

OpenFOAMに基づいた流量計CFDツール

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内容

- 背景
- 基本特徴
- GUI説明
- まとめ

背景—中小企業のCFDソフトの導入

- 汎用ソフトの導入における難点
 - ・ 経費
 - ・ 汎用ソフトの正確利用が難しい
 - ・ 専用CFDエンジニアの育成
- OpenFOAMの導入における難点
 - ・ 操作が難しい(GUIが無い)
 - ・ メンテナンスができない
 - ・ WindowsからLinuxへのシフト

背景—設計の思想



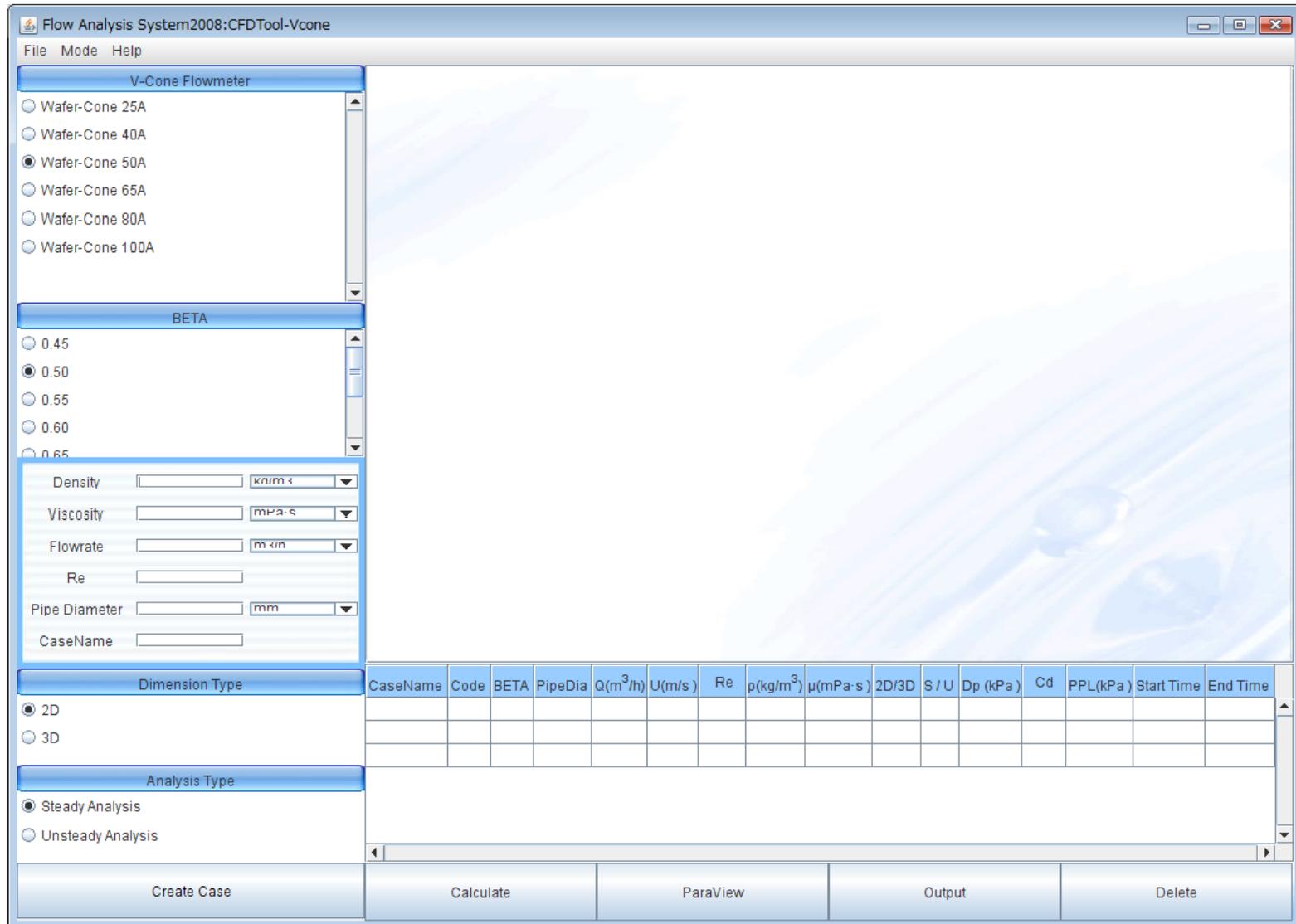
基本特徴

- ユーザーに特化したGUI
- 対象ユーザー
 - ・ 使用者は普通流体エンジニア、CFD知識無し
- 簡単
 - ・ ボタン数を最少にする
 - ・ 入力パラメーターは使用者の熟知したモノのみ
- 完全自動格子作成
 - ・ 事前に最適化した格子を作成
 - ・ 使用者が格子作成する必要なし
- 特定Post処理機能付き
- OS依存しない(現在開発中)
 - ・ 計算サーバーとGUI分離

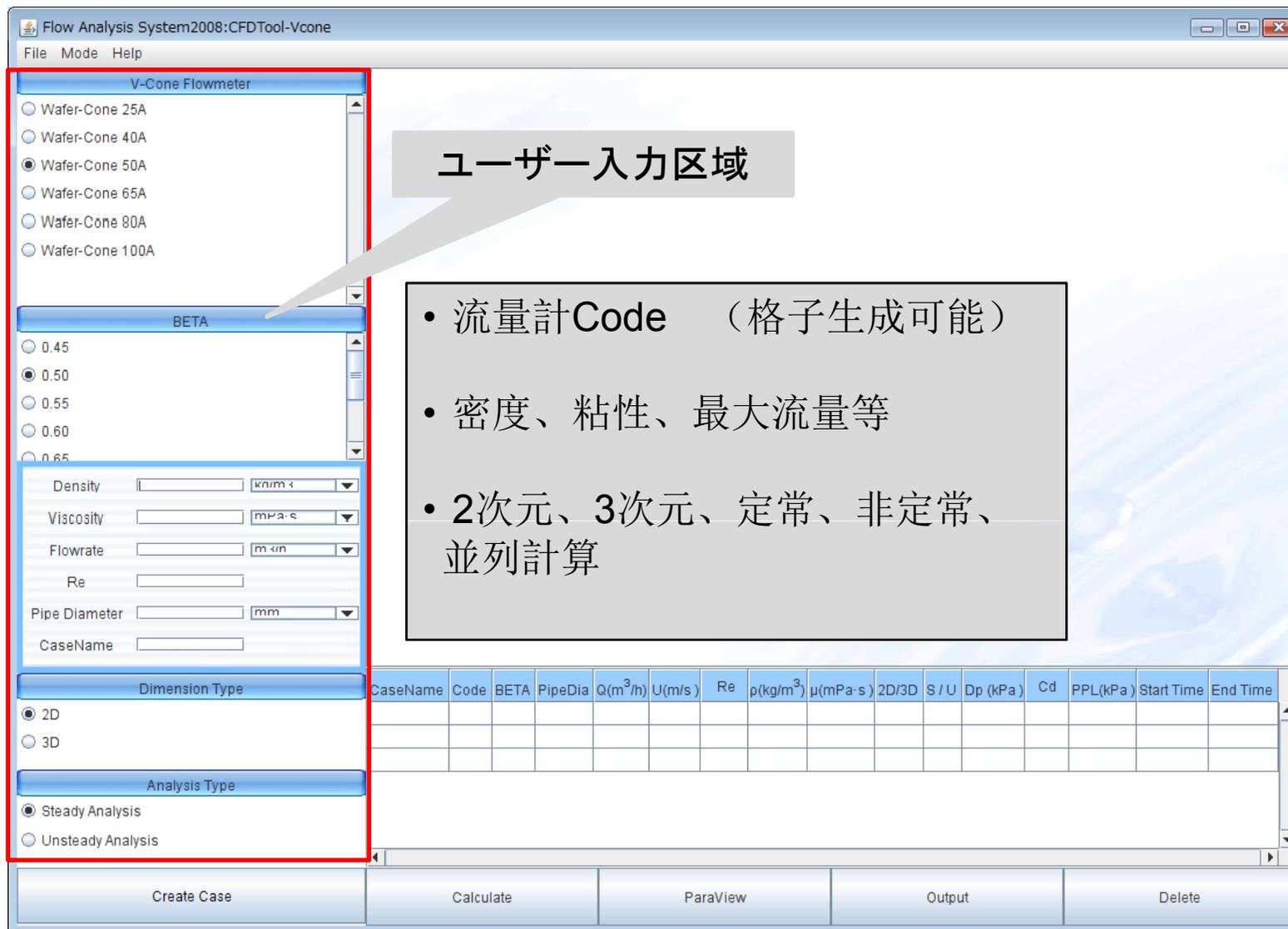
基本特徴

- GUI開発
 - JAVA言語
- ケース自動作成
 - OpenFOAMをベースに自社開発
 - 格子作成ツールはblockMesh
- ソルバー
 - OpenFOAM 標準solverをカスタマイズ
- 結果分析データ
 - OpenFOAMをベースに自社開発
- 可視化
 - paraFoam

GUI



GUI



ユーザー入力区域

- 流量計Code (格子生成可能)
- 密度、粘性、最大流量等
- 2次元、3次元、定常、非定常、並列計算

CaseName	Code	BETA	PipeDia	Q(m ³ /h)	U(m/s)	Re	ρ(kg/m ³)	μ(mPa·s)	2D/3D	S / U	Dp (kPa)	Cd	PPL(kPa)	Start Time	End Time

Create Case Calculate ParaView Output Delete

GUI

Flow Analysis System2008:CFDTool-Vcone

File Mode Help

V-Cone Flowmeter

- Wafer-Cone 25A
- Wafer-Cone 40A
- Wafer-Cone 50A
- Wafer-Cone 65A
- Wafer-Cone 80A
- Wafer-Cone 100A

BETA

- 0.45
- 0.50
- 0.55
- 0.60
- 0.65

Density: kg/m^3

Viscosity: $\text{mPa}\cdot\text{s}$

Flowrate: m^3/h

Re:

Pipe Diameter: mm

CaseName:

Dimension Type

- 2D
- 3D

Steady An

Unsteady Analysis

CaseName	Code	BETA	PipeDia	Q(m ³ /h)	U(m/s)	Re	$\rho(\text{kg/m}^3)$	$\mu(\text{mPa}\cdot\text{s})$	2D/3D	S / U	Dp (kPa)	Cd	PPL(kPa)	Start Time	End Time

計算ケース管理

計算ケース作成

計算開始

paraFoam

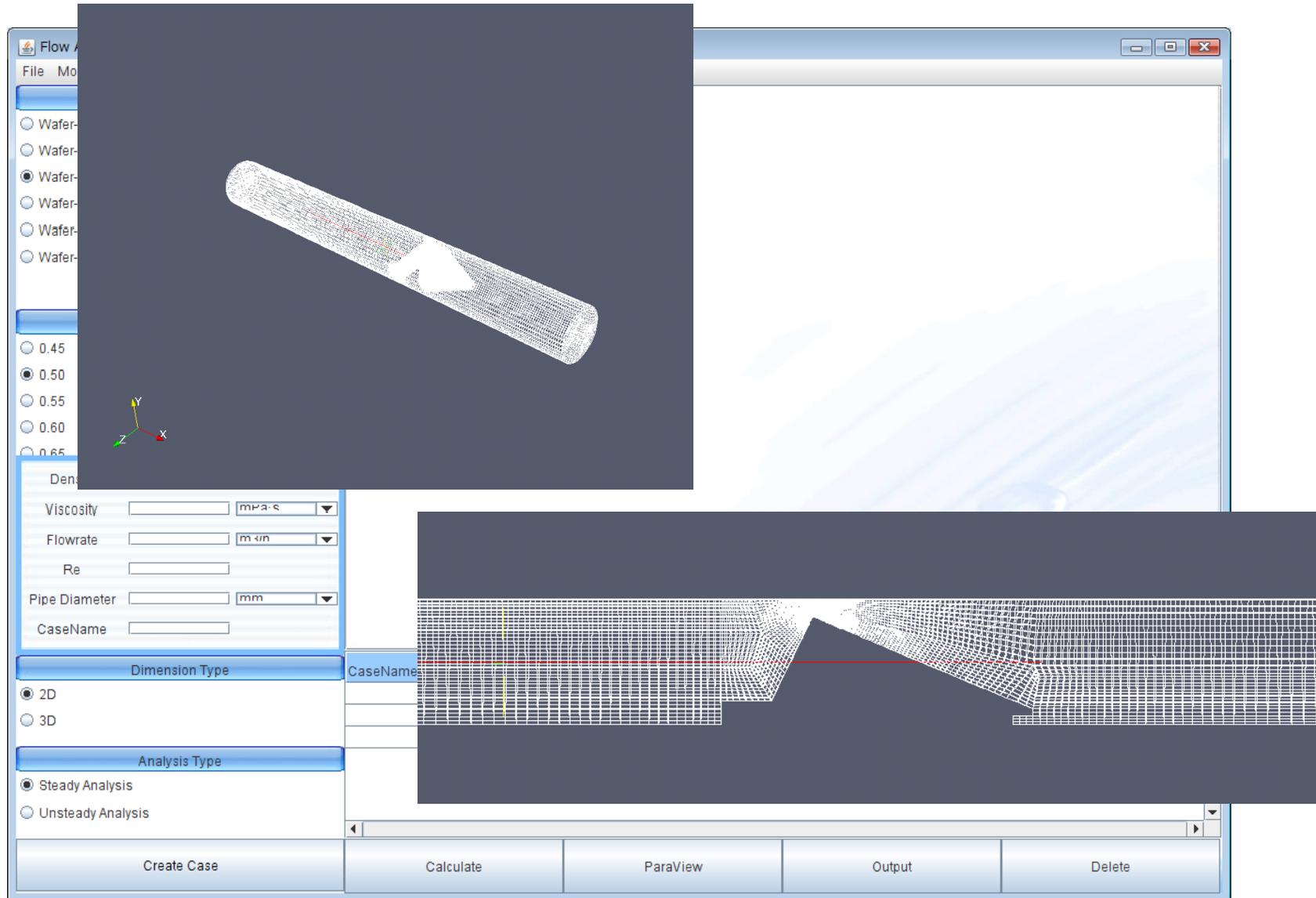
結果出力

Create Case Calculate ParaView Output Delete

GUI

The screenshot shows the 'Flow Analysis System2008:CFDTool-Vcone' application window. On the left, the 'V-Cone Flowmeter' section has radio buttons for models: Wafer-Cone 25A, 40A, 50A (selected), 65A, 80A, and 100A. Below this is the 'BETA' section with radio buttons for 0.45, 0.50 (selected), 0.55, 0.60, and 0.65. Further down are input fields for Density (kn/m³), Viscosity (mPa·s), Flowrate (m³/h), Re, Pipe Diameter (mm), and CaseName. The 'Dimension Type' section has radio buttons for 2D (selected) and 3D. At the bottom left, there are radio buttons for 'Steady Analysis' (selected) and 'Unsteady Analysis'. The central area displays two 3D models of a wafer-cone flowmeter: a perspective view and a wireframe view. Below the models is a table with columns: CaseName, Code, BETA, PipeDia, Q(m³/h), U(m/s), Re, ρ(kg/m³), μ(mPa·s), 2D/3D, S / U, Dp (kPa), Cd, PPL(kPa), Start Time, and End Time. The table is currently empty. At the bottom, a control bar contains five buttons: 'Create Case', 'Calculate', 'ParaView', 'Output', and 'Delete'. A grey callout box with the text '計算ケース作成' (Create Calculation Case) points to the 'Create Case' button.

基本特徴



基本特徴

Flow Analysis System2008:CFDTool-Vcone

File Mode Help

V-Cone Flowmeter

- Wafer-Cone 25A
- Wafer-Cone 40A
- Wafer-Cone 50A
- Wafer-Cone 65A
- Wafer-Cone 80A
- Wafer-Cone 100A

BETA

- 0.45
- 0.50
- 0.55
- 0.60
- 0.65

Density kg/m^3

Viscosity $\text{mPa}\cdot\text{s}$

Flowrate m^3/min

Re

Pipe Diameter mm

CaseName

Dimension Type

- 2D
- 3D

Steady Analysis
 Unsteady Analysis

CaseName	Code	BETA	PipeDia	$Q(\text{m}^3/\text{h})$	$U(\text{m/s})$	Re	$\rho(\text{kg/m}^3)$	$\mu(\text{mPa}\cdot\text{s})$	2D/3D	S / U	Dp (kPa)	Cd	PPL(kPa)	Start Time	End Time

計算ケース管理

計算ケース作成

Create Case Calculate ParaView Output Delete

基本特徴

計算情報出力

Calculate Information [CaseName : myCase]

```

DILUPBiCG: Solving for k, Initial residual = 0.00159647, Final residual = 7.18615e-05, No Iterations 1
Dp = -0.207161 Pa
  UsolverPerf.niterations() = 1
  pSolverPerf.niterations() = 72
ExecutionTime = 39.8 s ClockTime = 61 s

Time = 0.225

DILUPBiCG: Solving for Ux, Initial residual = 0.0011321, Final residual = 7.57576e-05, No Iterations 1
DILUPBiCG: Solving for Uy, Initial residual = 0.00250865, Final residual = 0.000223395, No Iterations 1
DILUPBiCG: Solving for Uz, Initial residual = 0.0225644, Final residual = 0.00127882, No Iterations 1
DICPCG: Solving for p, Initial residual = 0.0303742, Final residual = 0.000303265, No Iterations 31
DICPCG: Solving for p, Initial residual = 0.00381091, Final residual = 3.70044e-05, No Iterations 148
time step continuity errors : sum local = 3.13964e-08, global = -2.49764e-10, cumulative = -7.40121e-08
DILUPBiCG: Solving for omega, Initial residual = 0.00064789, Final residual = 1.92872e-06, No Iterations 2
DILUPBiCG: Solving for k, Initial residual = 0.00157607, Final residual = 7.0952e-05, No Iterations 1
Dp = -0.207391 Pa
  UsolverPerf.niterations() = 1
  pSolverPerf.niterations() = 31
ExecutionTime = 39.98 s ClockTime = 61 s

Time = 0.226
    
```

Stop Close

計算開始

Flow Analysis System2008:CFDTool-Vcone

File Mode Help

V-Cone Flowmeter

- Wafer-Cone 25A
- Wafer-Cone 40A
- Wafer-Cone 50A
- Wafer-Cone 100A

BETA

- 0.45
- 0.50
- 0.55
- 0.60
- 0.65

Density kg/m^3

Viscosity $\text{mPa}\cdot\text{s}$

Flowrate m^3/min

Re

Pipe Diameter mm

CaseName

Dimension Type

- 2D
- 3D

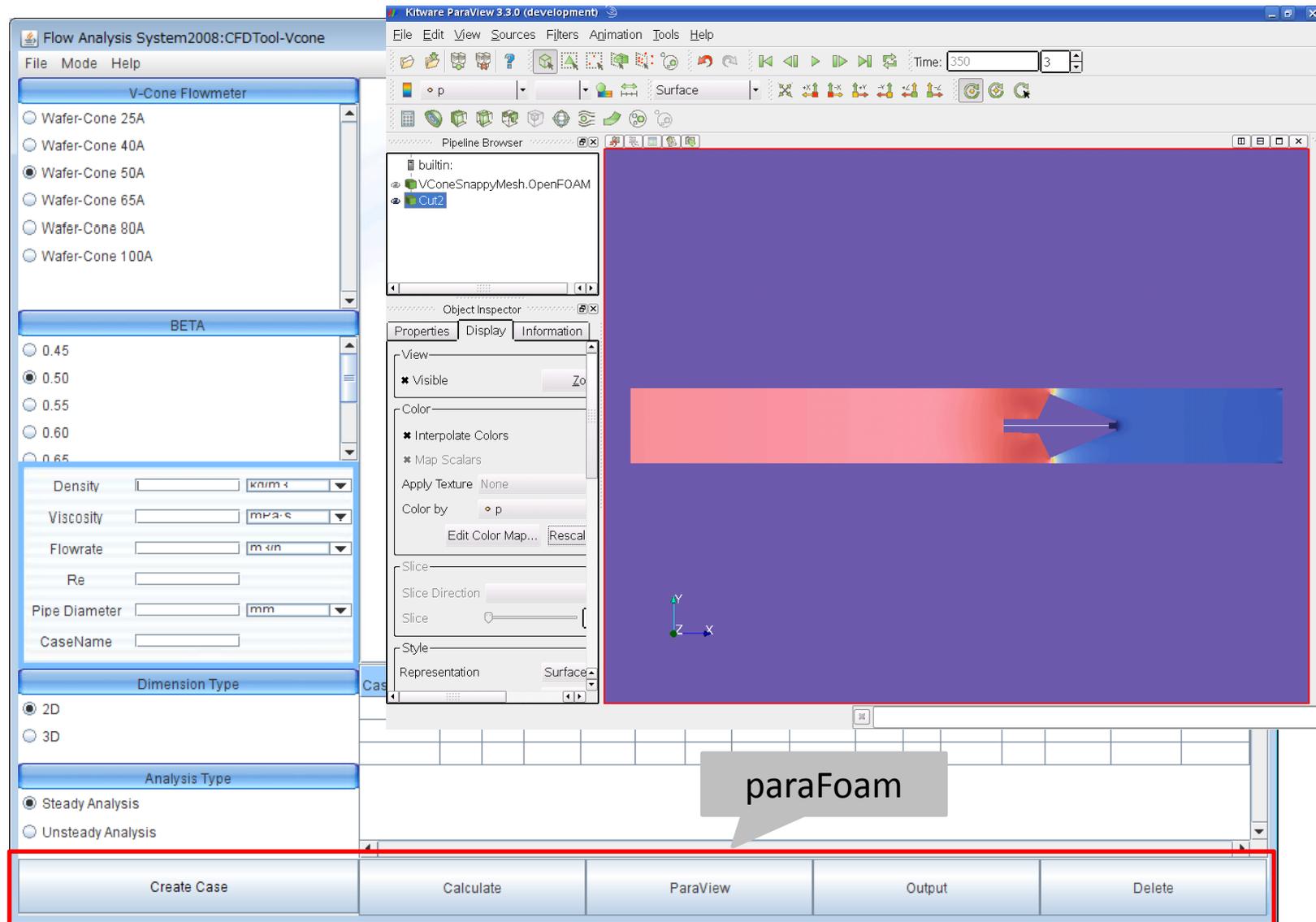
Analysis Type

- Steady Analysis
- Unsteady Analysis

CaseName	Code	BETA	PipeDia	Q(m ³ /h)	U(m/s)	Re	$\rho(\text{kg/m}^3)$	$\mu(\text{mPa}\cdot\text{s})$	2D/3D	S/U	Dp (kPa)	Cd	PPL(kPa)	Start Time	End Time

Create Case Calculate ParaView Output Delete

基本特徴



GUI

The screenshot shows the 'Flowmeter Tools' application window. On the left, there are several configuration panels: 'V-Cone Flowmeter' with radio buttons for sizes 25A through 100A (50A is selected); 'BETA' with radio buttons for values 0.45 through 0.75 (0.50 is selected); 'Density' (998.203 kg/m³), 'Viscosity' (1.03 mPa·s), 'Flowrate' (0.7 m³/h), and 'Re' (4871.71); 'Pipe Diameter' (49.25 mm); 'CaseName' (mycase); 'Dimension Type' with radio buttons for 2D (selected) and 3D; and 'Analysis Type' with radio buttons for Steady Analysis (selected) and Transient Analysis.

The main area is a 'Case Post Information' dialog box containing a code editor with the following content:

```

/*----- C++ -----*/
|=====|
| \ \ / Field | OpenFOAM: The Open Source CFD Toolbox |
| \ \ / Operation | Version: 1.4.1 |
| \ \ / And | Web: http://www.openfoam.org |
| \ \ / Manipulation | |
|-----*/

FoamFile
{
  version 2.0;
  format ascii;

  root "/home/fan/OpenFOAM/fan-1.4.1/applications/TokyoKEISO/FlowMeterCFDTools/Data/V-Cone-50A/0.50";
  case "mycase";
  instance "";
  local "";

  class dictionary;
  object casePost;
}

// ***** //

Time 2;
Dp 0.104396;
Cd 0.864141;
PPL 0.080705;

// ***** //
  
```

At the bottom of the dialog box, there is an 'OK' button and a table of results:

Cd	PPL(kPa)	Start Time	End Time
0.8641...	0.0807...	14:27:...	14:48:...

計算結果出力
計算結果から設計者の指定したデータを入力する

結果出力

GUI

The screenshot displays the Flow Analysis System 2008:CFDTool-VAFM GUI. The interface includes a menu bar (File, Mode, Help), a parameter configuration panel on the left, a central design workspace, and a data table at the bottom.

Parameter Configuration Panel:

- Float Flowmeter:** NMX
- Code:** 3BDF, 5BDF
- Float Height:** [] mm
- Density:** [] kg/m³
- Viscosity:** [] mPa·s
- Float Weight:** 1.4 N
- CaseName:** []
- Dimension Type:** 2D, 3D
- Analysis Type:** Steady Analysis, Unsteady Analysis

Design Workspace: Shows a blue channel geometry with nodes labeled A1 through A12 and B1 through B13. A vertical red line indicates the float height, with a value of 50.0 mm. The text "5BDF" is visible in the workspace.

Data Table:

CaseName	Code	H(mm)	Q(L/h)	Re	ρ (kg/m ³)	μ (mPa·s)	W(N)	Coordinat	2D/3D	S/U	Start	End

Buttons: Create Case, Calculate, ParaView, Output, Delete

形状変更可能
最適設計に役立つ

まとめ

- OpenFOAMのカスタマイズ機能を十分利用し、ユーザーがCFD技術を意識しなくてもCFD計算できるGUIを開発した。
- OpenFOAMを企業に導入する一つ方法を提案した。
- 最初GUI設計の時、お客様のニーズを正確に把握するのが難点
- 格子作成ツールの制限によって複雑境界に対応できない。snappyHexMeshに期待する。