settings**) to your local ESI support representative with the “Save HOSTID Info to file” option.



Once you have received your(s) license file(s), it/they must be moved to the appropriate directory `c:\flexlm` on each machine with the file name `pam_lmd.lic`.

## Starting the FLEXnet™ License Server

The FLEXnet™ license server installation must be done with administrator privileges.

Once the ProCAST installation is completed, your `pam_lmd.lic` file must be moved to the appropriate directory, updated and the FLEXnet™ license server started.

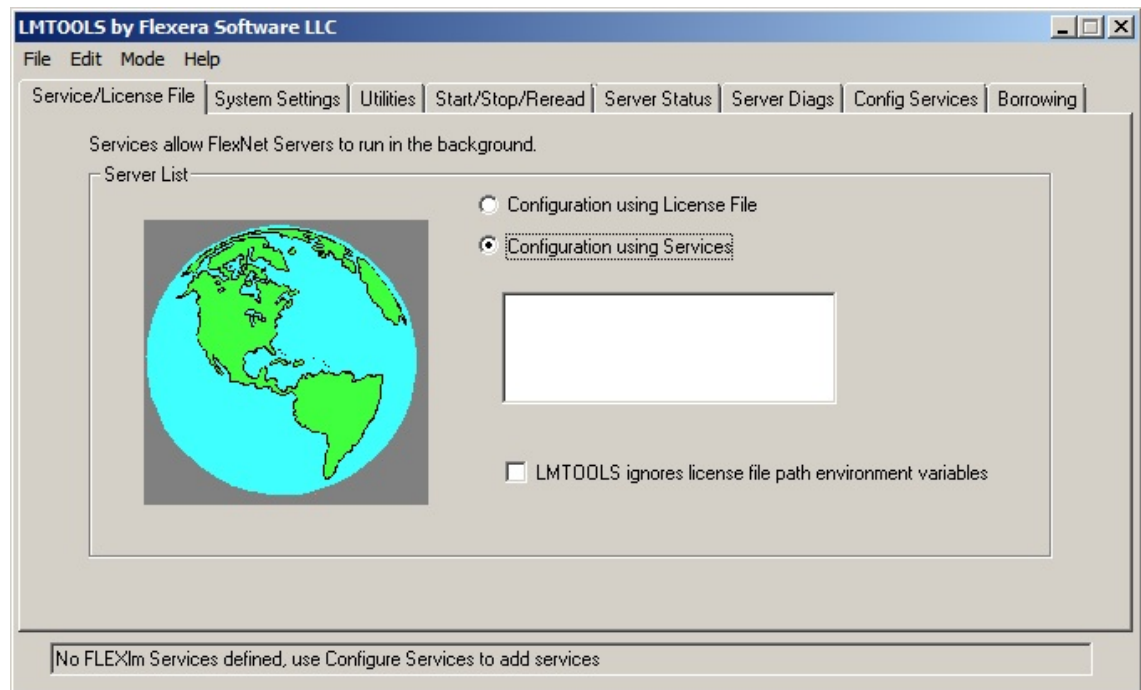
To move and update the license file:

- Move `pam_lmd.lic` to the directory `c:\flexlm`
- Using any usual text editor, edit `pam_lmd.lic` and adapt the **SERVER/VENDOR** lines if necessary

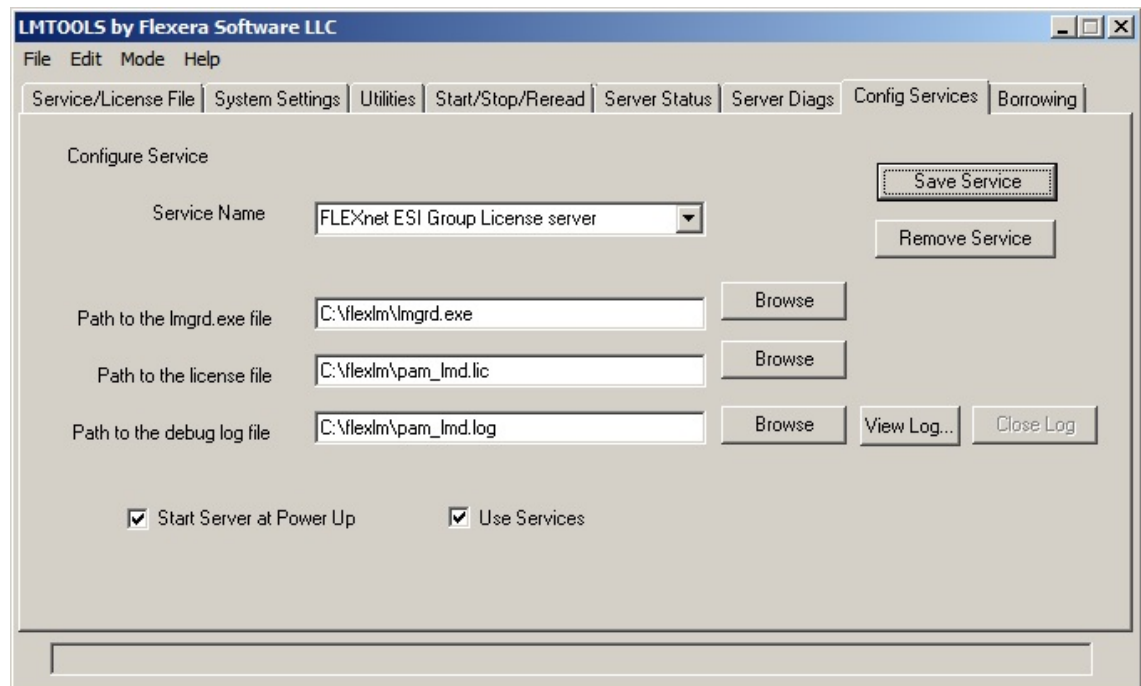
To start the license server:

- Execute `c:\flexlm\lmtools.exe`

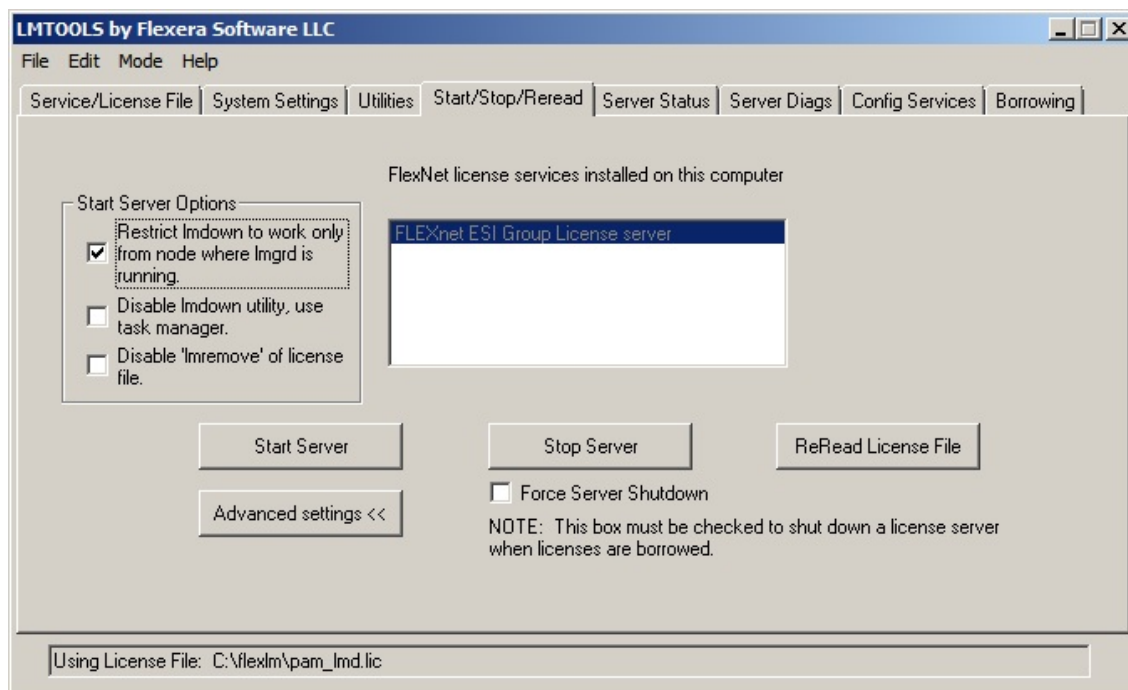
- Select the **Service/License file** tab and select **Configuration using Services**



- Select the **Configure Services** tab, adjust parameters as below and click the **Save Service** button



- Select the **Start/Stop/Reread** tab and click the **Start Server** button



After completing these installation steps, you may start using ProCAST.

Additional specific FLEXnet™ documentation is also provided with the software on the installation CD-ROM.

# SOFTWARE INSTALLATION ON LINUX

## Overview

To install the ProCAST product on **Linux** platforms, two installation procedures are available:

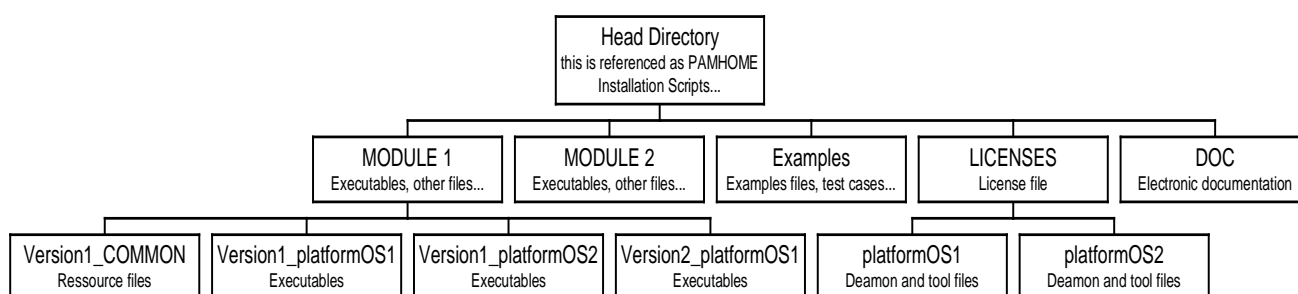
- **paminst-gui.sh** graphical User Interface script,
- **paminst.sh** command line script.

Both procedures perform the following tasks:

1. Install the software :
  - Copy from the CD-ROM all the software files to the chosen location.
2. License management :
  - Install the license file,
  - Start the license daemons *lmgrd* and *pam\_lmd* if needed,
  - Install the license daemon startup scripts\*.
3. Customization :
  - Set up the ESI Group software environment for each current user.

Tasks 2 and 3 can be performed later if the user does not want to do them immediately.

After the installation, the files installed on the hard disk are organized in a directory tree as indicated below:



\* Sufficient privileges may be required by the system during the installation of ESI Software products. Although no system library is updated in the process, sufficient privileges will be needed to mount the CD-ROM and to install the boot files to start the license server.

## CD-ROM Mounting Instructions

Insert the CD-ROM into the CD-ROM drive.

Follow the CD mounting and dismounting instructions in the table below.

When the installation is done, don't forget to quit the directory */cdrom* before ejecting the CD-ROM from the drive.

PLATFORM	MOUNTING	SPECIFIC INSTRUCTIONS	DISMOUNTING
PC Windows	Automatic	-	-
PC Linux	Automatic	-	eject

*# symbol is the SCSI Id number of the CD-ROM drive*  
*Device names in italics are site dependent*

## Graphical Installation

### System requirement:

The installation through graphical user interface is available on Linux. In order to use the graphical installation, you need an X compliant window system available on your display. You must position the **DISPLAY** environment variable for display on the current screen, and if necessary allow this display using an appropriate **xhost** command on the display host. You also need about 5 Mb of free space in */tmp*, in order to store graphical tools temporarily.

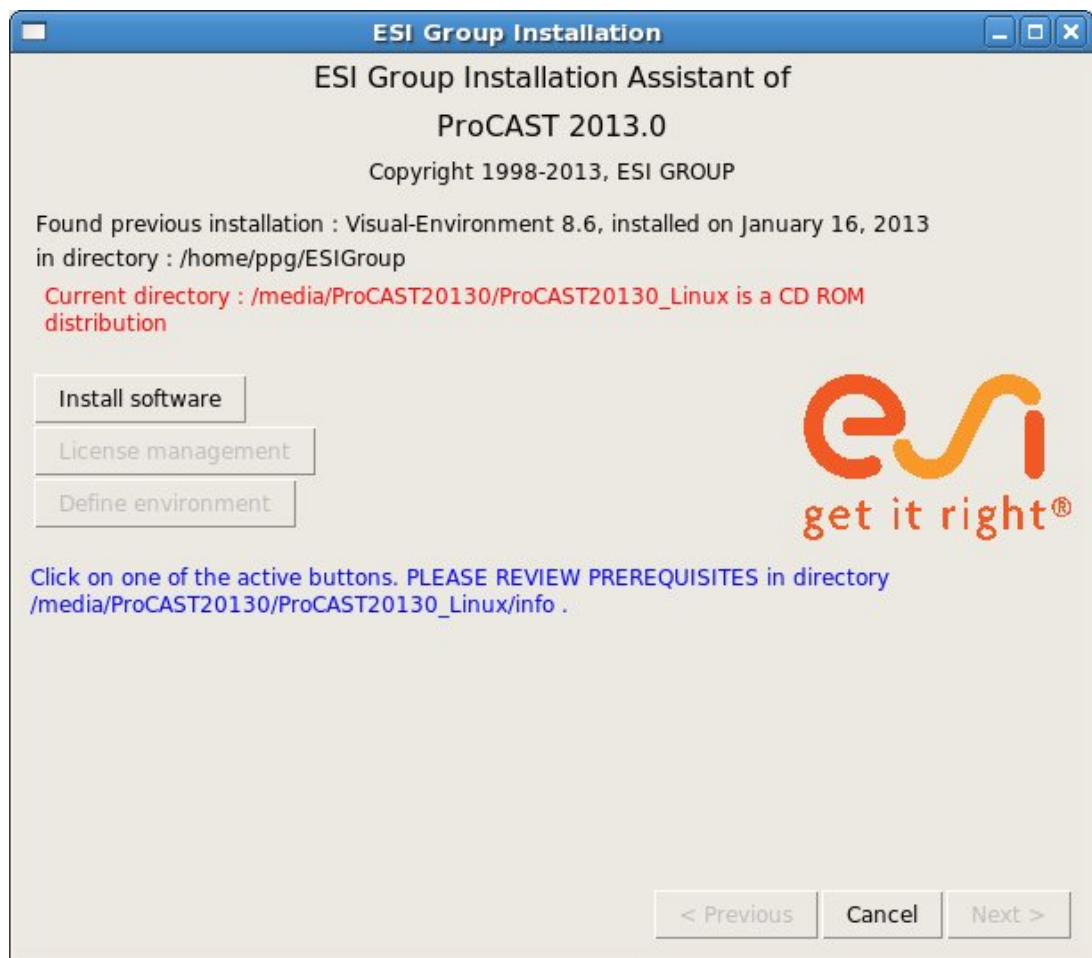
To start the graphical software installation script, go to the */cdrom* directory then type the following command:

```
. /INSTALL.SH
```

To complete the installation follow the instructions displayed in blue color in the dialog boxes presented by the installation tool.

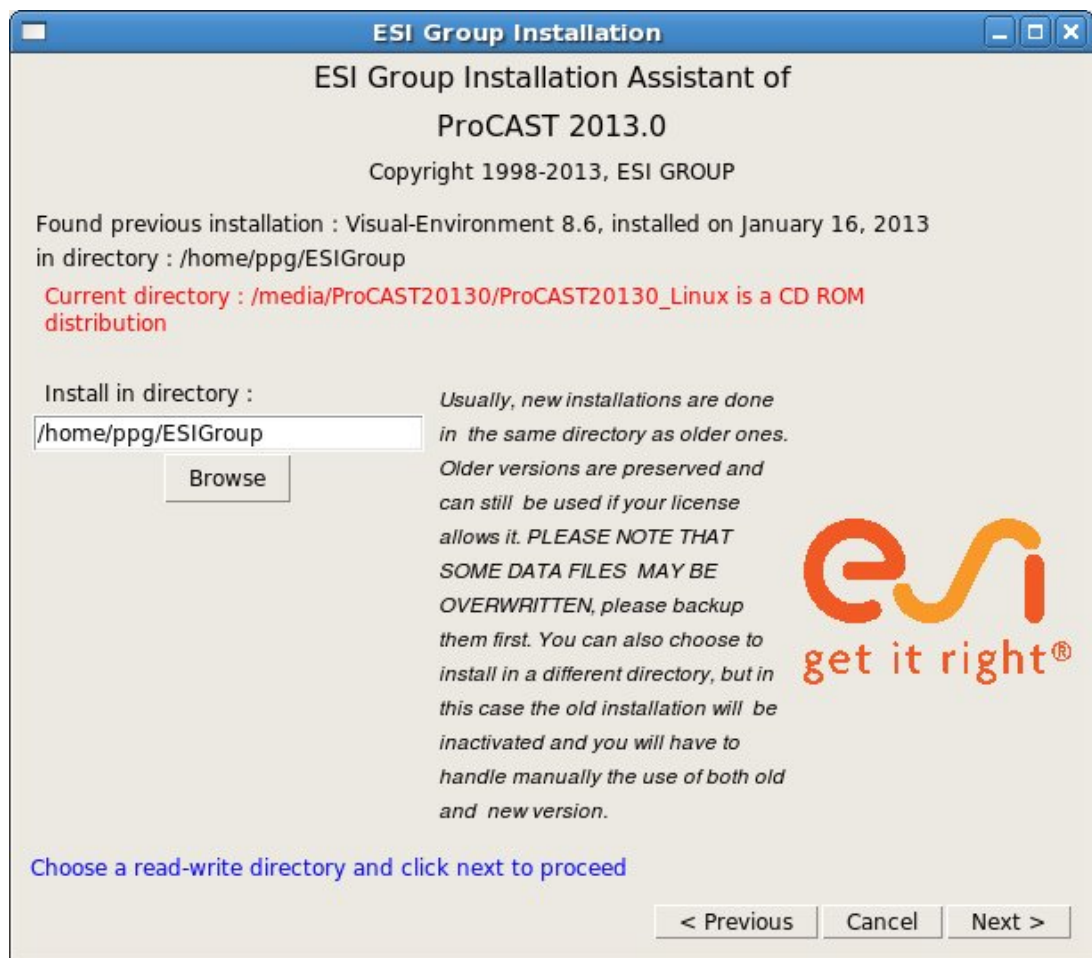
After the graphical tools are loaded in */tmp*, the main dialog box window appears:





*Main Dialog Box Window*

- Click the **Install software** button. It will highlight the **Next** button to continue.
- Click the **Next** button to continue the software installation.
- Click the **Cancel** button to abort/exit the software installation.



*Installation directory dialog box window*

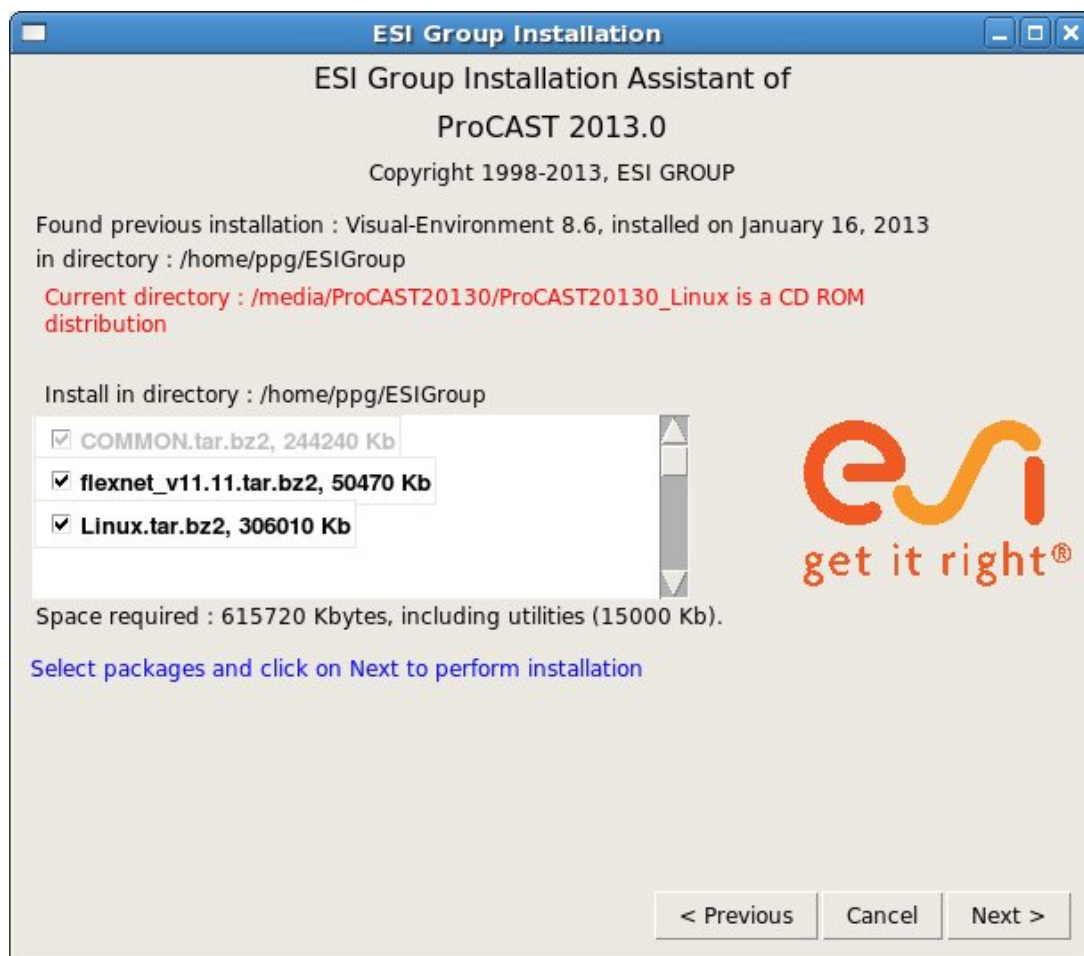
This dialog box is used to specify the installation directory.

By default, the text field of the installation directory is filled with the previous pathname of ESI Group software installation directory if any.

Two possibilities are available to select a new software installation location on the system:

- a. Click on and fill the text field with a valid pathname directory (read, write, execute permissions are required),
  - or
  - b. Click the **Browse** button to select another software installation location (see Directory selector dialog box for using it).
- Click the **Next** button when you are satisfied with the software installation directory selected.
  - Click the **Previous** button to go back to the main dialog box of the software installation.

## Package Selection:



*Package Selection Window*

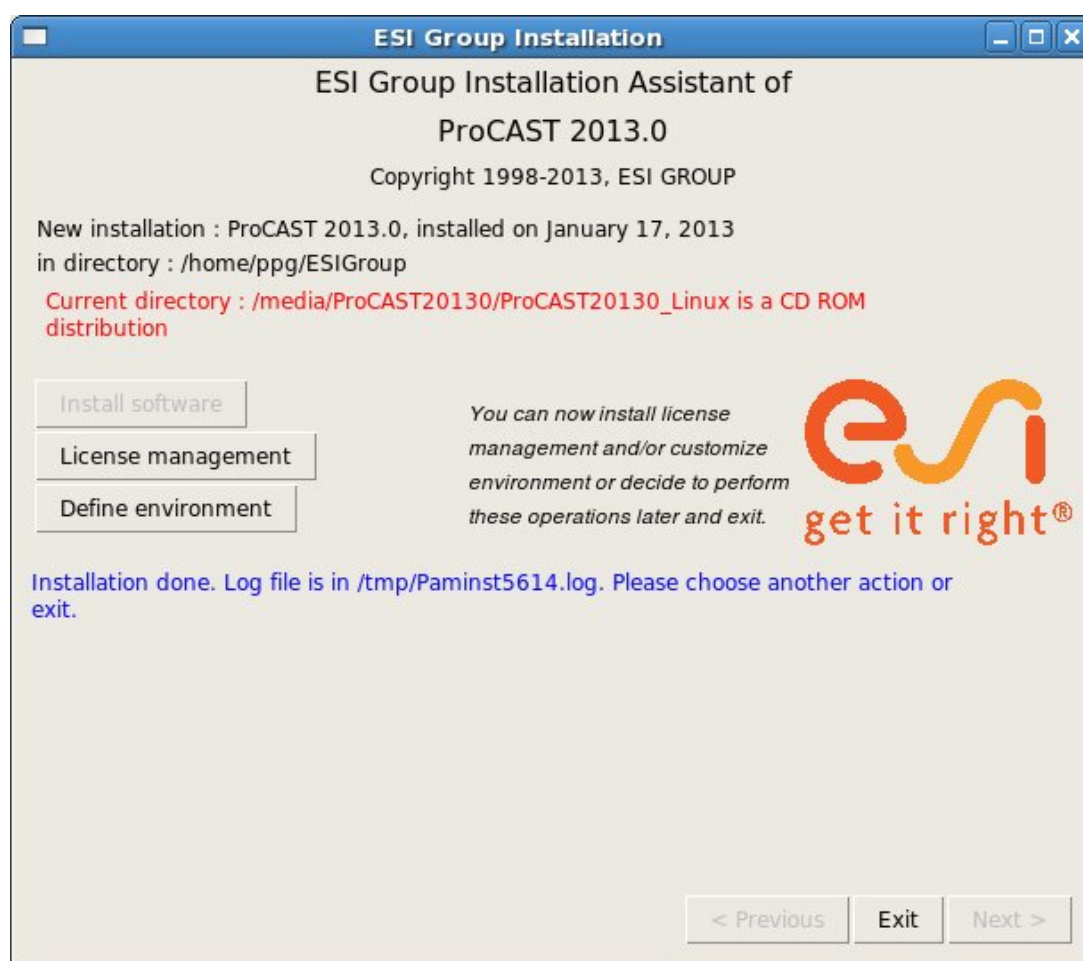
This dialog box is used to select all the software package(s).

- Select all the platform package(s) you wish to download on the system by clicking on the toggle(s) then click the **Next** button to continue. Note that, if not already done, the **flexnet\_v11.11** package should also be installed for all platforms.

A scrolled window is displayed showing the downloading of files.

When the downloading is finished, the **Close** button will be highlighted.

- Click **Close** to continue.



The main dialog box window appears again to perform the next steps, the license installation and/or Customization of the software environment.

- Click the **Exit** button if you wish to perform the License installation and software customization later.
- Click the **License management** button to install the license. A license file is needed to perform this task. For more detail, please and see the Installation of the license section.
- Click the **Define environment** button to customize the software environment. For more detail, please see the Customization section.

## Installation of the License

Before starting the license installation you should copy the new or updated FLEXnet™ license file provided by ESI Group representatives in the following directory PAMHOME/licenses with the filename pam\_lmd.temp.

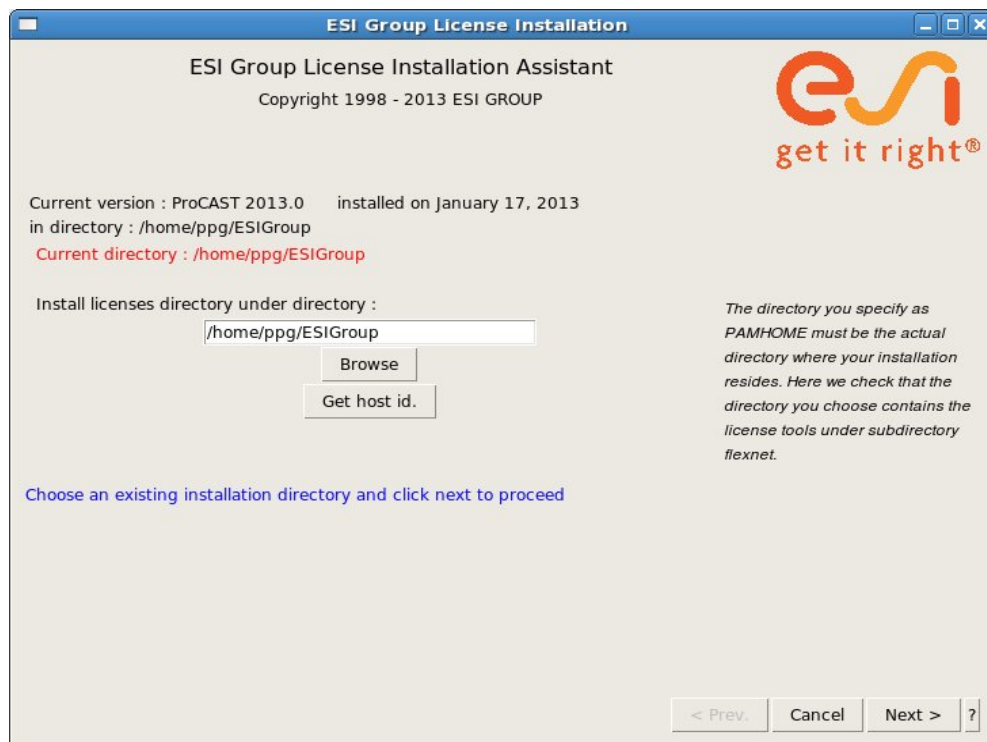
Note that the ProCAST software is version protected and compiled with FLEXnet™ version 11.6.1. License files delivered for the previous ProCAST versions are not valid

with this version of the software, except if your license does already contain the 2013 label.

The installation of the license should be performed on the system where the license server will run. To start the graphical license installation script, go to the software installation directory and type the following command:

```
./paminst-gui.sh lic or ./paminst-gui.sh install_lic
```

After the graphical tools are loaded in /tmp, the following assistant window appears:



Follow the instructions displayed [in blue color](#).

## Get host id. Button

- Click the **Get host id** button to get the information (hostname, hostid) of the system needed for license server installation (floating license) or standalone license (node-locked license). It will display the following window:



## License directory selection:

By default, the **Install licenses directory under directory:** text field is filled with the pathname of the previous software installation directory.

- Click the **Browse** button to redefine the pathname of the software installation directory.

### Note:

- *The specified directory in the text field should contain a licenses subdirectory with write permission to highlight the Next button.*
- Click the **Next** button when the installation directory pathname is selected. The license file is installed in the right location and the following dialog box appears:

The screenshot shows the 'ESI Group License Installation Assistant' window. It displays system information: 'Current system : runwor051.rungis.esi.fr', 'Current OS : Linux-lsb3\_x86\_64\_2.5', and 'Current directory : /home/ppg/ESIGroup'. Below this, there are two sections: 'CURRENT LICENSE FILE INFORMATION' and 'NEW LICENSE FILE INFORMATION'. The 'CURRENT' section shows 'Server line (0/0) : \*\*\* no file \*\*\*' and 'Daemon line (0/0) : \*\*\* no VENDOR line \*\*\*', with a 'Display file' button and 'Port used :'. The 'NEW' section shows 'Server line (0/0) : \*\*\* no SERVER lines \*\*\*' and 'Daemon line (0/0) : \*\*\* no VENDOR line \*\*\*', with a 'Display file' button, 'Use port :', and a 'Pending changes' message: 'Port modified, INVALID, server name INVALID'. At the bottom, there are buttons for 'Apply changes to new file', 'Save new file as current', 'Get another license file', '< Prev.', 'Cancel', 'Next >', and a help icon '?'. A blue link 'Review changes and click on appropriate button' is also present.



**Warning on Linux i686 or x86 64 based distributions:**

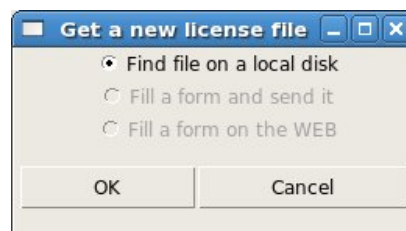
The FLEXnet Toolkit can only run on LSB3 (Linux Standard Base™) compliant Linux distributions.

The “*Current OS*” detail must display “Linux-lsb3\_i686” or “Linux-lsb3\_x86\_64” otherwise your Linux distribution cannot run a license server with this latest version of the FLEXnet Toolkit.

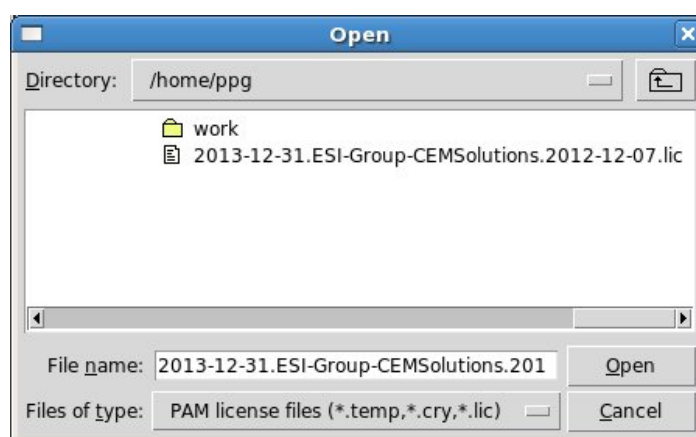
- Check that the following package is installed on the station:
  - RedHat Based Operating Systems:  
For RedHat, CentOS, Oracle Enterprise Server, Fedora ...: package **redhat-lsb**  
How to check installation: `rpm -q redhat-lsb`  
How to install it (as root or with sudo): `yum install redhat-lsb`
  - SUSE Based Operating Systems:  
For SUSE Enterprise, openSUSE ...: package **lsb**  
How to check installation: `rpm -q lsb`  
How to install it (as root or with sudo): `yast2 -i lsb`
  - Debian Based Operating Systems:  
For Debian, Ubuntu ...: package **lsb**  
How to check installation: `dpkg-query -l lsb`  
How to install it (as root or with sudo): `apt-get install lsb`

After this check, license file installation can continue.

- Click the **Get another license file** button to select a new license file.



- Click the **OK** button to find the new license file on the local disk. A new file browser window appears.



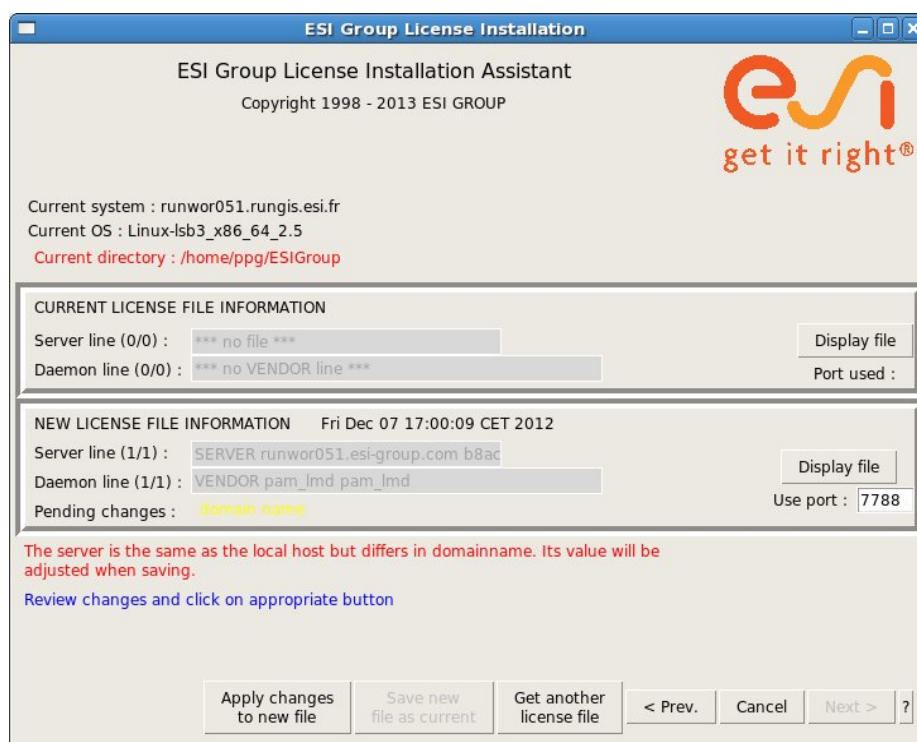
By default the file filter is set for find PAM license file.

- Select the new license file then click the **Open** button to validate the selection.

A small window pops up displaying the checking result of the selected license file with the host id.

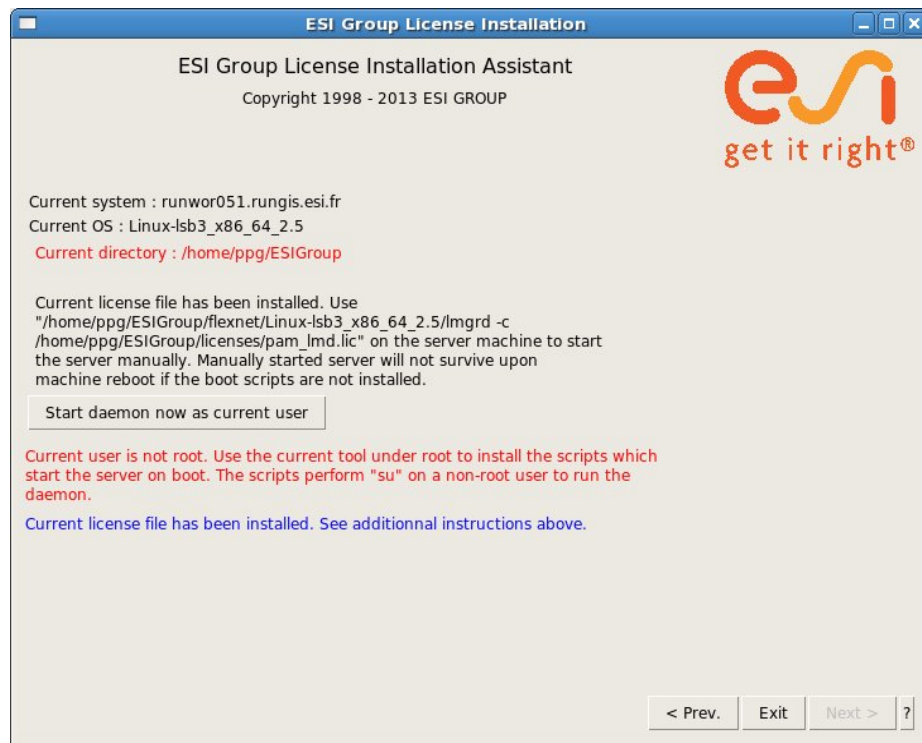


The dialog box of license file selection will be displayed again and filled with information corresponding to the selected license file.





- Click on Apply changes to new file and then on **Save new file as current** button.  
The new license file is installed and the **Next** button is activated to continue.
- Click the **Next** button to start the license daemons.

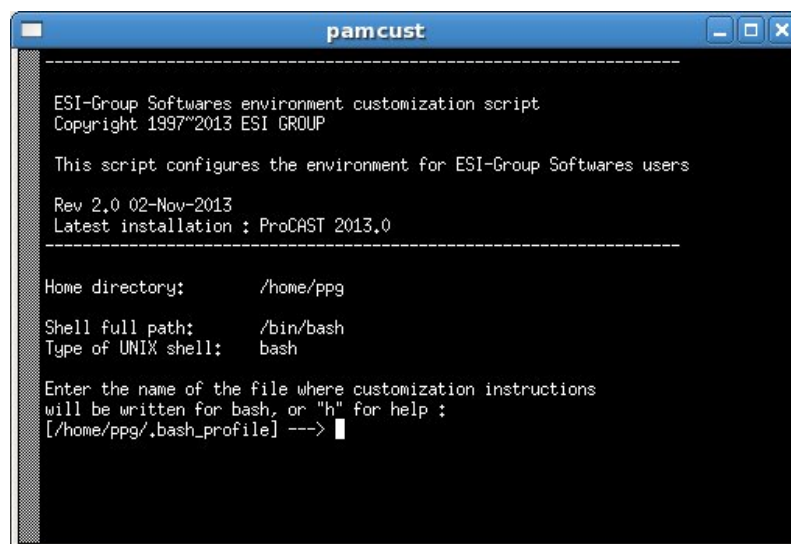


- Click the **Start daemon now as current user** button to start the daemon.

Additional specific FLEXnet™ documentation is also provided with the software on the installation CD-ROM.

## Customization

The ESI Group software installation script `paminst.sh` can be used for customization.



```
pamcust

-----
ESI-Group Softwares environment customization script
Copyright 1997-2013 ESI GROUP

This script configures the environment for ESI-Group Softwares users

Rev 2.0 02-Nov-2013
Latest installation : ProCAST 2013,0
-----

Home directory:      /home/ppg
Shell full path:     /bin/bash
Type of UNIX shell:  bash

Enter the name of the file where customization instructions
will be written for bash, or "h" for help :
[/home/ppg/.bash_profile] --> |
```

This customization is done with `pamcust.sh` which can also be used separately. To perform the customization separately:

- Log in on the machine on which you want to perform the customizations,
- Change directory to the `$PAMHOME` directory where the installation has been done,
- Type `./pamcust.sh` and follow the instructions.

The customization script creates definitions to allow access to the ProCAST executables and configuration files for all users or for selected users, depending on the method selected. The software configuration is defined in the following files:

- `psi.Cenv` for **csh** and derivatives,
- `psi.Kenv` for **ksh** and derivatives,
- `Psi.Baenv` for **bash**.

Note that **sh** is not supported, due to its lack of functionality necessary for ESI Group products. We recommend **sh** users to migrate to **ksh** which preserves **sh** syntax and habits.

The customization procedure will automatically update the `.cshrc`, `.profile` or `.bash_profile` files accordingly, as shown below.

C Shell - .cshrc file	<pre> ### ESI-Group begin ### # #       ESI-Group Software environment # setenv PAMHOME /home/ppg/ESIGroup setenv PAMENV \$PAMHOME/env-`uname` if ( -r \$PAMENV/psi.Cenv ) then     source \$PAMENV/psi.Cenv endif ### ESI-Group end ### </pre>
Korn Shell - .profile	<pre> ### ESI-Group begin ### # #       ESI-Group Software environment # PAMHOME=/home/ppg/ESIGroup; export PAMHOME PAMENV=\$PAMHOME/env-`uname`; export PAMENV if [ -r \$PAMENV/psi.Cenv ]; then     . \$PAMENV/psi.Kenv fi ENV=\${ENV:""} if [ -z "\$ENV" ]; then     ENV=\$HOME/.kshrc; export ENV fi ### ESI-Group end ### </pre>
Bourne Again Shell - .bash_profile	<pre> ### ESI-Group begin ### # #       ESI-Group Software environment # PAMHOME=/home/ppg/ESIGroup; export PAMHOME PAMENV=\$PAMHOME/env-`uname`; export PAMENV if [ -r \$PAMENV/psi.Baenv ]; then     . \$PAMENV/psi.Baenv fi if [ -z "\$BASH_ENV" ]; then     BASH_ENV=\$HOME/.bashrc; export BASH_ENV fi ### ESI-Group end ### </pre>

The same procedure must be repeated for the customization of each candidate user.

---

# GETTING STARTED

## Starting the Software

### For Windows platforms:

When the software is installed on Windows, a file folder named ESI Group is automatically created on the computer Desktop. Inside this folder, "ProCAST 2013.0" and "Visual-Cast 8.6" icons are present. A double click on the corresponding icon will automatically start the software manager, respectively the new environment and give access to the different product modules.

### For Linux platforms:

The installation procedure includes a customization procedure. The customization script creates definitions to allow access to the different executables and configuration files for all users or for selected users, depending on the method chosen.

After a complete and successful product installation, necessary environment variables and aliases are automatically defined to start different product modules. Type the following commands for a direct access:

- **cast** for the software manager,
- **meshcast** for the mesh generator,
- **precast** for the pre-processor,
- **datacast** , **procast** and **procastdmp** for the solvers,
- **vcast** for the new post-processor VisualCAST.

Note that access to previous versions of ProCAST is possible with modified aliases. For instance, type **cast11** for the ProCAST 2011.0 software manager.

## On-line Product Documentation

On-line product documentation is available for most ProCAST features. Two manuals are provided with the standard installation: the *MeshCAST User Manual* and the *ProCAST User manual*. These User Manuals provide extensive information to guide users through the different modules of ProCAST, to explain the use of different software features as well as to give technical information on models and algorithms.

Refer to the *User Manual* and in particular to the *What's New / Version 2013.0* section for detailed information on all new and improved product features.

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# AVAILABLE PLATFORMS AND PRE-REQUISITES

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## PRODUCT AVAILABILITY

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ProCAST has currently been tested and validated on the following hardware platforms:

***Solver & Visual Environment:***

Vendor	Processor	OS	Memory addressing
Windows	Intel / AMD	Windows XP SP3 Windows 7	64 bits
Linux	Intel / AMD	Redhat EL5 & 6	64 bits

Refer to the Visual Environment product documentation and in particular to the *VisualEnvironment-8.6\_InstallationGuide.pdf* document for detailed information on hardware requirements.

***Remarks:***

- *The ProCAST 2013.0 package requires the installation of the Visual-Environment 8.6 version.*

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## AVAILABILITY OF THE ProCAST DMP VERSION

The ProCAST DMP version is included on the installation CD-ROM.

The standard DMP parallel version of ProCAST is currently available on

- Linux 64 bits Redhat Enterprise Linux 5 & 6 using PCMPI, PETSc and ParMetis libraries (Linux kernel above 2.4.21 and glibc version above 2.3.2),
- Windows 64 bits XP and above using PCMPI, PETSc and Parametis libraries.

The PCMPI: Message Passing Interface version 8.2.1 on Linux and Windows are used and required runtime libraries are included in the software package.

The PETSc: Portable, Extensible Toolkit for Scientific Computation (Copyright 1995-2004, University of Chicago) version 3.3-p3 is used on all platforms and required runtime libraries are included in the software package when appropriate.

The ParMetis version 3.1.1 is used on all platforms for dynamic domain partitioning and required runtime libraries are included in the software package when appropriate.

For additional information, refer to the *User Manual* and in particular to the *Parallel solver / Use of the parallel solver* section for a detailed description of the necessary commands.

---

## GENERAL REQUIREMENTS

In the list below, some global recommendations are given for running ProCAST on the various platforms. Please consult with the local ESI Group support for more information.

- A minimum of 8 Gb (ideally 16Gb) of memory is required to operate the software. More memory is however recommended for large industrial applications.
- OpenGL hardware graphic accelerator is highly recommended. Screen resolution should be set to at least 1280\*1024 with small fonts selected.
- 3.0 GB disk (free) space required in the Program Files folder for complete installation
- Consult the information provided in the installation directory `$PAMHOME/info/README_ProCAST_2013.0` for a complete list of run time libraries and pre-requisites corresponding to each platform.
- For access to on-line documentation, Firefox (or equivalent) is required on all Linux platforms.
- For optimal graphics performance on Windows platforms, the installation of the latest graphics drivers is recommended.
- 3 button mouse is required (middle mouse button required for dynamic rotations in graphics window with Visual-Cast).
- ProCAST 2013.0 requires the installation of the Visual-Environment 8.6 version.
- On Linux and Windows platforms, the `icc` compiler version 12.1 is used for the solver compilation.
- To compile User functions, the following compilers should be available on the target platform:
  - Windows : Microsoft Visual C++ 2008 Express Edition
  - Linux : Intel *icc* compiler version 12.1 or gcc compiler version 3.2.3





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# SURVEY

The information you will provide is of highest value for us in order to better understand your expectations and to enhance our services. Therefore, we warmly thank you in advance for the time and assiduous attention you will devote to filling in this form and for sending it back by fax (+41 21 693 4740), post mail to Marco Aloe / Calcom ESI / Parc Scientifique EPFL / PSE-A / CH-1015 Lausanne / Switzerland or by email to support.cast@esi-group.com.

1	GENERAL INFORMATION	Your data :
1.1	Name of the company	
1.2	Field of activity	
1.3	Department or service	
1.4	Address 1	
1.5	Address 2	
1.6	Your first and last name	
1.7	Your title or function	
1.8	Your direct phone and fax	
1.9	E-mail	
2	INFORMATION ON THE PRODUCT FEATURES	
2.1	Operating system (Windows, Linux, other...)	
2.2	How long have you been using this product?	
2.3	How many people are using this product?	



		Your assessment :			
3	PERFORMANCE OF THE PRODUCT	Unsatisfactory	Fair	Good	Excellent
3.1	Meshing time from CAD import	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.2	Pre-processing effectiveness / relevancy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.3	Simulation time	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.4	Solver stability :				
	3.4.1 thermal simulation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	3.4.2 fluid-flow simulation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	3.4.3 stress simulation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	3.4.4 ..... simulation (***)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	3.4.5 ..... simulation (***)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.5	Accuracy and relevancy of the results according to each feature :				
	3.5.1 thermal simulation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	3.5.2 fluid-flow simulation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	3.5.3 stress simulation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	3.5.4 ..... simulation (***)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	3.5.5 ..... simulation (***)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.6	Post-processing effectiveness and relevancy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.7	General graphic rendering of software	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.8	User-friendliness, comprehensibility, ease of navigation in menus	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.9	User manual, release notes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

(\*\*\*) Please mention the additional simulation features, if any, you work with



		Your assessment :			
4	PERFORMANCE OF THE RELATED SERVICES	Unsatisfactory	Fair	Good	Excellent
4.1	Frequency of product's delivery (CD-ROM and accessories)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.2	Packaging of the delivered product (CD-ROM and accessories)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.3	Ease of installation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.4	License key delivery	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.5	Answer's accuracy of our hot line (with respect to software)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.6	Answer's quickness of our hot line (with respect to software)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.7	Training quality	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.8	Commercial follow-up	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.9	Overall assessment	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

5	EVOLUTION OF THE PRODUCT			
5.1	Simulation's accuracy	↘	→	↗
5.2	CPU time	↘	→	↗
5.3	Software stability	↘	→	↗
5.4	Number of functionalities	↘	→	↗
5.5	Graphical User Interface (GUI)	↘	→	↗

Please circle the arrow corresponding to the evolution of the product you have observed over the last years.

Comments







**ESI Group  
Headquarters**  
100-102 Avenue de Suffren  
75015 Paris  
France  
T. +33 (0)1 53 65 14 14  
F. +33 (0)1 53 65 14 12

## EUROPE

### BENELUX & SCANDINAVIA

**ESI Group Netherlands**  
Radex Innovation Centre  
room 4.57  
Rotterdamseweg 183 C  
2629 HD Delft  
The Netherlands  
T. +31 (0)15 2682501  
F. +31 (0)15 2682514

### CZECH REPUBLIC & EASTERN EUROPE

**MECAS ESI**  
Brojova 2113/16  
326 00 Pilsen  
Czech Republic  
T. +420 377 432 931  
F. +420 377 432 930

### FRANCE

**ESI France  
Headquarters**  
Parc d'Affaires Silic  
99, rue des Solets - BP 80112  
94513 Rungis Cedex - France  
T. +33 (0)1 49 78 28 00  
F. +33 (0)1 46 87 72 02

**ESI France**  
Le Récamier  
70, rue Robert  
69458 Lyon Cedex 06  
France  
T. +33 (0)4 78 14 12 00  
F. +33 (0)4 78 14 12 01

### SPAIN

**ESI Group Hispania  
Headquarters**  
Parque Empresarial Arroyo  
de la Vega  
C/ Francisca Delgado, 11.  
Planta 3ª - 28108 Alcobendas  
Madrid - Spain  
T. +34 91 484 02 56  
F. +34 91 484 02 55

**ESI Group Hispania, S.L.**  
C/ Balmes, 188  
Oficinas B188  
08006 - Barcelona  
Spain  
T. +34 93 152 10 25  
F. +34 93 218 01 01

### GERMANY

**ESI GmbH  
Headquarters**  
Mergenthalerallee 15-21  
D-65760 Eschborn - Germany  
T. +49(0)6196 9583 0  
F. +49(0)6196 9583 111

**ESI GmbH**  
Werner-Eckert-Str. 6  
81829 München - Germany  
T. +49 89 45 10 888 0  
F. +49 89 45 10 888 18

### GERMANY

**ESI GmbH**  
Kruppstr. 82-100 / ETEC  
V5-105  
45145 Essen  
Germany  
T. +49 (0)201 125 072 0  
F. +49 (0)201 125 072 24

**ESI GmbH**  
Jurastr. 8,  
70565 Stuttgart  
Germany  
T. +49 (0) 711 27 303 0  
F. +49 (0) 711 27 303 110

### ITALY

**ESI Italia**  
Via San Donato 191  
40127 Bologna  
Italy  
T. +39 0516335577  
T. +39 0516335578  
F. +39 0516335601

### SWEDEN

**Efield ESI**  
Sjoangvägen 15  
SE-192 72 Sollentuna  
Sweden  
T. +46 8 410 03 511  
M. +46 70 999 18 71

### SWITZERLAND

**Calcom ESI**  
Parc Scientifique EPFL /  
PSE-A  
CH-1015 Lausanne  
Switzerland  
T. +41 21 693 2918  
F. +41 21 693 4740

### UNITED KINGDOM

**ESI UK**  
16 Morston Court,  
Kingswood Lakeside,  
Cannock, WS11 8JB  
United Kingdom  
T. +44 (0) 1543397900  
F. +44 (0) 1543504898

## ASIA

### CHINA

**ESI China**  
Unit 1006-1008,  
Metropolis Tower  
No. 2 Haidiandongsanjie,  
Haidian District,  
Beijing, 100080 - China  
T. +86 (10)-65544907/8/9  
F. +86 (10)-65544911

### INDIA

**ESI India  
Headquarters**  
No. 24-25, Ground floor  
27th Cross Banashankri  
2nd stage  
Bangalore 560 070  
India  
T. +91 80 4017 4747  
F. +91 80 4017 4705

**ESI MW India**  
502, Pentagon 2,  
Magarpatta City  
Pune - 411 013  
Maharashtra  
India  
T. +91-20-26898  
172/173/175/229  
F. +91-20-26898 239

### JAPAN

**ESI Japan  
Headquarters**  
15F and 16F Shinjuku Green  
Tower Bldg, 6-14-1,  
Nishi-Shinjuku  
Shinjuku-ku, Tokyo 160-0023  
Japan  
T. +81 3 6381 8490 / 8494  
F. +81 3 6381 8488 / 8489

**ESI Japan  
Kansai Branch Office**  
Nishi-Nihon Sales office  
5F Advance Esaka Bldg,  
8-10 Toyotsu-cho  
Suita-shi,  
Osaka 564-0051  
Japan  
T. +81 6 6330 2720  
F. +81 6 6330 2740

**ESI Japan  
Chubu Branch Office**  
9F Daisan Horiuchi Bldg.  
4-6-23, Meieki  
Nakamura-ku, Nagoya-shi,  
Aichi 450-0002  
Japan  
T. +81 52 589 7100  
F. +81 52 589 7001

### RUSSIA

**ESI Russia**  
Vainera str. 51b, 3<sup>rd</sup> floor  
620014, Yekaterinburg  
Russian Federation  
C. +7 919 361 14 80  
T./F. +7 343 311 02 33

## AMERICAS

### USA

**ESI North America  
Headquarters**  
32605 W 12 Mile Road,  
Suite 350,  
Farmington Hills,  
MI 48334-3379  
USA  
T. +1 (248) 381-8040  
F. +1 (248) 381-8998

**ESI North America**  
12555 High Bluff Drive  
Suite 250  
San Diego, CA 92130  
USA  
T. +1 (858) 350 0057  
F. +1 (858) 350 8328

**ESI South America**  
2880 Zanker Road  
Suite 105  
San Jose, CA 95134  
USA  
T. +1 (408) 824 1212  
F. +1 (408) 824 1216

**ESI North America**  
6767 Old Madison Pike  
Suite 600  
Huntsville, AL 35806  
USA  
T. +1 (256) 713-4700  
F. +1 (256) 713-4799

### SOUTH AMERICA

**ESI South America**  
Av. Pedrosa de Moraes,  
1619 cj.312  
São Paulo  
SP CEP 05419-001  
Brazil  
T./F. +55 (011) 3031-6221



info@esi-group.com



## ABOUT ESI GROUP

ESI is a pioneer and world-leading provider in Virtual Prototyping that takes into account the physics of materials. ESI boasts a unique know-how in Virtual Product Engineering, based on an integrated suite of coherent, industry-oriented applications. Addressing manufacturing industries, Virtual Product Engineering aims to replace physical prototypes by realistically simulating a product's behavior during testing, to fine-tune fabrication and assembly processes in accordance with desired product performance, and to evaluate the impact of product use under normal or accidental conditions. ESI's solutions fit into a single collaborative and open environment for End-to-End Virtual Prototyping. These solutions are delivered using the latest technologies, including immersive Virtual Reality, to bring products to life in 3D; helping customers make the right decisions throughout product development. The company employs about 900 high-level specialists worldwide covering more than 30 countries. ESI Group is listed in compartment C of NYSE Euronext Paris.