



Visual Analysis for Extremely Large-Scale Scientific Computing

Evaluation Event

USE CASE 2: Discrete Element Simulation (DEM) Simulation Tool & Discrete2Continuum (D2C): GiD



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1 GiD Installation Guide

1.1 Download and installation of GiD

- Enter to <u>www.gidhome.com/download/developer-versions</u>
- Download the 13.1.1d (developer version) for your operating system
- Install it in your computer.

1.2 Get a password of GiD 13

• The first time you open GiD, the Help->Register GiD window will appear:

Enter	password window
Con	tact gid@cimne.upc.edu to obtain the password for this host:
Nan Ope Sysi or g	ne: gigri irating System: windows info: 0969418eacbb02ba et it from: www.gidhome.com/password
Ente	r the password:
	Ok Evaluation Cancel

- In case you already have a password for a GiD v13 installed in your computer, you can get the password from it by clicking the button in the lower right part of the window (icon with a folder) and selecting the path where the other GiD is installed.
- In case you don't have a password for GiD v13, you should ask for a free temporary password:
 - Go to:









- Select 'Local' type of license, and 'One month (free)' period of time
- Follow the instructions and click 'Send'
- A free password for one month of duration will be given to you in the web site, and you should put in the 'Register GiD window' and click ok.
- In the upper right part of GiD window, the icon indicating if GiD has password or not should be changed from red to green.

1.3 Installation of VELaSSCo plug-in

- Select the option '*Problem type -> Internet Retrieve...*' from the '*Data*' menu.
- In the appearing window (see Figure below), select the module '*VELaSSCo*' and click '*Retrieve module*'. Note that you need internet connection for retrieving it.

😣 🖨 🗊 🛛 R	etrieve	modules				
Note: In order to use this function, it is necessary to be connected to internet						
-Category Filter						
X Simulation programs X Interfaces X Plugins X Examples X Documents X Themes X Not installed X Compatible						🗙 Not installed 🗶 Compatible
<u>L</u> inux 64 O	ther OS					
Module		Version	Platform	Installed	Publish date	Characteristics
Tdyn		11.0.9	Linux 64		22.06.2011	Tdyn - Multiphysics coupled s
LsDyna-exa	mples	2.1	All All		11.10.2013	Examples using the GiD LS-DY
Nastran		4.1	All All		20.06.2012	Interface to NASTRAN progra
Nastran-exa	amples	4.1	All All		20.06.2012	Examples using the GiD NAST
Abaqus		4.0.1	All All		04.01.2016	Interface to Abaqus program
Fluent		1.2	All All		21.12.2012	Interface to Fluent v.6 (CDF a
MAT-fem 1.1		1.1	All All		27.12.2012	Interface to solve problems us
OpenFoam		1.1	All All		20.03.2013	Interface to OpenFOAM (CDF
Kratos		5.0.15642	Linux 64		30.05.2016	Multiphysics solver and frame
VELaSSCo 1.		1.0.2	Linux 64		21.10.2016	Visualization For Extremely La
1						
Retriev	ve module	e N	Iodule information		Module news	Close

1.4 Connect to EDDIE Cluster

- The usernames created for the Evaluation Event to connect to the VPN network are **velgst2** to **velgst50** (the first 9 have only 7 characters).
- Each one has an initial/registration EASE password set to "VELaSSCo". This will have to be changed through the EASE webpage (<u>https://www.ease.ed.ac.uk/</u>).
- Setup VPN connection to EDDIE cluster following the instructions provided in the URL: <u>http://www.ed.ac.uk/information-services/computing/desktop-personal/vpn/vpn-service-using</u>
- Once connected to VPN, to login in into VELaSCCo will be need provided the following info into the GiD access window:







- Multi-user connection:
 - Username: velassco (default)
 - Password: --- (default)
 - VELaSSCo host: velassco-cluster01-ext.ecdf.ed.ac.uk
 - Port: provided individually by mail. Please check the invitation mail.
- Tunnel through:
 - Tunnel host: velassco-cluster01-ext.ecdf.ed.ac.uk
 - Local Port: same value that Port.
 - Username: provided individually by mail. Please check the invitation mail.
 - Password: provided individually by mail. Please check the invitation mail.

Next, it is provided an example of an instantiation of GiD access windows for the user "velgst37" in Linux:

😣 🖨 🗊 🛛 VELaS	SCo access window
VELas	SSCo login
X Multi-user conn	nection
Username:	velassco
Password:	******
VELaSSCo host:	velassco-cluster01-ext.ecd
Port:	26267
X Tunnel through	n:
Tunnel host:	velassco-cluster01-ext.ecd
local port:	26267
Username:	velgst37
Password:	******
	Logged in
Login	Status Logout







In MS Windows the connection window is slightly different because you need to enter the password on a separate window:

GD VELaSSCo access with	ndow) [CD VELaSSCo access wi	ndow
VELaSSO	Co login		VELaSS	Co login
Multi-user connecti	ion		Multi-user connect	ion
Username:	velassco		Username:	velassco
Password:	******		Password:	******
VELaSSCo host:	velassco-cluster01-ext.		VELaSSCo host:	velassco-cluster01-ext.
Port:	26267		Port:	26267
X Tunnel through:			X Tunnel through:	
Tunnel host:	ter01-ext.ecdf.ed.ac.uk		Tunnel host:	ter01-ext.ecdf.ed.ac.uk
local port:	26267		local port:	26267
Username:	velgst37		Username:	velgst37
pass entry delay (s):	10		pass entry delay (s):	10
Not I	ogged in		Lo	gged in
Login	itatus Logout		Login	Status Logout
š				



🧬 velassco-cluster01	-ext.ecdf.ed.ac.uk - PuTTY	_	Marca I	
Using username velgst37@velass	"velgst37". co-cluster01-ext.	ecdf.ed.ac.uk's	password:	







2 User instructions and brief tasks description

Thank you for your participation in this study. You will carry out the tasks on your own in the presence of a facilitator. The facilitator will be giving hints, asking questions, observing your responses to the exercises and supporting you during the whole process. The study will comprise a series of tasks, to be completed one at a time; i.e. once the facilitator, who would be observing your interactions, agrees that you have concluded one task, you will be presented another one.

The study is about the use of VELaSCCo Platform by means of GiD or IFX visualizations clients to operate with a FEM or DEM simulation previously calculated and injected into the Platform. You will be asked to carry out tasks that involve simple simulations actions on the client side.

During the session you have the following tools at your disposal:

- VELaSSCo Open Platform
- GiD Client V.13.1.1d (Visualization Tool)
- Text editor and viewer (e.g. Notepad, Word,...)
- Web browser

Your work may be monitored and at the end you will be asked to fill in a simple questionnaire. This will help us understand how people use VELaSCCo Platform and Visualization Clients, how efficient and effective is the VELaSCCo Platform, etc.







2.1 Fluidized Bed Model Description

Fluidized bed processes are very common in pharmaceutical and chemical industries. The Fluidized Bed model selected has the following settings:

- ~ 12,000 particles per time-step
- ~ 3,000 contacts (p2p and p2w) per time-step.
- 48,000 time-steps.
- Particle results: mass, volume, velocity vector
- Contact results: Force vector.









2.2 Rail Embankment Model Description

Simulations with a high frequency output that cover long time durations are difficult to deal with on a desktop machine due to the large quantity of data generated. The rail embankment model selected has the following settings:

- 207,440 particles per time-step
- ~ 560,000 contacts (p2p and p2w) per time-step.
- 9,102 time-steps 100Hz output.
- Particle results: mass, volume, velocity vector, angular velocity vector
- Contact results: Force vector.



This results in a total data file size of approximately 540 GB generated by the DEM solver.







2.3 Introduction to necessary VELaSSCo Functionality

The following figure highlights the necessary tools used in this uses and the user should familiarise themselves with the layout with the GiD visualization client:











2.4 Task 1: Use Case DEM.M1-01 & M1-02

2.4.1 Motivation

Connect to the VELaSSCo platform and visualise the particle assembly in the visualisation client. Get a result on a particle; concretely get the velocity value specifying a concrete particle id and time-step.

2.4.2 Specification

• Load VELaSSCo module:



• Connect to VELaSSCo Server using GiD (You will have received separate instruction about user-names and ports to use):







Evaluation Event

💷 VELaSSCo acce — 🗆 🗙	💷 VELaSSCo acce — 🗆 🗙
VELaSSCo login	VELaSSCo login
Multi-user connection	Multi-user connection
Username: velassco	Username: velassco
Password: *******	Password: ******
VELaSSCo host: velassco-cluster01-ext.	VELaSSCo host: velassco-cluster01-ext.
Port: 26626	Port: 26626
X Tunnel through:	Tunnel through:
Tunnel host: velassco-cluster01-ext.	Tunnel host: velassco-cluster01-ext.
local port: 9990	local port: 9990
Username: velassco	Username: velassco
pass entry delay (s): 10	pass entry delay (s): 10
Not logged in	Logged in
Login Status Logout	Login Status Logout

Open a simulation model from the 'open a model' tool option

 Select Fluidized Bed Large model (FluidizedBed_large)

VELaSSCo model selection			- 🗆 X
VELaSSCo model selection			
Group qualifier: *	Name pattern: * Refresh table		
Name	Full path	Location	Model ID
NexembankmentTest,0,1m,77K D2C,Fluidzeldes_mall EmbankmentAnalysis FullEmbankment,70kmph_10Cycles VEL8SCo_HbaseBasicTest_part FluidisedBed_ment_70kmph_10Timesteps FluidisedBed_small FullEmbankment_70kmph_10Timesteps FluidisedBed_large fluidisedBed_large fluidisedBed_large Barcelona_fullmodel_dm_370M_ascii Barcelona_fullmodel_dm_370M_ascii fine_mesh-ascil_ VEL8SSCo_HbaseBasicTest_part_	<pre>/export/scce/datatore/eng/aroup/velasso/imulation_files/RaiEmbankment/NewEmbankmentTest_0_Im_77K/ /export/scce/datatore/eng/aroup/velasso/imulation_files/RaiEmbankment_10Timesteps/mesh/ /export/scce/datatore/eng/aroup/velasso/imulation_files/RaiEmbankment_10Timesteps/mesh/ /export/scce/datatore/eng/aroup/velasso/imulation_files/RaiEmbankment_10Timesteps/ /export/scce/datatore/eng/aroup/velasso/imulation_files/RaiEmbankment_10Timesteps/ /export/scce/datatore/eng/aroup/velasso/imulation_files/RaiEmbankment_10Timesteps/ /export/scce/datatore/eng/aroup/velasso/imulation_files/RaiEmbankment_10Timesteps/ /export/scce/datatore/eng/aroup/velasso/imulation_files/RaiEmbankment_10Timesteps/ /exports/scce/datatore/eng/aroup/velasso/imulation_files/RaiEmbankment_10Timesteps/ /exports/scce/datatore/eng/aroup/velasso/imulation_files/RaiEmbankment_10Timesteps/ /exports/scce/datatore/eng/aroup/velasso/imulation_files/RaiEmbankment_10Timesteps/ /exports/scce/datatore/eng/aroup/velasso/imulation_files/RaiEmbankment_10Timesteps/ /exports/scce/datatore/eng/aroup/velasso/imulation_files/RaiEmbankment_10Timesteps/ /exports/scce/datatore/eng/aroup/velasso/imulation_files/ReiEmbankment_10Timesteps/ /exports/scce/datatore/eng/aroup/velasso/imulation_files/ReiEmbankment_10Timesteps/ /exports/scce/datatore/eng/aroup/velasso/imulation_files/ReiEmbankment_10Timesteps/ /exports/scce/datatore/eng/aroup/velasso/imulation_files/ReiEmbankment_20Timesteps/ /exports/scce/datatore/eng/aroup/velasso/imulation_files/ReiEmbankment_20Timesteps/ /exports/scce/datatore/eng/aroup/velasso/imulation_files/ReiEmbankment_20Timesteps/ /exports/scce/datatore/eng/aroup/velasso/imulation_files/ReiEmbankment_20Timesteps/ /exports/scdeiE_apps_local/apps/community/VELaSSCo/simulation_files/ReiEmbankment_20Timesteps/ /exports/scdeiE_apps_local/apps/community/VELaSSCo/simulation_files/ReiEmbankment_20Timesteps/ /exports/scdeiEa_apps_local/apps/community/VELaSSCo/simulation_files/REIEmbankment_20Timesteps/ /exports/scdeiEa_apps_local/apps/community/VELaSSCo/simula</pre>	HbareVELaSSCo_Models HbareVELaSSCo_Models HbareVELaSSCo_Models HbareVELaSSCo_Models HbareVELaSSCo_Models HbareVELaSSCo_Models HbareVELaSSCo_Models HbareVELaSSCo_Models HbareVELaSSCo_Models HbareVELaSSCo_Models HbareVELaSSCo_Models HbareVELaSSCo_Models HbareVELaSSCo_Models HbareVELaSSCo_Models	2a313100ac37c01e8 ac30bc7cesb02003ee ac30bc7cesb02003ee ac30bc7cesb02003ee bc78bca17c52bc71161 bc2ce02bfc501c35cc bc178bca17c52bc6747 bcb809bc21c01824 db1a5d793f7c58c45f db1a5d703f7c58c45f db1a57c00000000000 fed511c675500005 a0bcd50100000000028 a0bcd501000000008
Thumbnail image of selected model			,
	Open Cancel		







- Visualize a contour fill of a particle result.
 - Visualize the velocity-Y in the skin of the particles in time step 2939000 (the view results window can be opened via the GiD menu or ctrl+d and the required step selected from the drop-down list)
 - Rotate the model

2.5 Task 2: Use case DEM.M1-03

2.5.1 Motivation

Get the evolution of a result on a particle over time; for instance, get the velocity ycomponent value for all simulation time-steps of specific particle id.

2.5.2 Specification

- Get the evolution of a result on a particle over time.
 - Get the velocity y-component value for:
 - Analysis = DEM
 - Coordinates = Particles
 - Time-steps: ALL
 - Result = Velocity-Y
 - Node number 2724

2.6 Task 4: Use case DEM.M1-05 and DEM.M1-07

2.6.1 Motivation

Compute Discrete to Continuum (d2c) values of the model, get the result in a specific node of the d2c Mesh, do a cut plane and visualize the contour fill of a discrete2continuum result.

2.6.2 Specification

• Compute d2c of the model by opening Discrete2Cointinuum transformation window in VELaSSCo toolbar:







🚾 VELaSSCo Discrete 2 Continuum 🛛 🗆 🗡
VELaSSCo Discrete 2 Continuum transformation
Output D2C analysis name: M_100T_Embankn
Model name with static mesh:
NewEmbankmentTest_0_1m_77K (Hbase:VELaSSCo_Models)
Step selection
Selection mode: Interval
starting step: 0.6
ending step: 0.99
Coarse graining
Method: Gaussian
width cutoff = factor * width Width 0.09
Cut-off factor 3
Process contacts
Temporal averaging
Do Temporal averaging
All
Temporal window
DeltaT 30000
_Spatial integral
Do spatial integral
Dimension 1D
Direction X V
Do D2C Cancel

- Compute discrete to continuum with the following parameters:
 - Static mesh = D2C_Fluidizedbed_small
 - Output D2C analysis name = user initials (can be any unique string) + " D2C FB"
 - Time-step options = INTERVAL
 - Starting and Ending time-steps = 2799000,6799001
 - Coarse-graining method = Gaussian
 - Coarse-graining options:
 - Width = 0.0024
 - Cut-off factor = 3
 - Process contacts = True
 - Do temporal averaging = True
 - Temporal averaging options = ALL
- User: Open D2C_Mesh model from the 'open a model' tool option and open the static mesh used for the D2C query ("D2C_Fluidizedbed_small")
- Use "getBoundaryOfAMesh" option to load results and select **Bulk Density** as contour fill option.











Figure 2 - Bulk Density

- Query the result of the d2c mesh:
 - User: Open D2C_Mesh model
 - User: Get the **density** value for:
 - Analysis = user initials + "_D2C_FB"
 - Time-step # 4799000.5
 - Result = Density
 - Node number 300
 - Node number 1000
- Visualize a contour fill of a velocity result
 - User: Visualize the contour fill of **velocity-Y** in the skin of the volume mesh of the computed d2c result for **time step 4799000.5**







- Use "GetSimplifiedMeshWithResult" option to load contour data
- Set view plane to XZ
 Set view plane to XZ
- Do a cut plane (menu: "Geometry -> Cut Plane -> 2 Points" or shortcut) in the d2c mesh, parallel to Y direction, and passing through (0, 0, 0) coordinates (can also be drawn freehand).
- Remember to switch off outer mesh to view cut results (can be accessed from view styles

2.7 Task 4: Use case DEM.M2-01 and DEM.M2-02

2.7.1 Motivation

Compute temporally averaged Discrete to Continuum (d2c) values of the model, get the result in a specific node of the d2c Mesh and visualize the contour fill of a discrete2continuum result.

2.7.2 Specification

- Open a simulation model from the 'open a model' tool option
 - Select **Rail Embankment** model (RailEmbankment_100Timesteps)
- Compute d2c of the rail embankment model
 - Compute discrete to continuum for:
 - Static mesh = "NewEmbankmentTest_0_1m_77K"
 - D2C analysis name = user initials + "_D2C_RAIL"
 - Time-step options = INTERVAL
 - List of time-steps = 0.2,1
 - Coarse-graining method = Gaussian
 - Coarse-graining options:
 - Width = 0.09
 - Cut-off factor = 3
 - Process contacts = True
 - Do temporal averaging = True
 - Temporal averaging options = ALL
 - Do Spatial Integral = False
- User: Open D2C_Mesh model from the 'open a model' tool option and open the static mesh used for the D2C query ("NewEmbankmentTest_0_1m_77K")
 - Analysis = user initials + "_d2c_RAIL"
 - Time-step 0.595
- Use "getBoundaryOfAMesh" option to load results and select Contact Stress/S-ZZ as contour fill option. Query the values at the following nodes:
 - Result = S-ZZ







- Node number **30000**
- Node number 10120
- Visualize a contour fill of a result
 - User: Visualize the contour fill of **Bulk Density** in the volume mesh of the computed d2c (model "NewEmbankmentTest_0_1m_77K" and analysis name "user initials + "_D2C_ RAIL"") for temporally averaged time step 0.595
 - Use "GetSimplifiedMeshWithResult" option



Figure 3 - Simplified Mesh with Bulk Density Result

- Do Cut through Embankment to visualise the density distribution
 - \circ $\;$ Switch to plan view
 - Draw cut line plane (menu: "Geometry -> Cut Plane -> 2 Points" or shortcut) along centre of embankment







- \circ $\,$ Draw a cut line transversely through the embankment under sleeper 4 $\,$
- Using the layer manager, switch off the outer mesh to view the new cuts
- The bulk density can be further clarified by applying limit filters for the upper and lower bounds (1500-1650 kg/m³ used in the following example figures)



Figure 4 – Long-section through Embankment



Figure 5 - Cross-section Under Sleeper 4

- User can repeat for other queries such as Contact stress if they wish to explore further
- Logout







3 Questionnaire for participants

Measuring the quality of a service can be a very difficult exercise. Unlike product where there are specific specifications such as length, depth, width, weight, colour etc. a service can have numerous intangible or qualitative specifications. In addition, there is there expectation of the customer with regards the service, which can vary considerably based on a range of factors such as prior experience, personal needs and what other people may have told them.

The questionnaire below is in three sections. On the one hand the first section asks you to rank all software tools for pre and post processing of numerical simulations in science and engineering according to your expectations i.e. what you expect all these tools to provide. On the otherhand the second section asks you to rank the VELaSSCo Plugin for GiD according to your experiences and perceptions. The third section asks you about the overall satisfaction of VELaSSCo Plugin for GiD.

Expectations deals with your opinions of software tools for pre and post processing of numerical simulations. What we are interested in here is a number that best shows you expectations about software tools for pre and post processing of numerical simulations offering services.

Perceptions relate to your feelings about the VELaSSCo Plugin for GiD. Please show the extent to which you believe this tool has the feature described in the statement. Here, we are interested in a number from 1 to 7 that shows your perceptions about the VELaSSCo Plugin for GiD.

You should rank each statement following a seven-point Likert-style scale from 1=very unimportant to 7=very important

The questionnaire is available in the following URL to be filled:

https://docs.google.com/forms/d/e/1FAIpQLSdnbKEbF7703zyOU0S6Kg9ILCLXfiyDJEZ NkJsrHU2qXJcRgg/viewform#responses

In summary, our purpose is to get your valuable feedback about your experience with the VELASSCO Platform and its usability against expectations.

We would also appreciate your impressions on practical issues and any other comment or criticisms that you may find interesting.

Please send your completed questionnaires telematics using the URL indicated above.

Thanks for your time.

The VELASSCO project.



