

KULI 5.0

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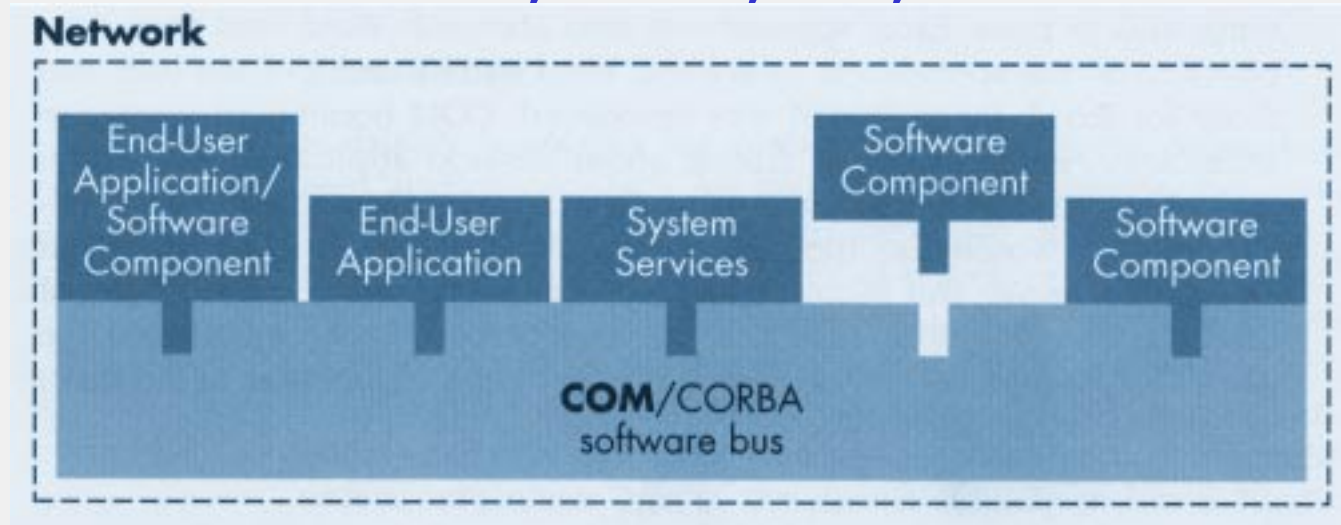
ECS Steyr



The Component Object Model



Also known as ActiveX[®], OLE
Extensions: DCOM, COM+, MTS, Windows[®] DNA



Advantages: Programming Language Independence
Location Transparency
The Operating System provides Runtime Environment

KULI as COM Server

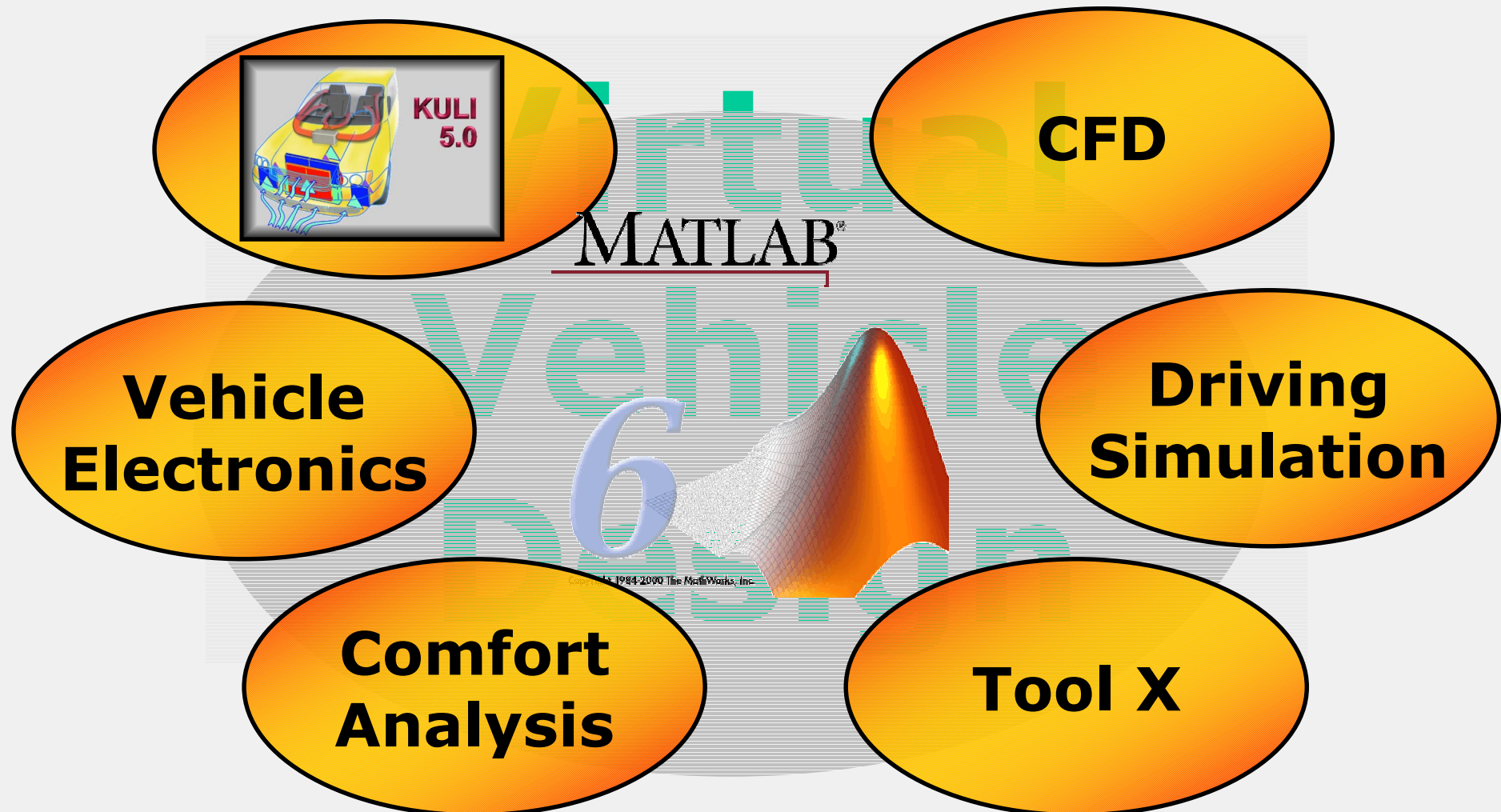
Motivation

- **Make KULI accessible for Application Frameworks**
- **Enhance existing Interfaces**
- **Combine the Comfort of the KULI GUI with the Power of System Integration Tools like Matlab®**

Benefits

- **KULI is callable from VBA and Matlab**
- **Integration of KULI in Expert Systems**
- **Integration of External Components into a KULI Model**
- **Free programmable external Controllers
(Fans, Water, Pumps, Thermostats, ...)**

Analysis Tools Integration



Using KULI's COM Component- Part 1

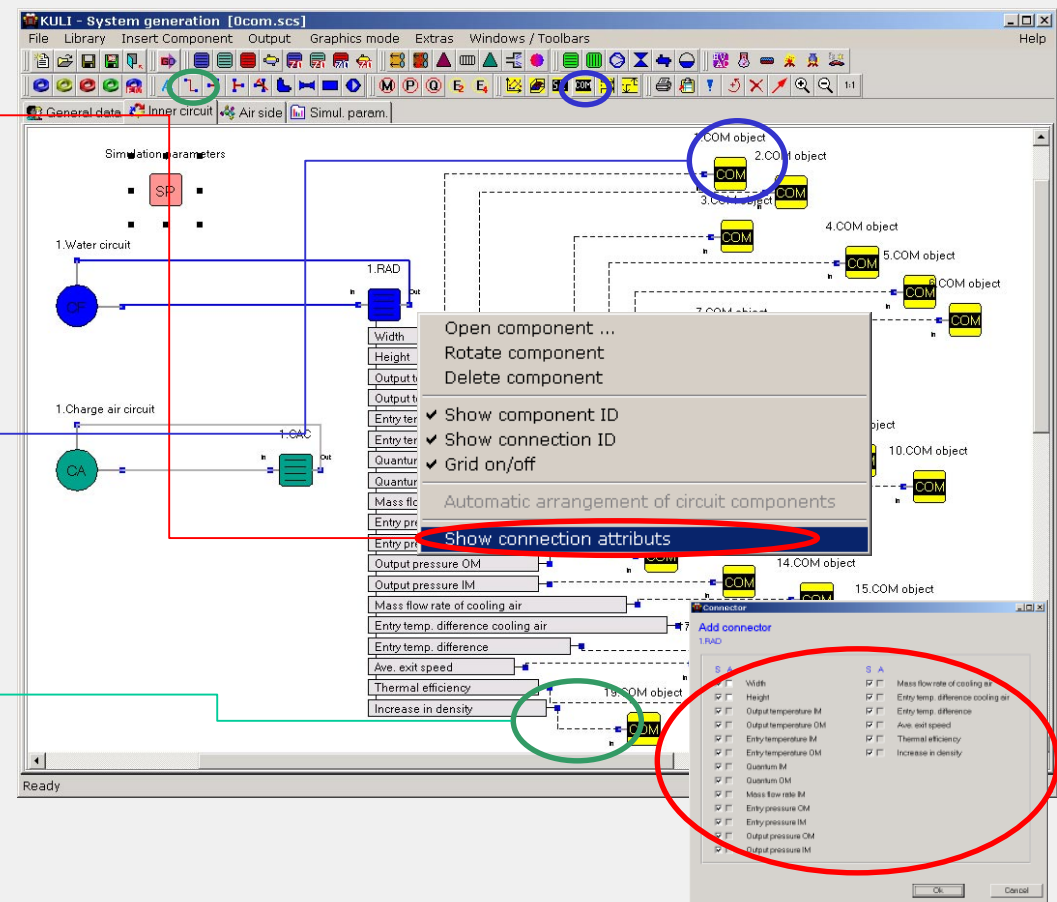
➤ Add Connectors

e.g. Entry temp. Air
Mass flow

➤ Add COM Components

e.g. COM1
COM2

➤ Connect Connectors with COM Components



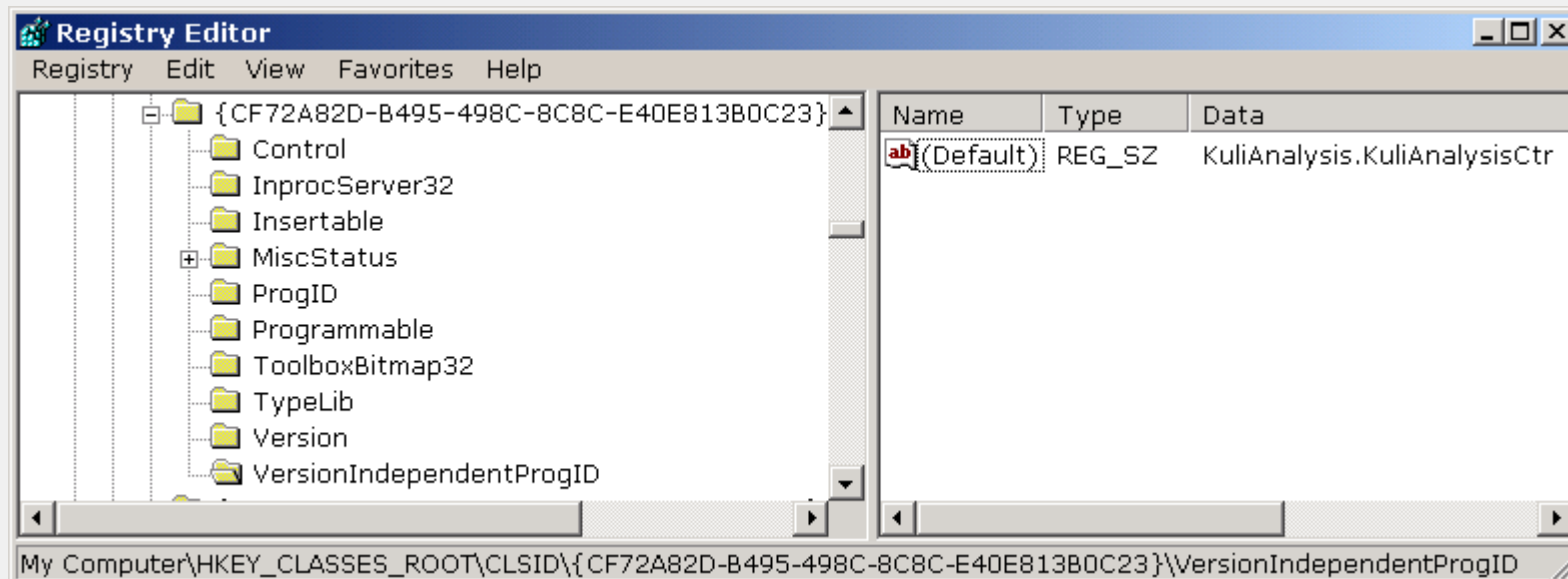
Definition

KULI's GUI COM Component is NO Software Component



**It is a KULI Component, which is accessible by
the Interface Functions**

Get / SetCOMValueByID defined in KuliAnalysis



Using KULI's COM Component- Part 2

➤ **COM Components are as easy to use as other KULI Comps**

- + Benefit from KULI GUI when using COM objects
- + No "Programming Expert Knowledge" required

➤ **All Information is available in KULI's Graph Window**

- + No components, connectors, COM objects, etc are hidden

➤ **COM Objects as Watch-Variable**

- + "Debugging" of unstable Systems
- + Runtime Visualization of Parameter changes in VBA / Matlab / COM supporting Tool

➤ **User friendly Interface Design**

- + Few Entry Points and Events

➤ **Accessing COM Objects via user definable Texts**

- + `GetComValueByID("ExitTempAtRadiator1")`

Interface Functions - Events

➤ Methods / Properties

```

IKuliAnalysisCtr
- AddToBatchList(BSTR fileName)
- BatchMode(BOOL * pVal)
- Cancel()
- CleanUp(BOOL * succ)
- EnableEvents(BOOL newVal)
- EnableEvents(BOOL * pVal)
- GetCOMValueByID(BSTR comName, double * value)
- Initialize(BOOL * succ)
- IsFinished(BOOL * val)
- IsNextOperatingPoint(BOOL * val)
- IsNextTimeStep(BOOL * val)
- KuliFileName(BSTR newVal)
- NextKULIIteration(BOOL * succ)
- PPFileName(BSTR * pVal)
- ResultFileName(BSTR * pVal)
- RunAnalysis(BOOL * succ)
- SetCOMValueByID(BSTR comName, double value, BOOL * succ)
- ShowResult()
- StartAnalysis(BOOL * succ)

```



➤ Events

```

_IKuliAnalysisCtrEvents
- OnCheckForCancel()
- OnError(BSTR fkt, BSTR msg, BSTR add, long type)
- OnMessage(BSTR fkt, BSTR msg, BSTR add, long type)
- OnNextIteration(long itNo)
- OnNextTime(long timeStepNo, double time)

```

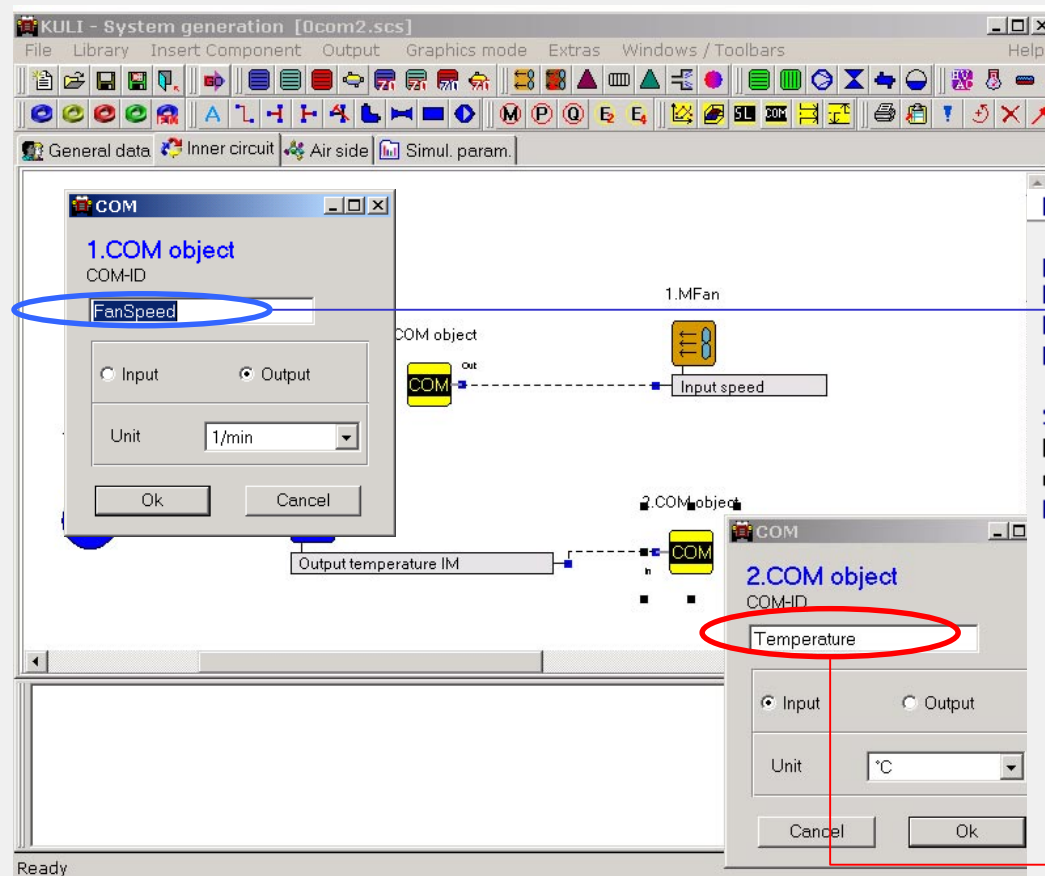

Implementation Details

- **KULI Analysis is implemented as “In-Process-Server” (dll)**
 - + Optimum Runtime Performance
 - + A few Interface Functions leads to Simple Handling

- **Direct Matlab® / Simulink® Integration in KULI**
 - + Simulink Controllers are available as Icons
 - + C++ Calls to Matlab / Simulink -> Runtime Performance

- **KULI GUI is not accessible via COM**
 - + All Required Features are implemented in KULI GUI
 - + Benefit of the user friendly KULI GUI when creating Models

Call KULI from VBA (Excel®)



```
Public WithEvents KULI As KuliAnalysisCtr
```

```
Private Sub CommandButton1_Click()  
Dim value As Double  
Dim rpm As Double  
Dim i As Integer
```

```
Set KULI = New KuliAnalysisCtr  
KULI.KuliFileName = "...ExTruck_50_T_COMSet.scs"  
calcOK = KULI.Initialize()  
For j = 1 To 5  
calcOK = KULI.StartAnalysis()
```

```
drehzahl = j * 1000  
calcOK = KULI.SetCOMValueByID("FanSpeed", rpm)  
Cells(1, j) = rpm  
i = 2  
Do Until KULI.IsFinished  
calcOK = KULI.NextKULIIteration()  
value = KULI.GetCOMValueByID("Temperature")  
Cells(i, j) = value  
i = i + 1
```

```
Loop  
i = i + 1  
Loop  
Next j
```

```
Set KULI = Nothing  
End Sub
```

Usage of Get/SetCOMValueByID

➤ KULI Analysis should be started using StartAnalysis()

Note: RunAnalysis() does not stop after an iteration

Syntax SetCOMValueByID("FanSpeed",1234)

+ Set only possible after StartAnalysis()
 and NextKULIIteration()

+ Type of COM object must be "Output"

Syntax GetCOMValueByID("Temperature")

+ Get can be called at any time
+ Type of COM object must be "Input"

Handling Events

➤ KULI fires 5 Events

- OnError / OnMessage
- OnNextIteration
- OnNextTime
- OnCheckForCancel

➤ Only “informing” Events, no Requests

➤ EnableEvents must be set to TRUE

KULI OnCheckForCancel

```
Private Sub KULI_OnCheckForCancel()  
Dim Condition As Boolean
```

```
Condition = True  
....  
If (Condition) Then  
    KULI.Cancel  
End If
```

```
End Sub
```

```
Private Sub KULI_OnError(ByVal fkt As String, _  
                        ByVal msg As String, _  
                        ByVal add As String, _  
                        ByVal xtype As Long)
```

```
Debug.Print fkt, msg, add
```

```
End Sub
```

```
Private Sub KULI_OnNextIteration(ByVal itNo As Long)
```

```
Dim value As Double
```

```
value = KULI.GetCOMValueByID("Temperature")
```

```
End Sub
```

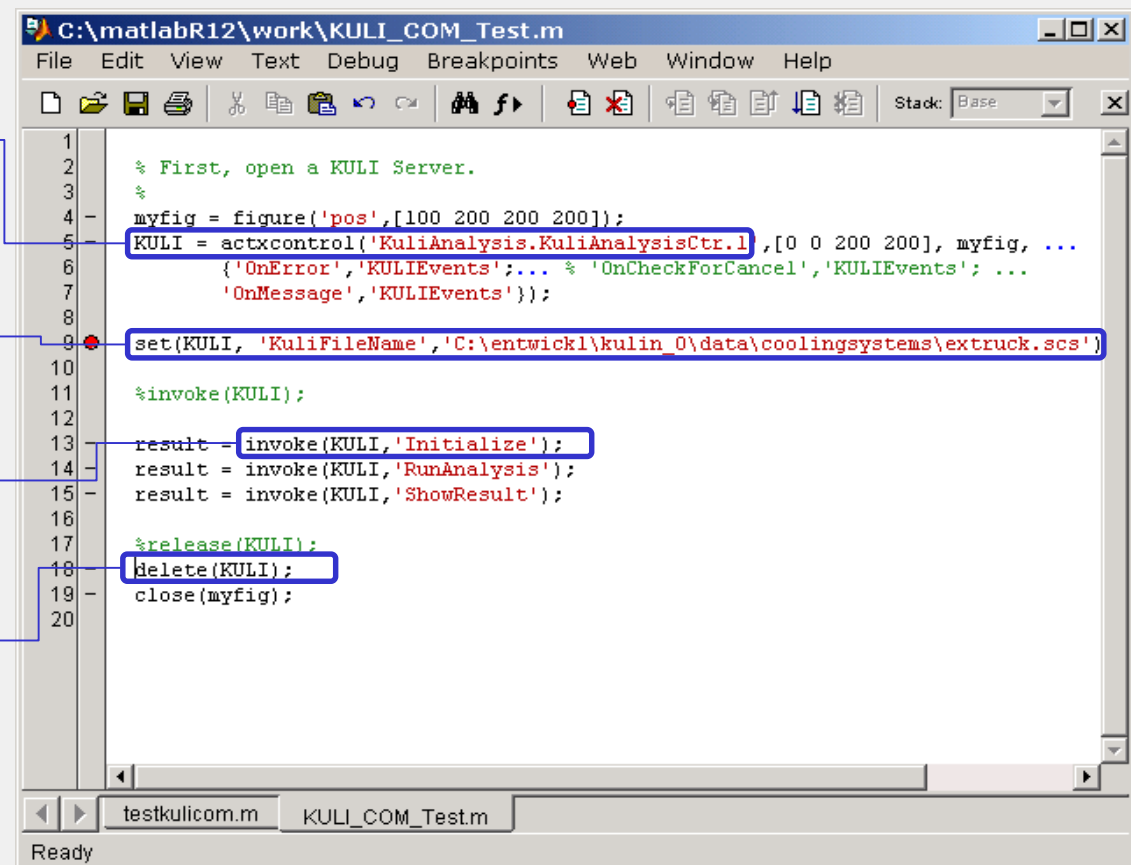
Call KULI from Matlab

➤ Create ActiveX Control

➤ Set System File Name

➤ Run KULI

➤ Free Control



```
1 % First, open a KULI Server.
2 %
3
4 myfig = figure('pos',[100 200 200 200]);
5 KULI = actxcontrol('KuliAnalysis.KuliAnalysisCtrl.1',[0 0 200 200], myfig, ...
6     {'OnError','KULIEvents';... % 'OnCheckForCancel','KULIEvents'; ...
7     'OnMessage','KULIEvents'});
8
9 set(KULI, 'KuliFileName', 'C:\entwickl\kulin_0\data\coolingsystems\extruck.scs')
10
11 %invoke(KULI);
12
13 result = invoke(KULI,'Initialize');
14 result = invoke(KULI,'RunAnalysis');
15 result = invoke(KULI,'ShowResult');
16
17 %release(KULI);
18 delete(KULI);
19 close(myfig);
20
```


External Components Integration

➤ 2 Models available

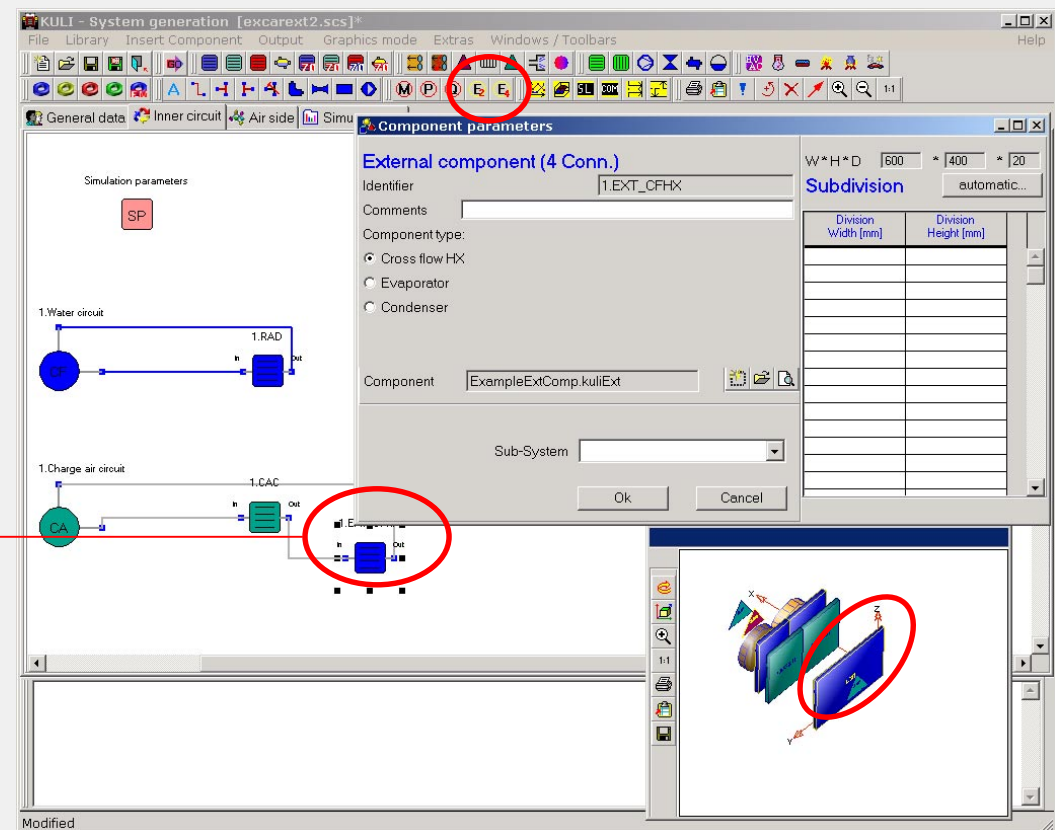
- 2-Arm External Components (Heat Exchangers)
- 4-Arm External Components (Parallel Flow Heat Exchangers)

➤ Full integration in KULI GUI

- External Components are handled like common KULI components

➤ Full Features User definable Analysis Methods

- End Users can provide their own models



External Components Specifications

- **User Defined COM Component called "KuliExtComp" providing the methods:**

InitializeComponent

SetComponentInlet_Inside SetComponentInlet_Outside

GetComponentOutlet_Inside GetComponentOutlet_Outside



- **"KuliExtComp" can be generated with any COM supporting Tool**
- **Component overlapping not considered. Only mean values for temperature, pressure and an overall value for the mass flow rate are passed**
- **Information about the cooling media (air and fluid properties) is hard to interchange. The user is responsible for equal properties in both programs.**
- **KULI does not have access to any geometric information of the „User Defined“ component**

```
library KuliExtComp
{
  InitializeComponent (BSTR kuli_ID, BSTR filename,
                      BSTR comment,
                      VARIANT_BOOL is_in_AC_Circuit);

  SetComponentInlet_Inside (BSTR kuli_ID, double temp_In,
                           double press_In,
                           double x_In, double massFlow);

  SetComponentInlet_Outside ( BSTR kuli_ID, double temp_In,
                             double press_In, double x_In,
                             double massFlow);

  GetComponentOutlet_Inside ( BSTR kuli_ID, double* temp_Out,
                              double* press_Out, double* x_Out);

  GetComponentOutlet_Outside( BSTR kuli_ID, double* temp_Out,
                              double* press_Out, double* x_Out);
};
```

New KULI Optimization

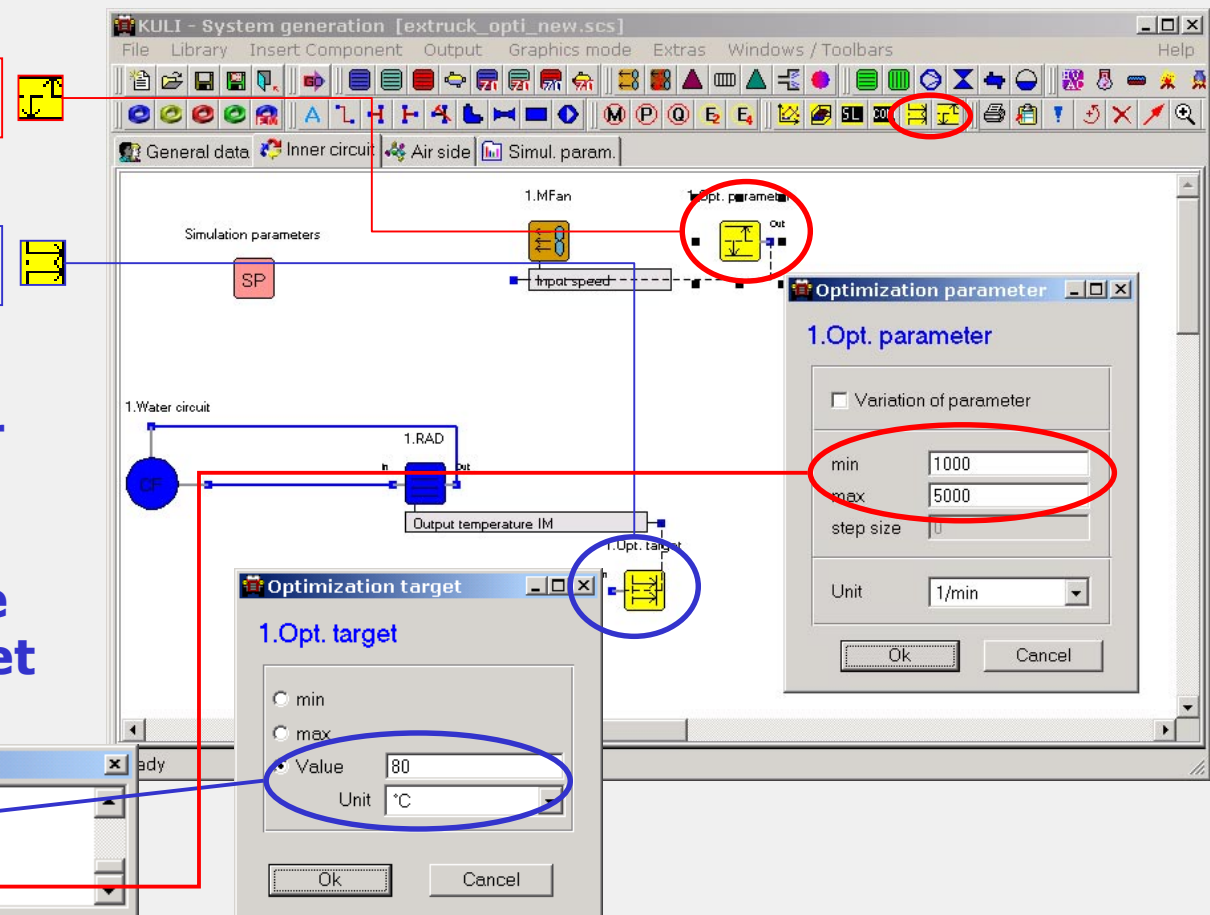
➤ New KULI Components

• Optimization Parameter

• Optimization Target

➤ New Algorithm for Solver

➤ Any changeable Attribute can be used as Opt. Target



Multi Parameter Optimization

➤ Combination of Multiple Parameters/Targets

Optimization parameter (2.Opt. parameter)

☐ Variation of parameter

min: 400
max: 800
step size: 200
Unit: mm

Optimization parameter (3.Opt. parameter)

☐ Variation of parameter

min: 25
max: 100
step size: 200
Unit: -

Optimization target (1.Opt. target)

☐ min
☐ max
☒ Value: 346
Unit: K

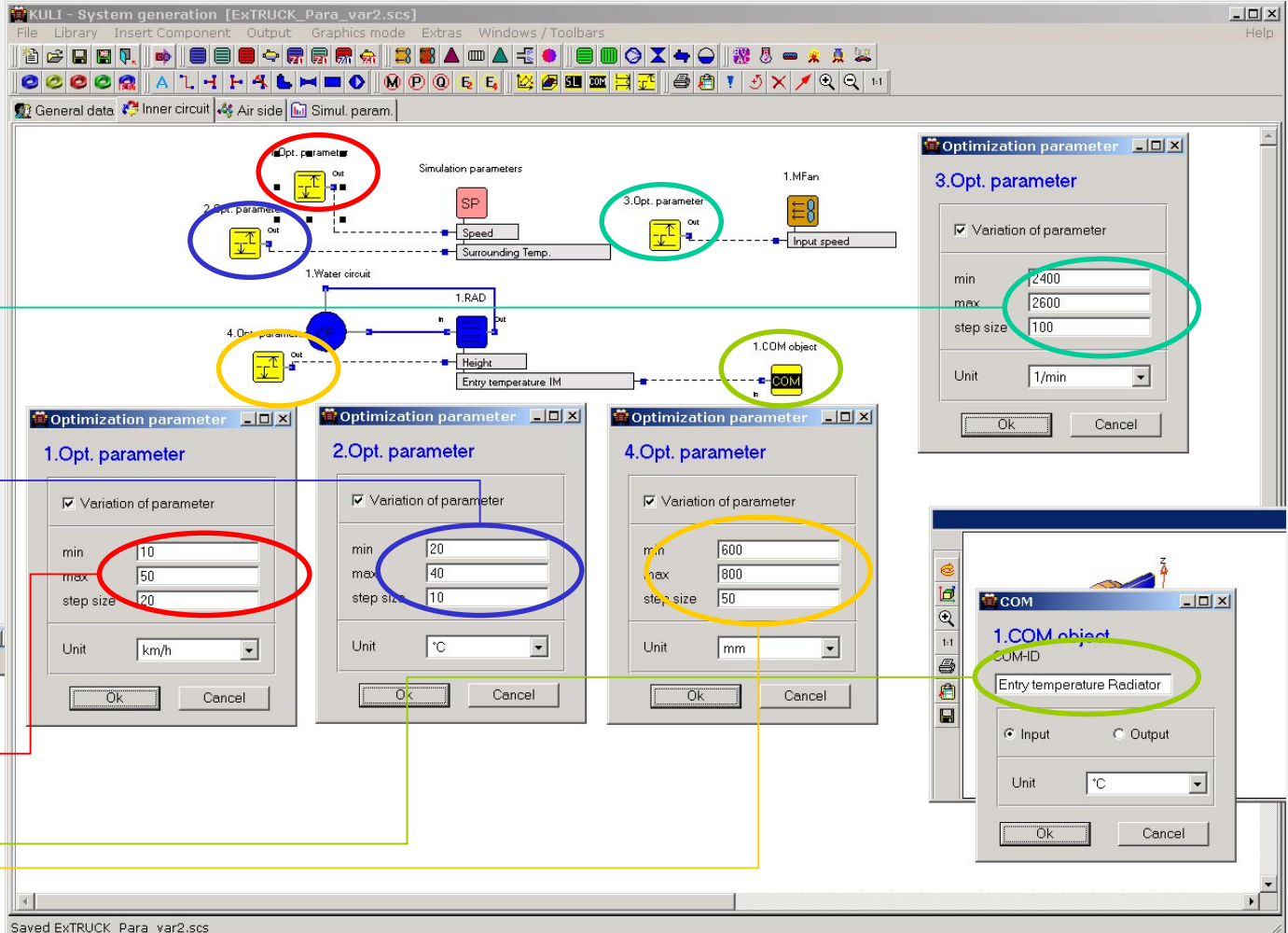
Messages

Parameter 1: 25.086
Parameter 2: 0.760685 [m]
Optimization target: 345.975 [K]

Saved extruck_50_2ParOpt.scs

Variation of Parameters

- Variation of n Parameters of a Cooling System
- Access to results using COM Objects
- Free definable Watch Points



The screenshot displays the KULI - System generation interface for a cooling system simulation. The main workspace shows a schematic diagram with four optimization parameters (1.Opt. parameter, 2.Opt. parameter, 3.Opt. parameter, 4.Opt. parameter) and their associated COM objects (1.COM object, 2.COM object, 3.COM object, 4.COM object). Each parameter has a corresponding 'Optimization parameter' dialog box with the following settings:

- 1.Opt. parameter:** min: 10, max: 50, step size: 20, Unit: km/h
- 2.Opt. parameter:** min: 20, max: 40, step size: 10, Unit: °C
- 3.Opt. parameter:** min: 2400, max: 2600, step size: 100, Unit: 1/min
- 4.Opt. parameter:** min: 600, max: 800, step size: 50, Unit: mm

The 'COM' dialog box for the 1.COM object shows the COMID 'Entry temperature Radiator' and the Unit '°C'.

A Notepad window titled 'ExTRUCK_Para_var2.aus' displays the following text:

```

Parameter 1: WK1: Height [mm]
Parameter 2: M1: Input speed [1/min]
Parameter 3: Sim.parameter: Ambient temperature [°C]
Parameter 4: Sim.parameter: Speed [km/h]
Watch-variable 1: Entry temperature Radiator [°C]

Par. 1  Par. 2  Par. 3  Par. 4  Watch 1
600    2400    20    10    72.9246
600    2400    20    30    72.7573
600    2400    20    50    72.0208
600    2400    30    10    82.359
600    2400    30    30    82.1767
600    2400    30    50    81.4931
600    2400    40    10    92.4604
600    2400    40    30    92.091
  
```


Licensing

Module BASE:

Limitations:

- No Support for External Components
- No Support for **GetCOMValueByID, SetCOMValueByID**

Module Advanced:

- ✓ Full Support of all Features

Future Perspectives

➤ External Components Enhancements

- Support for “Rastering”
- Additional Components (Air Side)

➤ Enhancements with CFD Interface

- “Interactive” CFD Interface additional to CFD Preprocessor

➤ Post processing

- Full Support for KULI’s COM Components
- Enhanced Output Options for Optimization / Parameter Variation