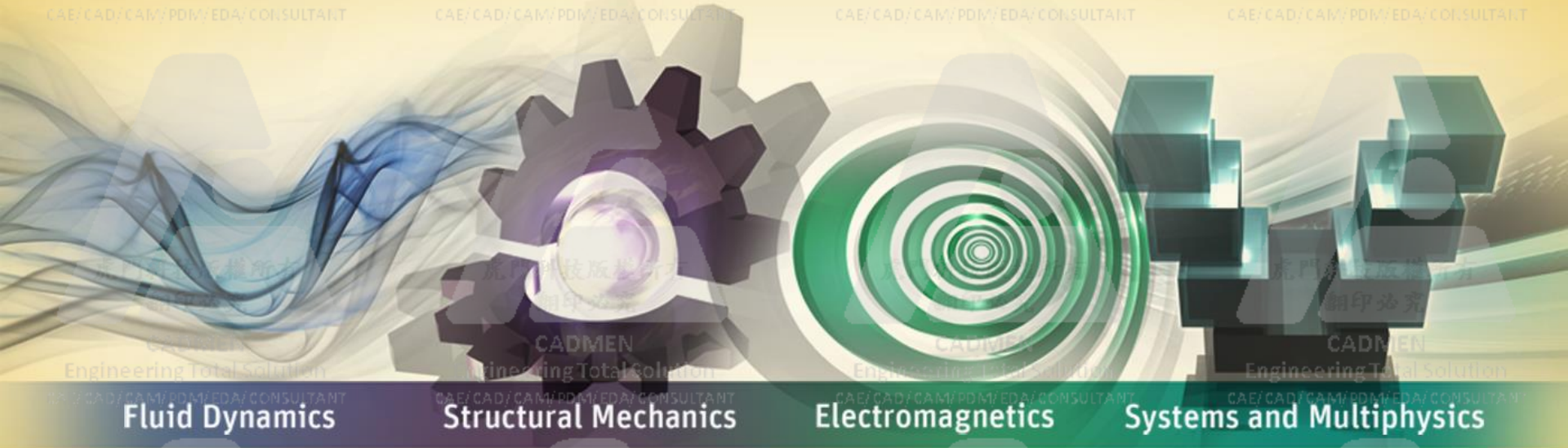


工程輔助分析於流體傳動元件上的應用



Fluid Dynamics

Structural Mechanics

Electromagnetics

Systems and Multiphysics

李龍育 Dragon
CAE事業群, 協理
虎門科技

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

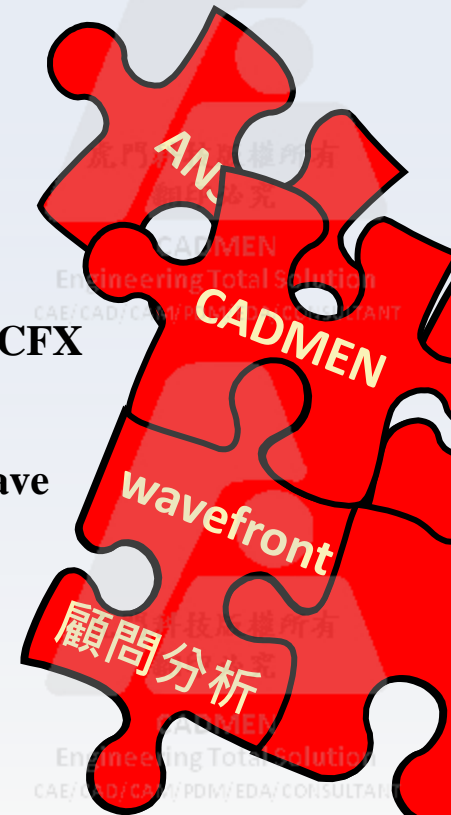
虎門科技版權所有
翻印必究



虎門科技股份有限公司，創立於1980年，提供客戶全球最優質的工程分析軟體 ANSYS與技術服務，同時榮獲ANSYS菁英級代理商與國家磐石獎的殊榮

- 結構強度分析
ANSYS Mechanical
- 落摔分析
ANSYS LS-DYNA
- 散熱與熱流場分析
ANSYS FLUENT、ICEPAK、CFX
- 電磁場分析
ANSYS Maxwell、HFSS、SIwave
- 多物理耦合分析

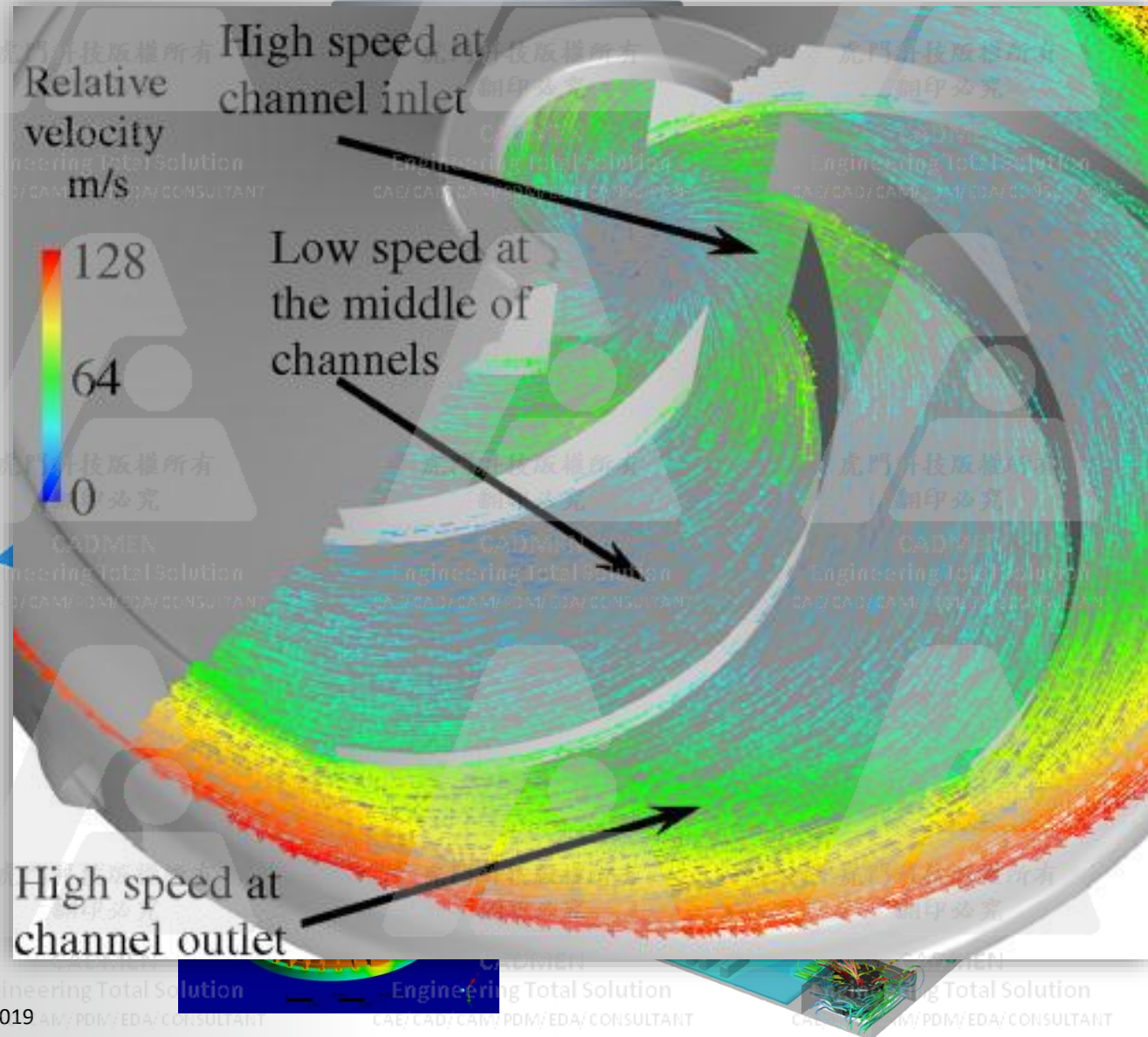
- 總公司：新北市板橋區
- 分公司：台中、新竹、台南



Provider of Engineering Solutions and Methodology

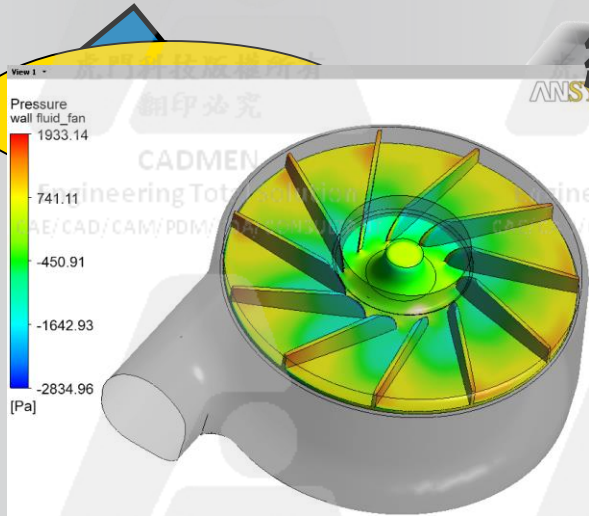
- 數位實驗
- 設計與偵錯工具
- 深入了解產品問題
- 改良產品性能表現

- 研發成本
- 開發時效
- 性能提升
- 創新研發利器

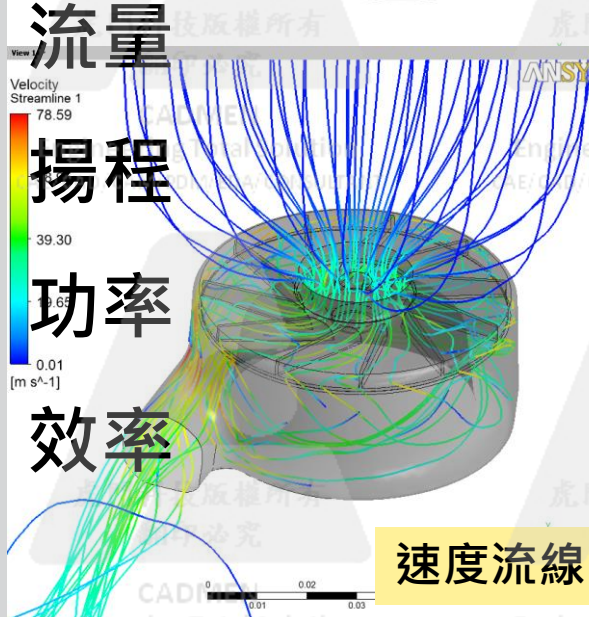


Virtual Prototyping for PUMP Design

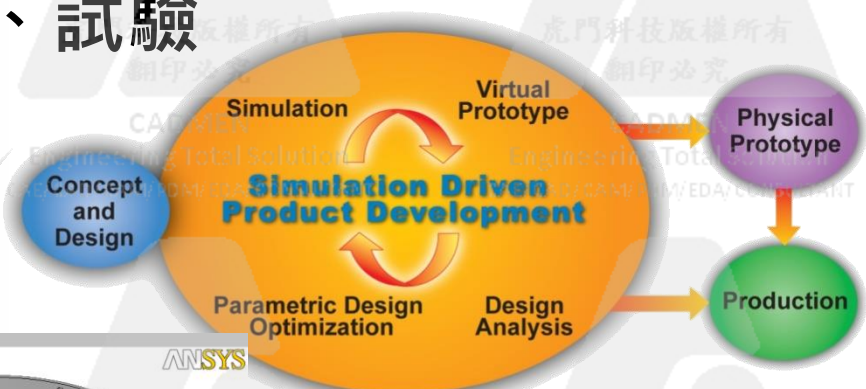
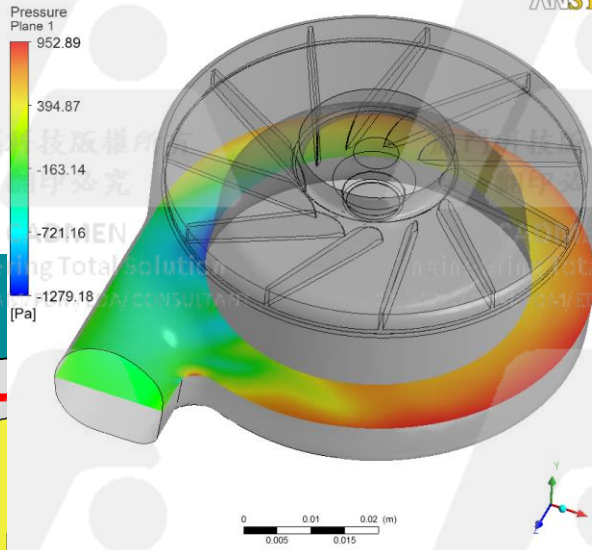
經驗、樣板、試驗



壓力分佈



速度流線



CAE, numerical modeling

Provides a solution to accelerate the different stages while reducing the risk of failure through virtual prototyping

- 研發成本
- 開發時效
- 性能提升
- 創新研發利器

ANSYS and the Electronics Design Flow

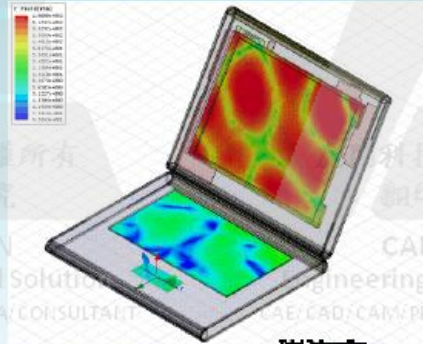
End Product

結構強度



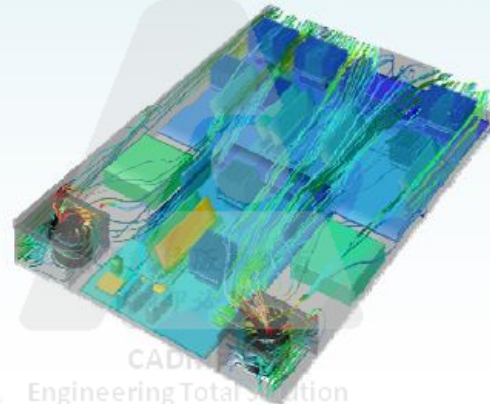
散熱設計

碰撞落摔



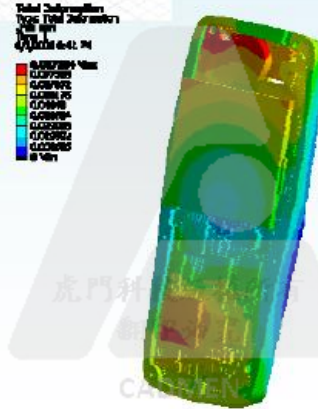
電路設計

包材設計



訊號干擾

震動噪音

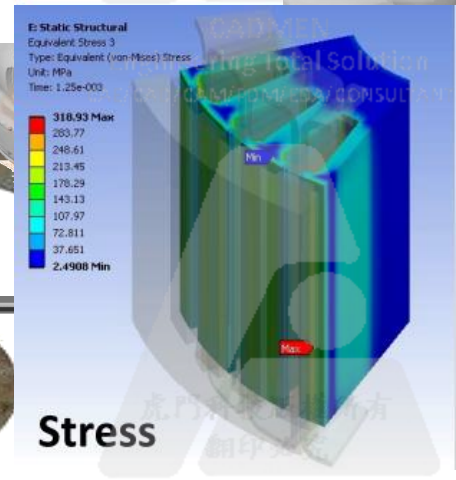
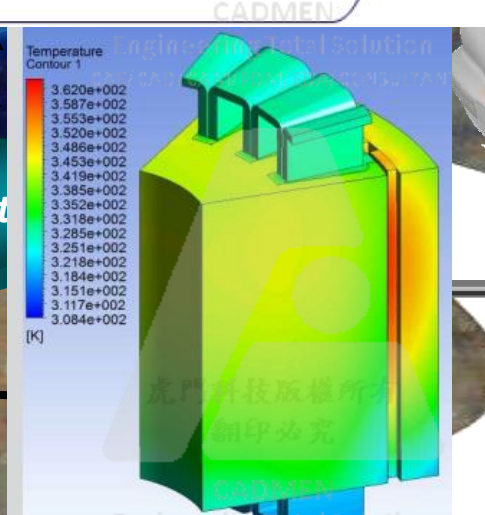
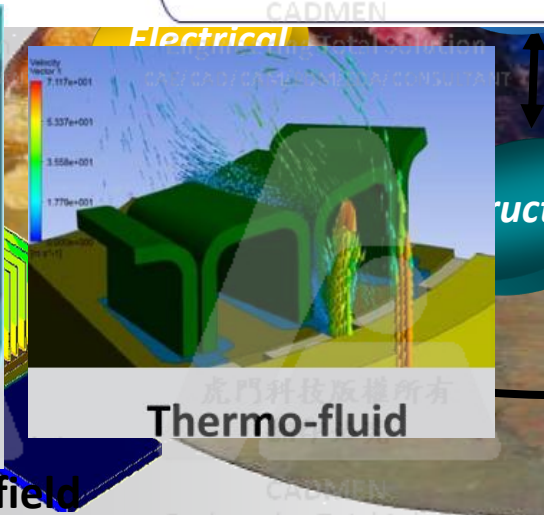
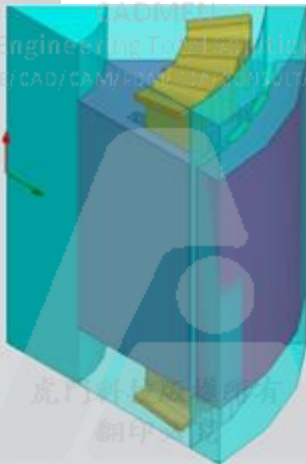
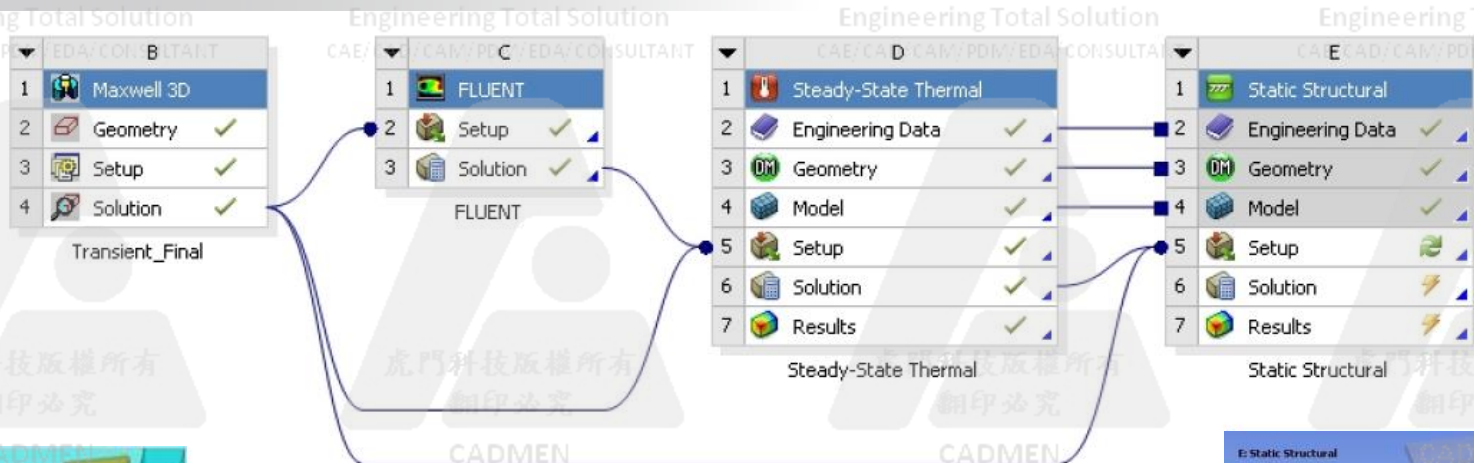


整合運算

全方位的CAE解決方案

In WorkBench

全方位解決方案—對眾多複雜的物理現象的整合解析
From electromagnetic fields to heat, cooling, and stress



Electromagnetic field

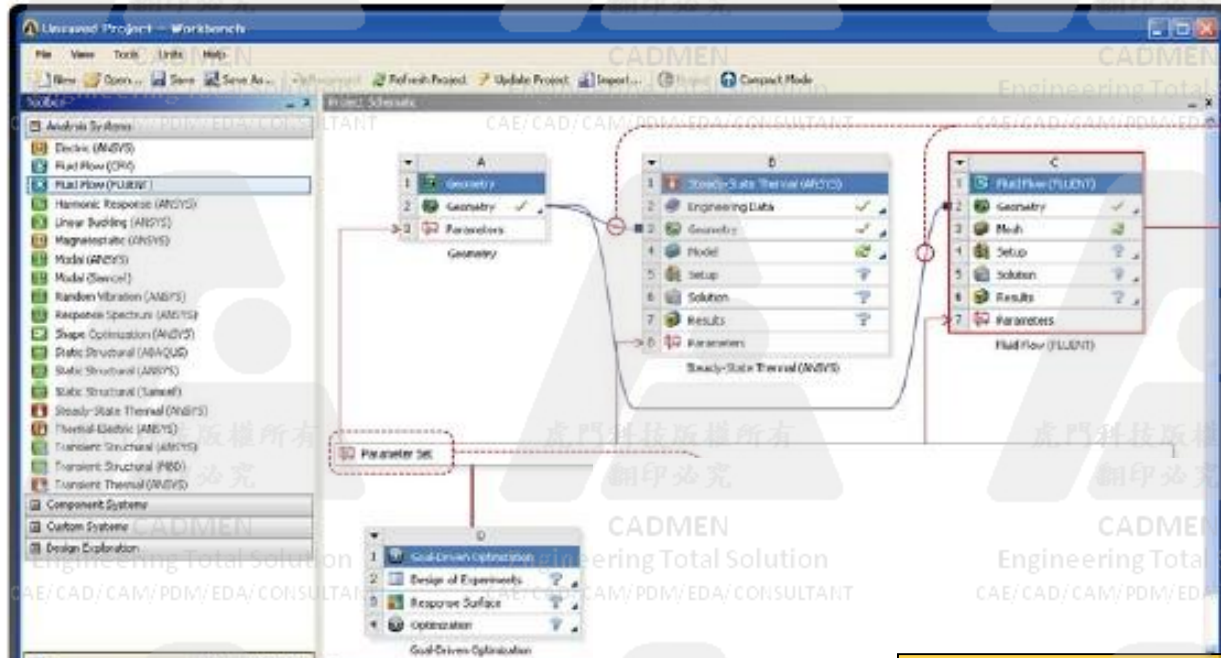
Heat transfer



About ANSYS Workbench

CAE Platform

- 分析專案管理
- 重複應用
- 參數分析
- 最佳化使用
- 共通使用介面
- 耦合運算



DesignModeler
SCDM
 建構分析模型

ANSYS MESH
 網格建構

ANSYS FLUENT
 設定&計算

CFD POST
 後處理可視化



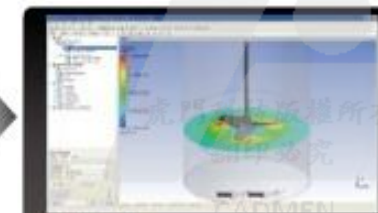
ANSYS DesignModeler



ANSYS Meshing Platform



ANSYS FLUENT
ANSYS CFX など

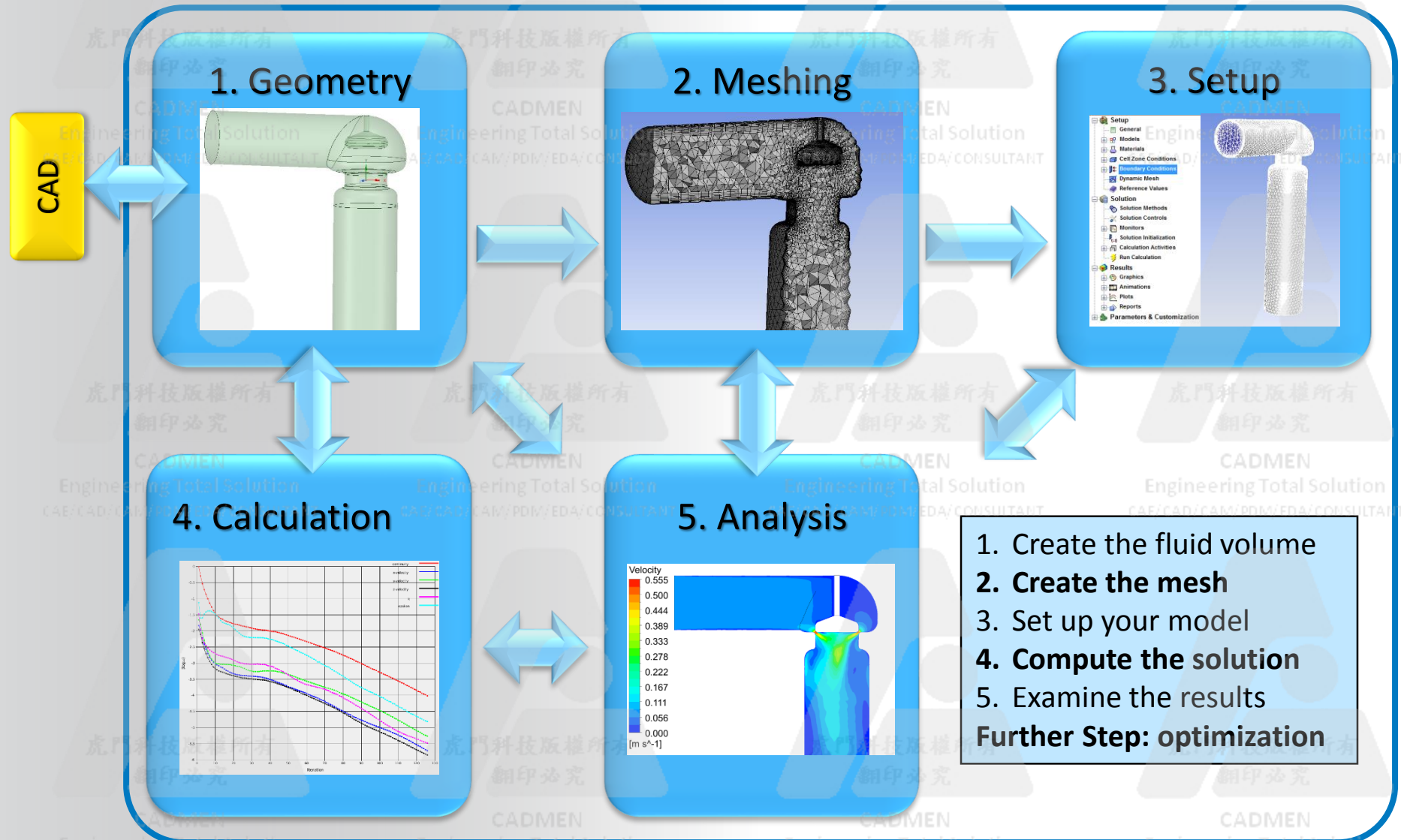


ANSYS CFD-Post

The workflow

ANSYS

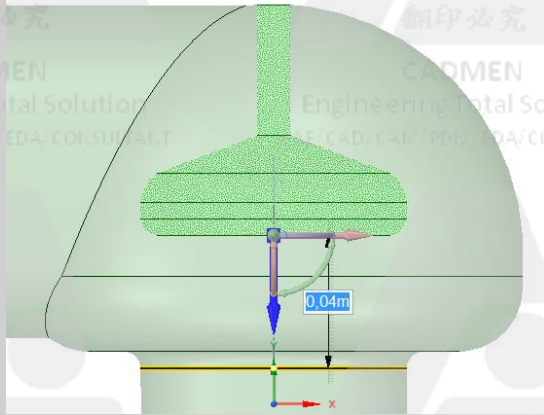
ANSYS Workbench



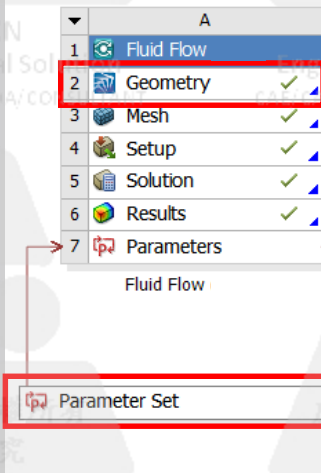
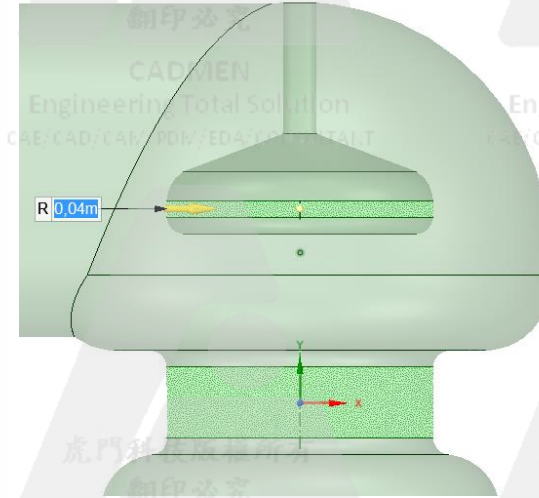
Influence of valve position and radius



Valve position:
0.5 cm – 5 cm



Valve radius:
35 cm, 40 cm, 45 cm



Name	P3 - Ventilloeffnung	P5 - Ventildurchmesser	P6 - Durchlass	P2 - KvWert	P7 - deltaP
Units				m ³ s ⁻¹	Pa
DP 0	0,04	0,04	0,04	0,067404	5,5125
DP 1	0,05	0,04	0,04	0,069236	5,2246
DP 2	0,03	0,04	0,04	0,064429	6,0333
DP 3	0,01	0,04	0,04	0,029555	28,672
DP 4	0,02	0,04	0,04	0,054708	8,3681
DP 5	0,005	0,04	0,04	0,015547	103,62
DP 6	0,05	0,035	0,035	0,055103	8,2486
DP 7	0,05	0,045	0,045	0,084377	3,5178
DP 8	0,04	0,045	0,045	0,081305	3,7887
DP 9	0,03	0,045	0,045	0,07645	4,2852
DP 10	0,02	0,045	0,045	0,063065	6,2972
DP 11	0,01	0,045	0,045	0,033727	22,017
DP 12	0,005	0,045	0,045	0,018157	75,972
DP 13	0,005	0,035	0,035	0,013959	128,54
DP 14	0,01	0,035	0,035	0,026126	36,693
DP 15	0,02	0,035	0,035	0,04621	11,729
DP 16	0,03	0,035	0,035	0,052499	9,0871
DP 17 (Current)	0,04	0,035	0,035	0,05383	8,6432

Analysis – examine the results



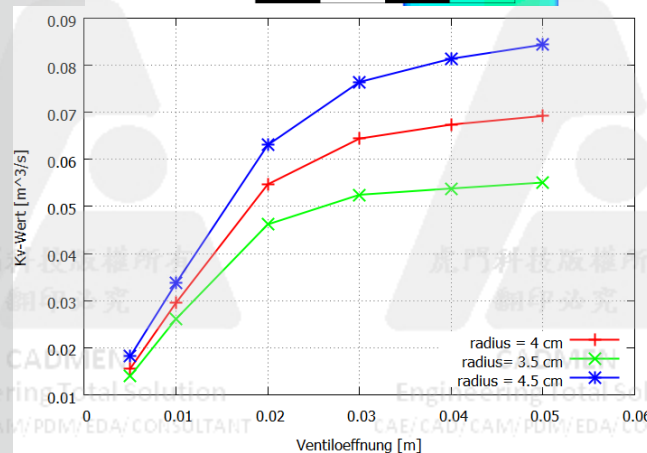
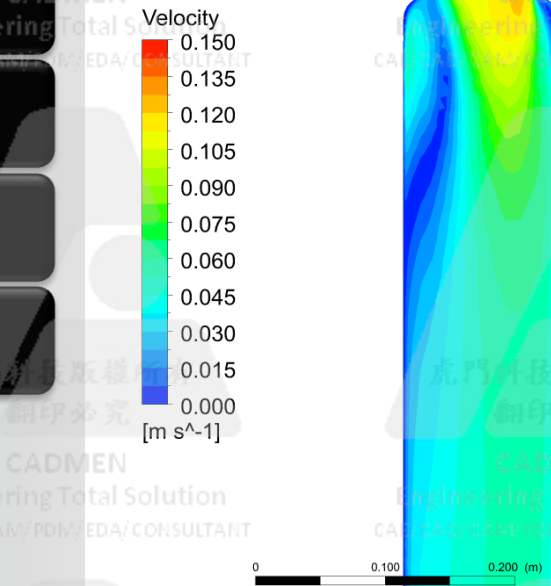
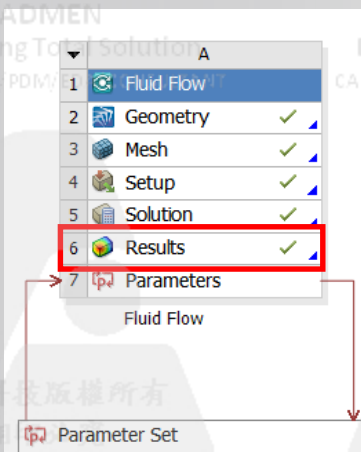
Locations & contours

Vectors & streamlines

Pictures & animations

Scripting & macros

Reports



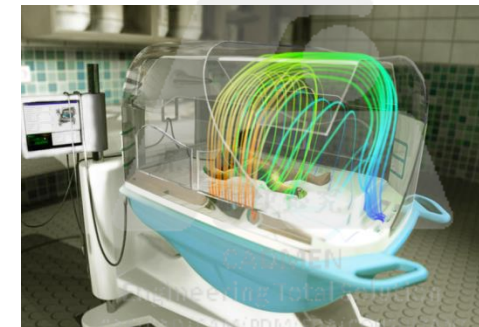
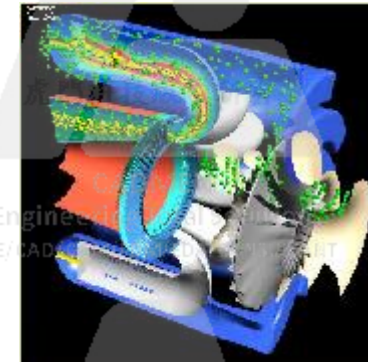
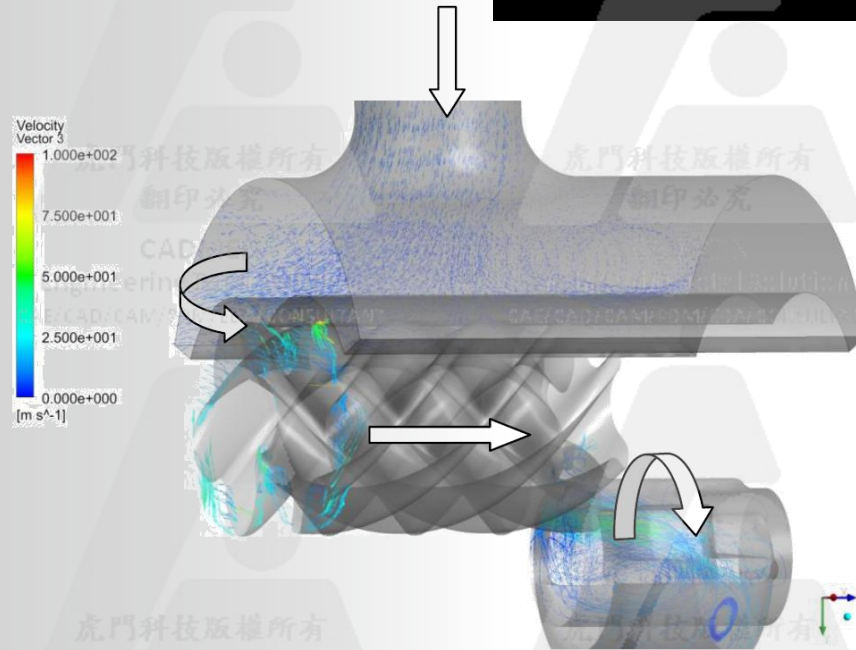
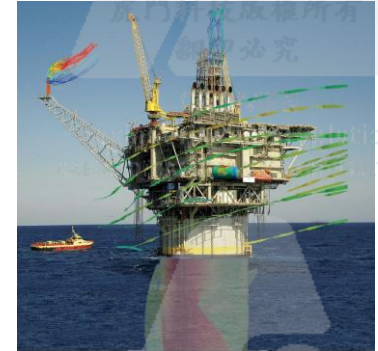
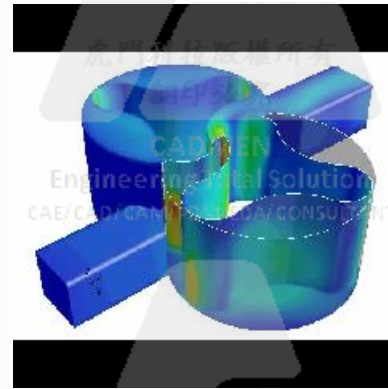
ANSYS CFD (FLUENT、CFX) 為功能強大、模組廣泛的旗艦型 CFD 產品

核心技術

- 移動/變形網格
- 多相流
- 化學反應流
- 紊流
- 熱輻射
- 氣動噪音

擴展分析

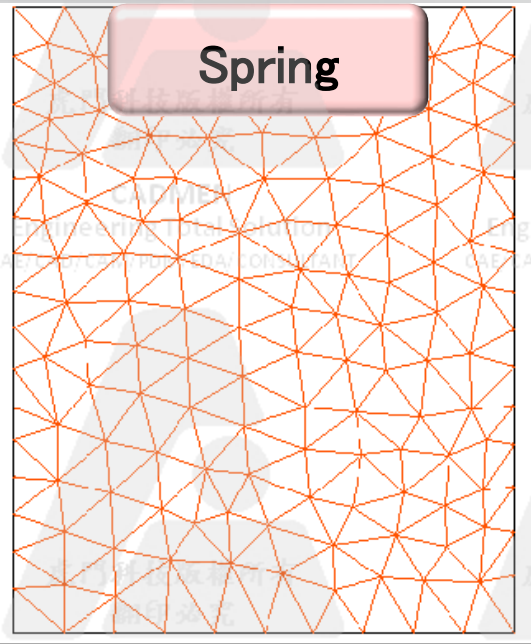
- 磁流模組 (MHD)
- 燃料電池模組
- 鋰離子電池模組
- 流固耦合 (FSI)
- 最佳化分析



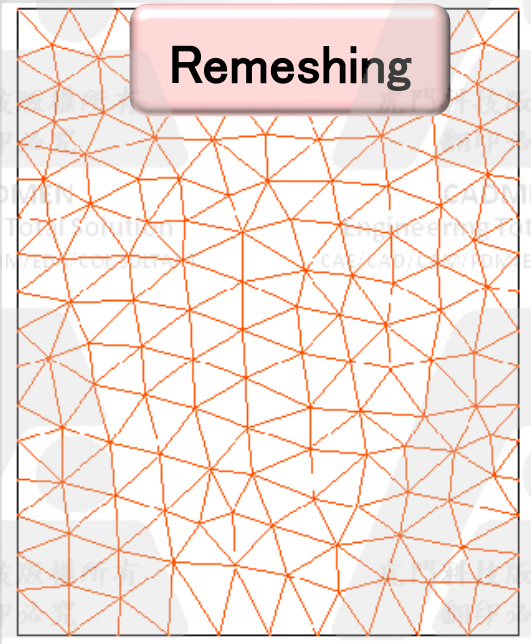
移動/變形網格(Dynamic Mesh)

ANSYS®

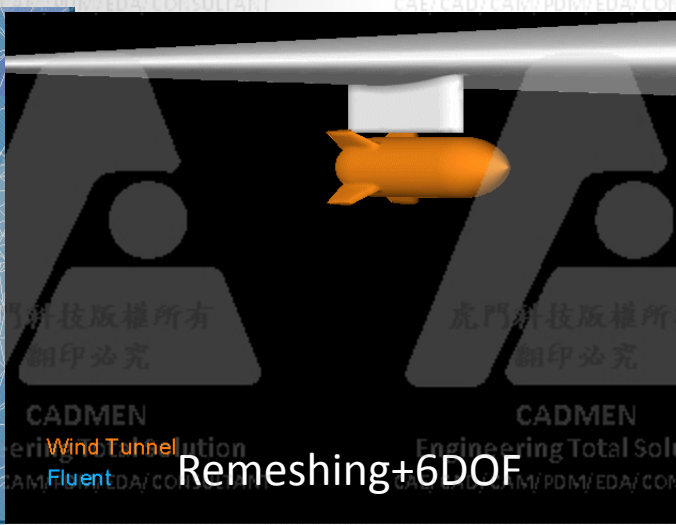
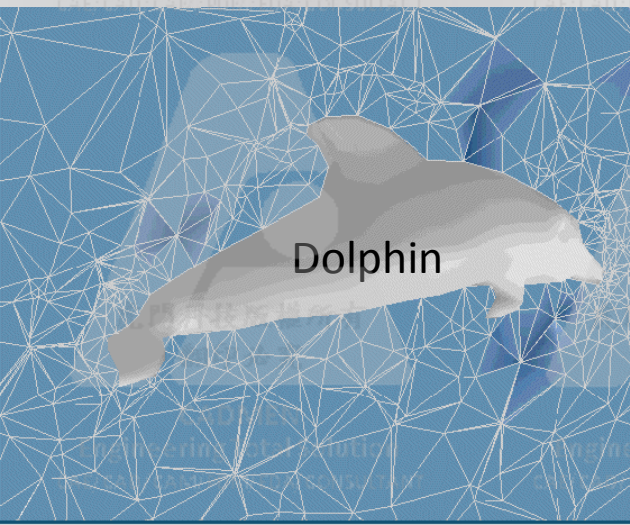
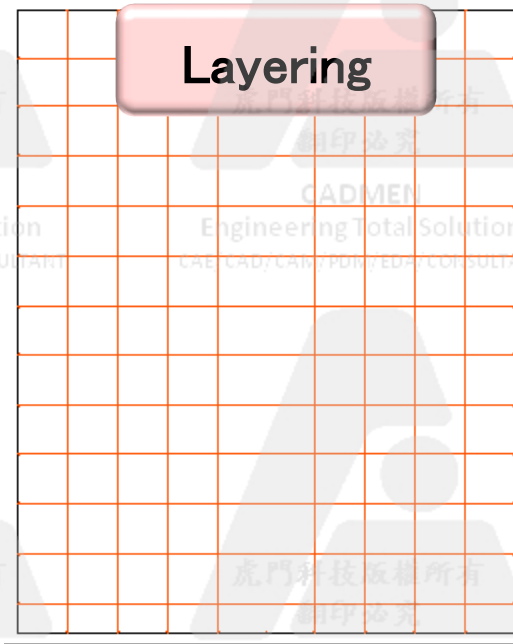
Spring



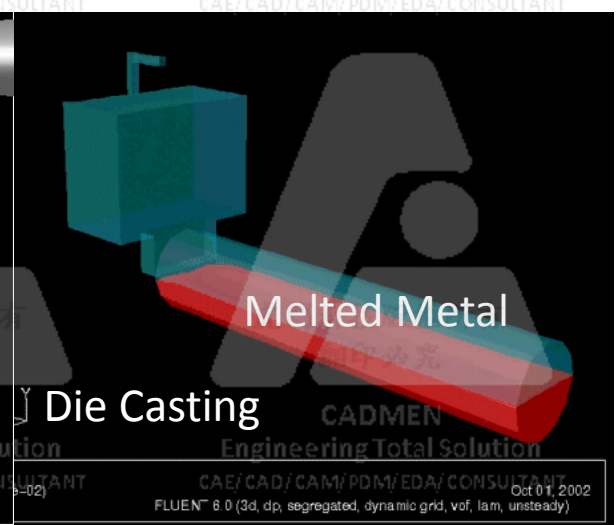
Remeshing



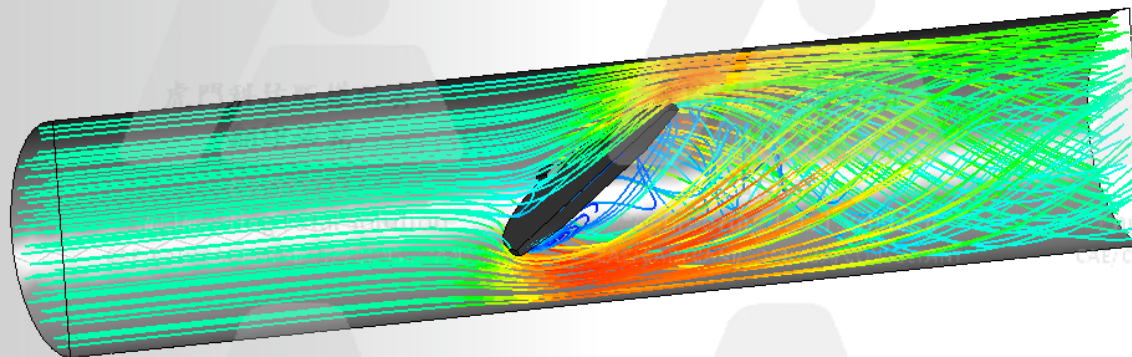
Layering



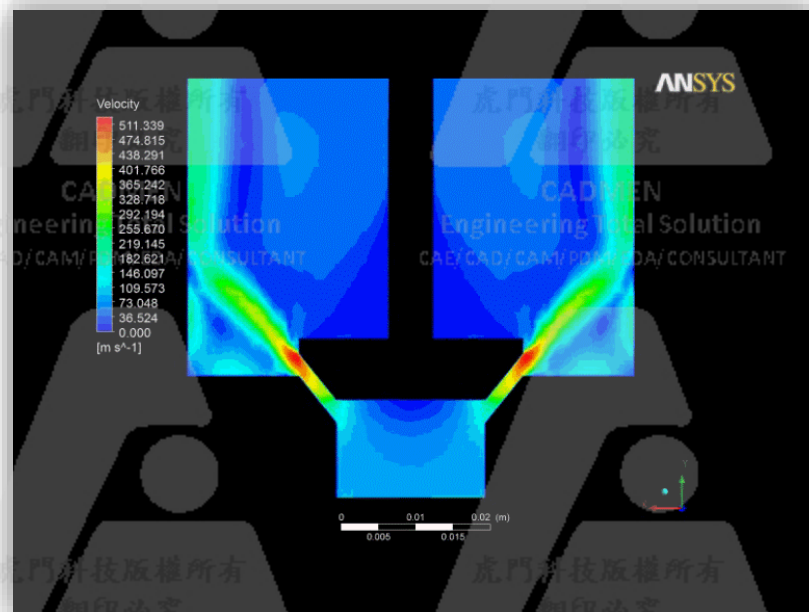
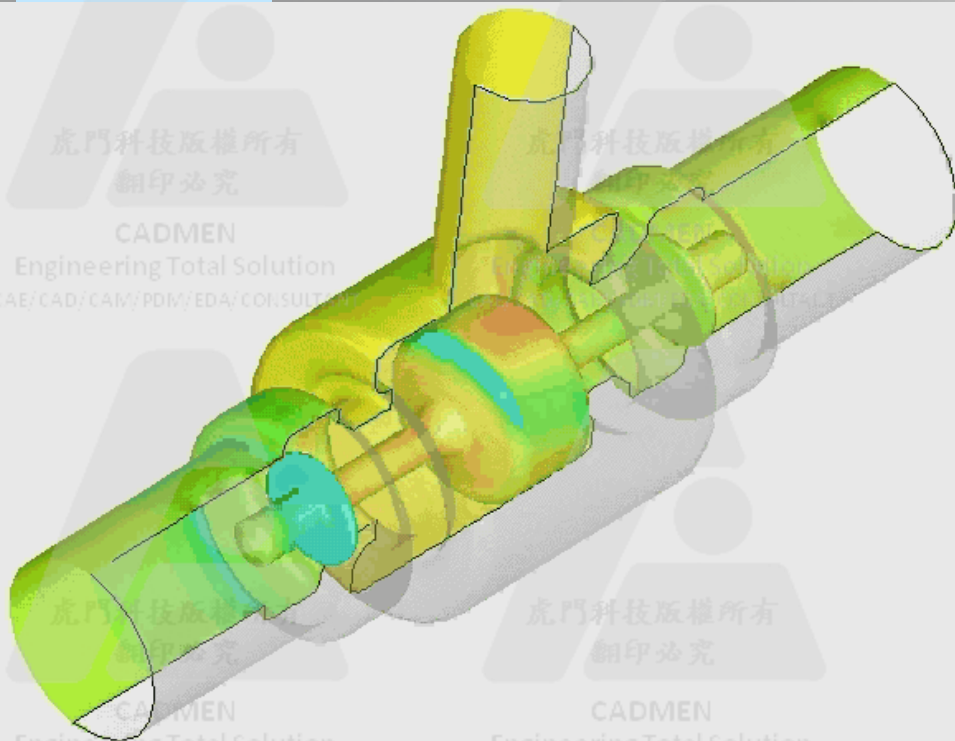
Remeshing+6DOF



Valves 動網格案例

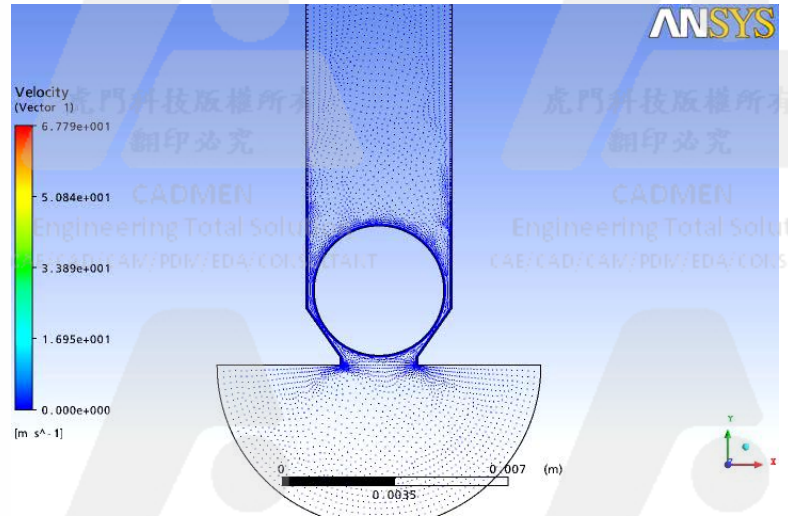
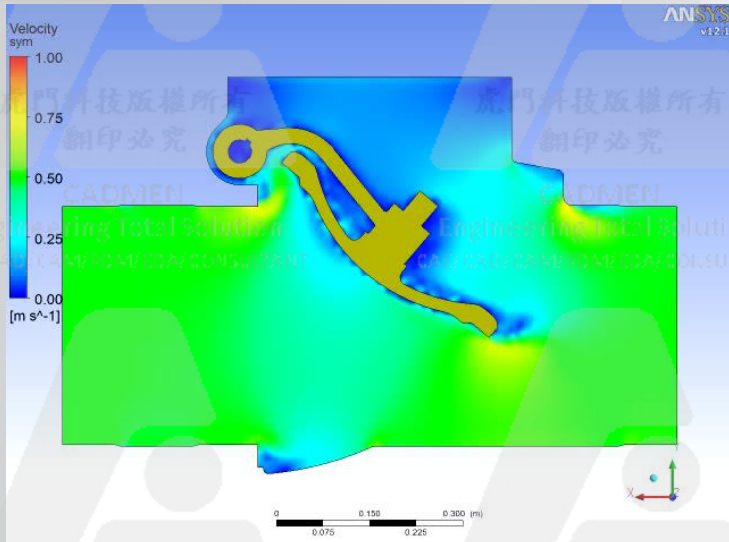


動態網格

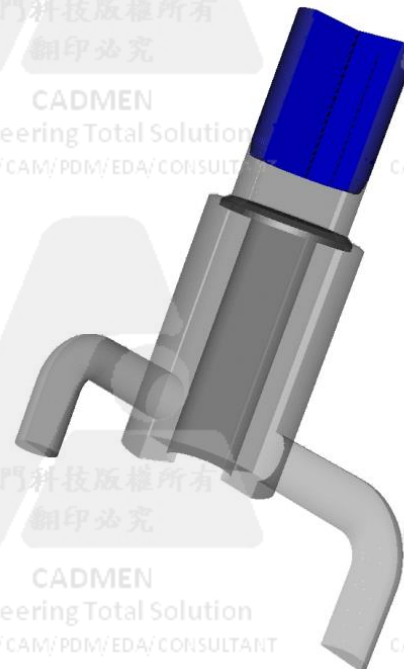
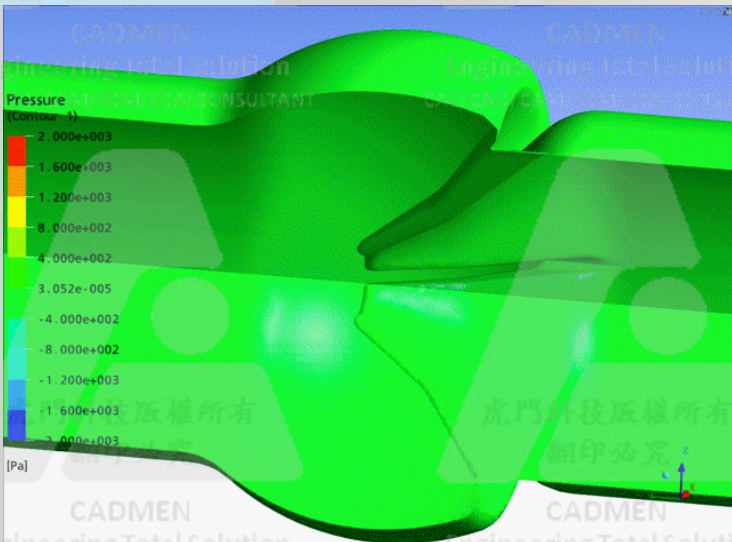


各類閘門案例應用

DOF



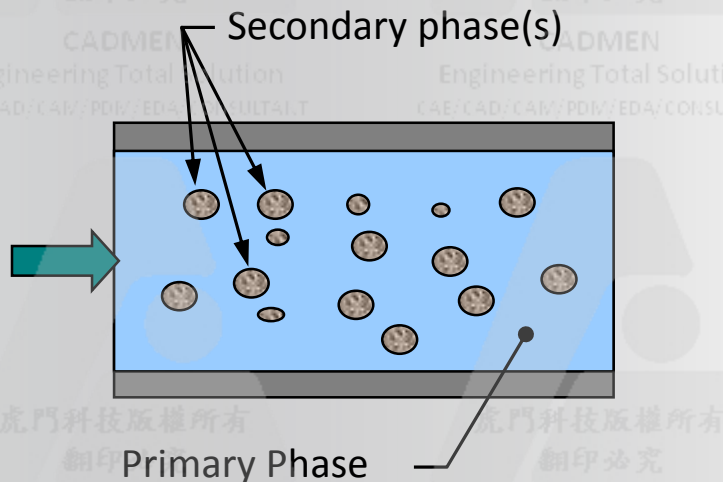
Two Way FSI



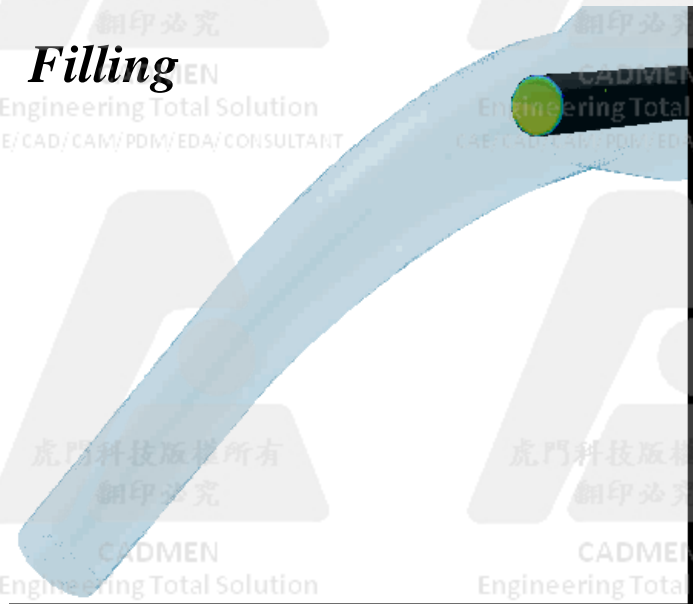
多相流 Multiphase Flows

The fluid system is defined by a primary and multiple secondary phases.

- **One of the phases** is considered continuous (primary)
- The others (secondary) are considered to be dispersed within the continuous phase.
- (Note that for *free-surface flows, using the Volume of Fluid model (VOF)*, a distinct interface is defined between the phases and both could be considered continuous)



Filling

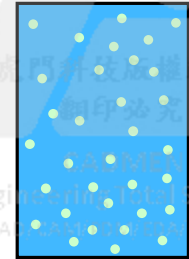


Multiphase Flow Regimes

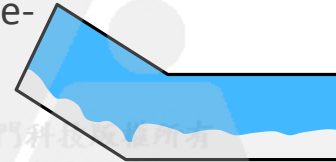
- **Bubbly flow** – Discrete gaseous bubbles in a continuous fluid, e.g. absorbers, evaporators, sparging devices.
- **Droplet flow** – Discrete fluid droplets in a continuous gas, e.g. atomizers, combustors
- **Slug flow** – Large bubbles in a continuous liquid
- **Stratified / free-surface flow** – Immiscible fluids separated by a clearly defined interface, e.g. free-surface flow



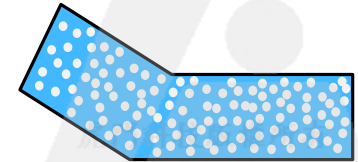
Slug Flow



Bubbly, Droplet, or Particle-Laden Flow

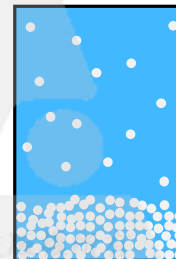


Stratified / Free-Surface Flow



Pneumatic Transport, Hydrotransport, or Slurry Flow

- **Particle-laden flow** – Discrete solid particles in a continuous fluid, e.g. cyclone separators, air classifiers, dust collectors, dust-laden environmental flows
- **Fluidized beds** – Fluidized bed reactors



Sedimentation



Fluidized Bed

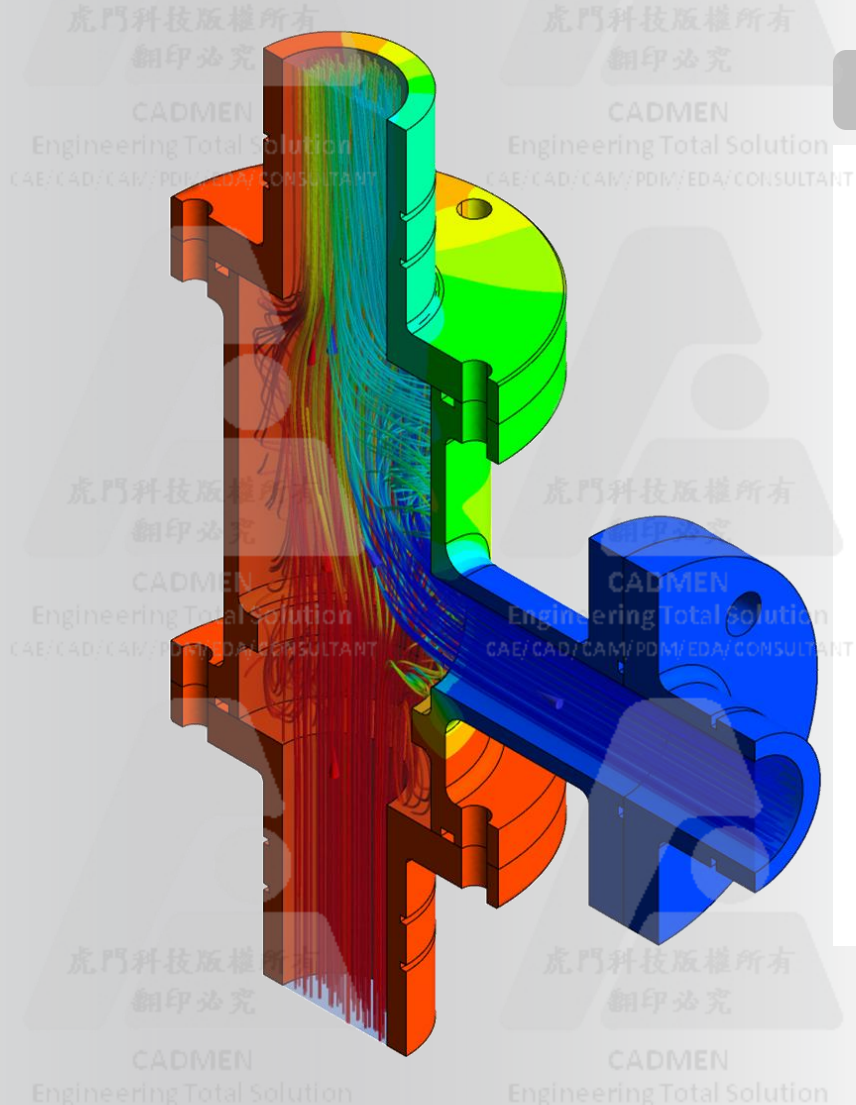
- **Slurry flow** – Particle flow in liquids, solids suspension, sedimentation, and hydro-transport

Gas/Liquid
Liquid/Liquid

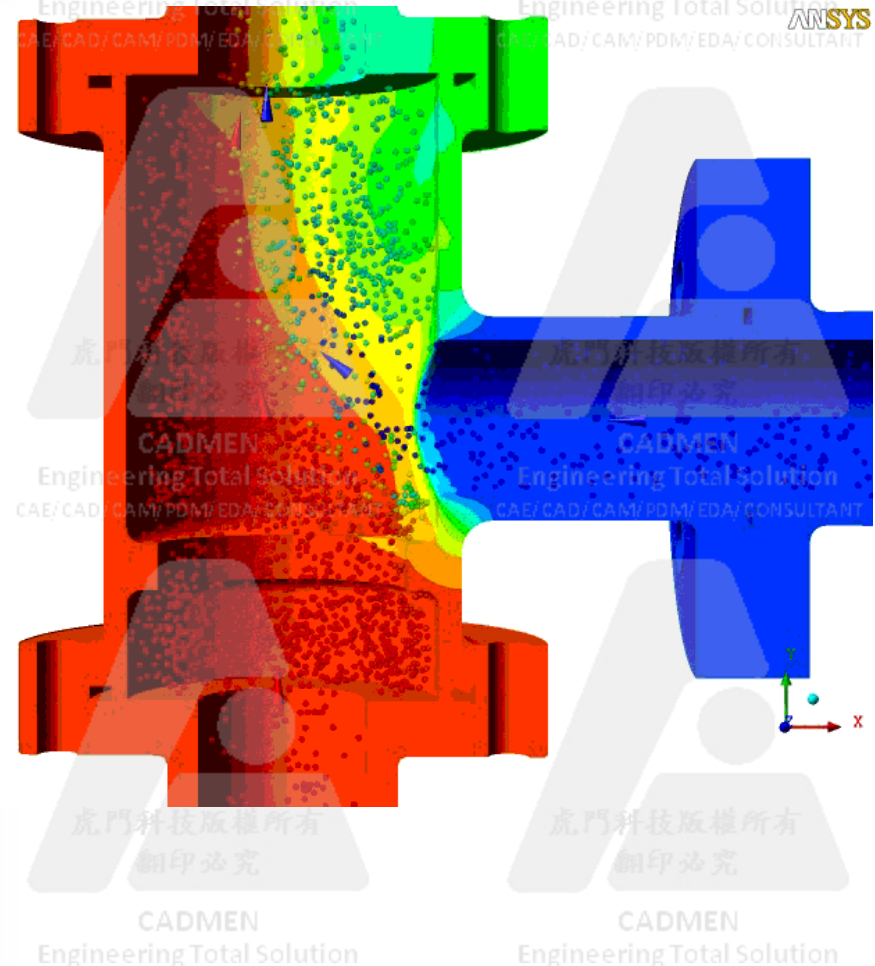
Gas / Solid

Liquid / Solid

管路流場分析



顆粒流動分析



Sand/Particulate Transport

- Sand is often produced in both onshore and offshore production systems,
- Sand production may be continuous, or sudden
- The sediment consists mud, sand and scale picked up during the transport of the oil
- Sand deposition could lead to corrosion of the pipeline
- Problem of sand deposition and re-entrainment can be addressed by Particulate modeling in ANSYS CFD.

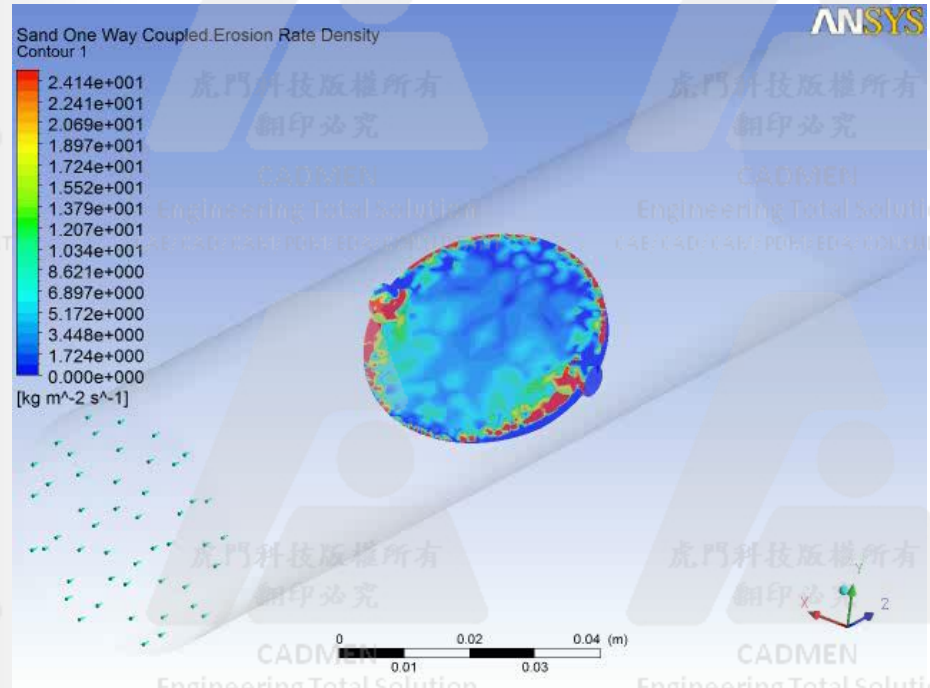
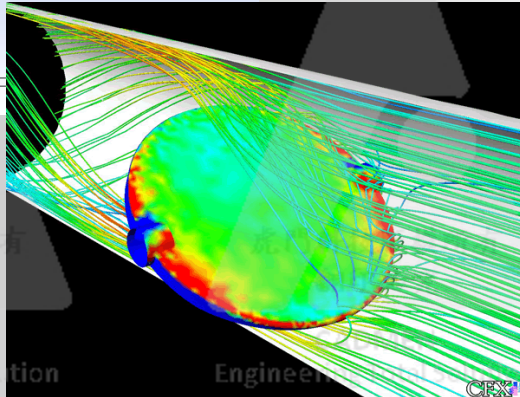
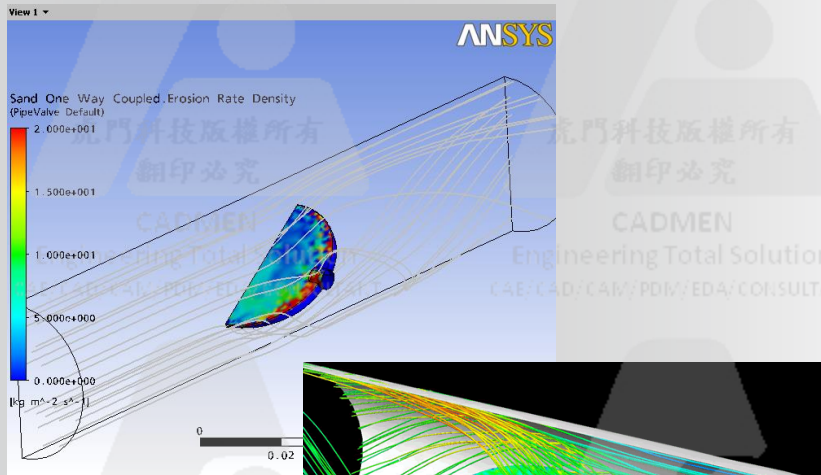
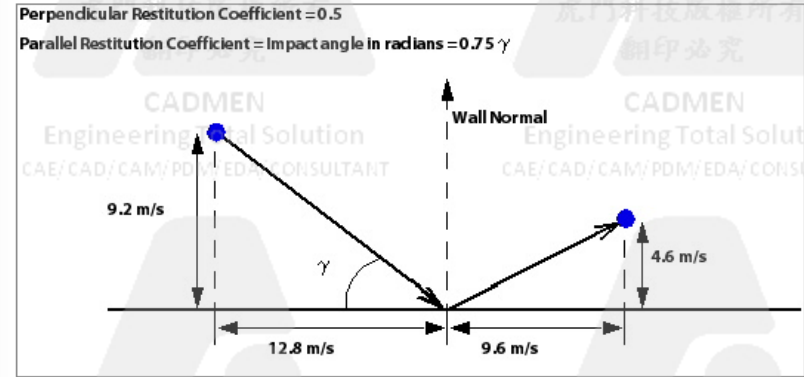
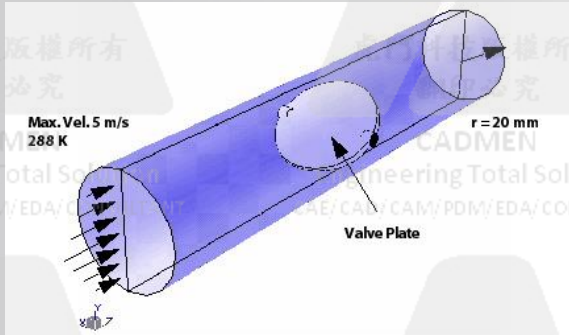


*Internal flow of natural gas containing **sand particles**.*

Selected particle trajectories are colored in grey

*The **erosive** wear hotspots on the piping is colored out in red.*

泥沙冲刷 - 考虑颗粒侵蚀效应



Water Hammer 流固耦合

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

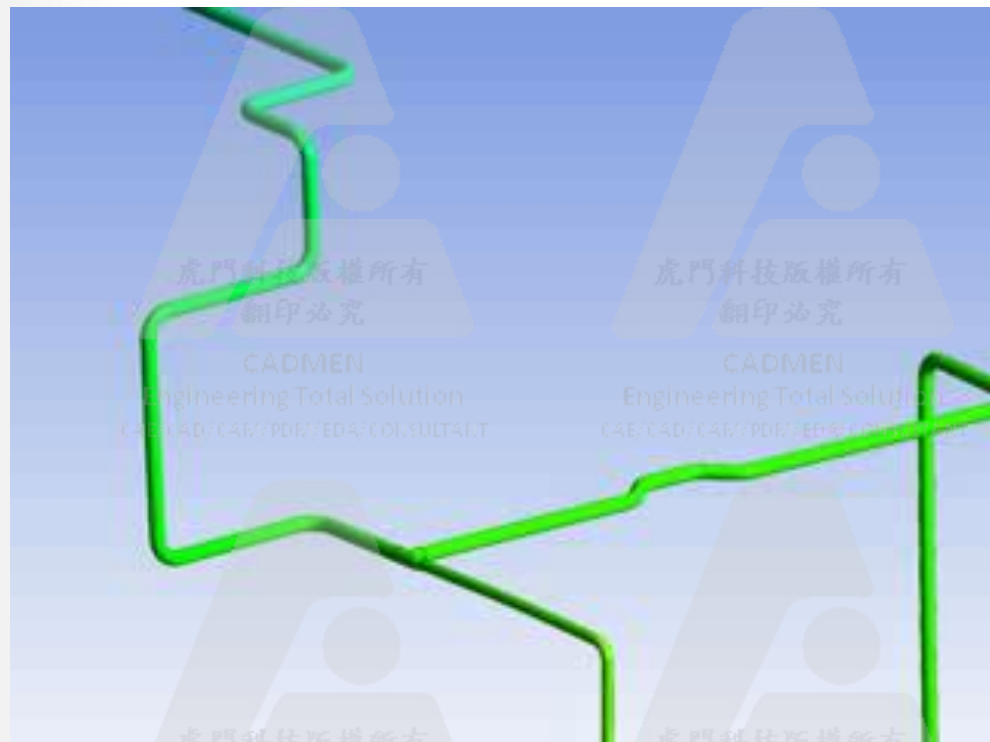
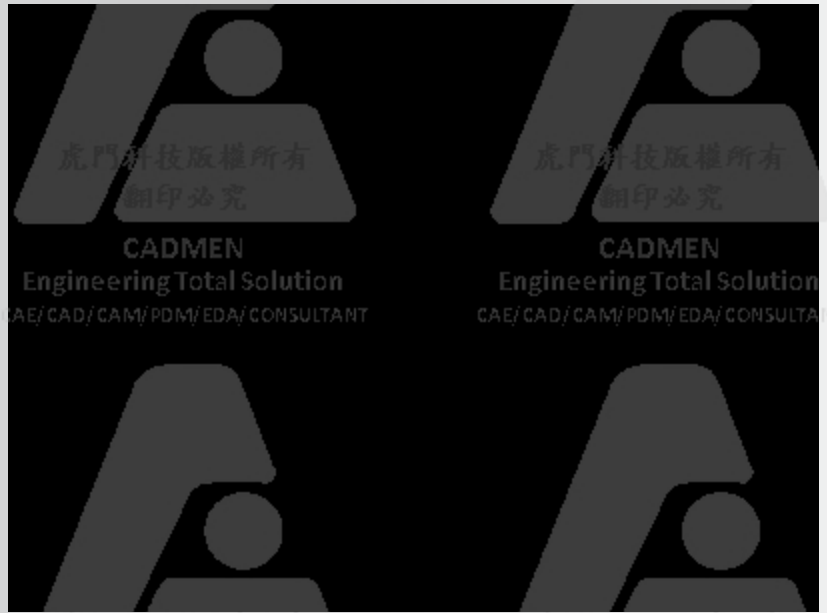
CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

考慮流固耦合，可分析因
水槌現象所造成之管路偏移與應力

管路出口突然關閉
所造成之水槌現象



虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

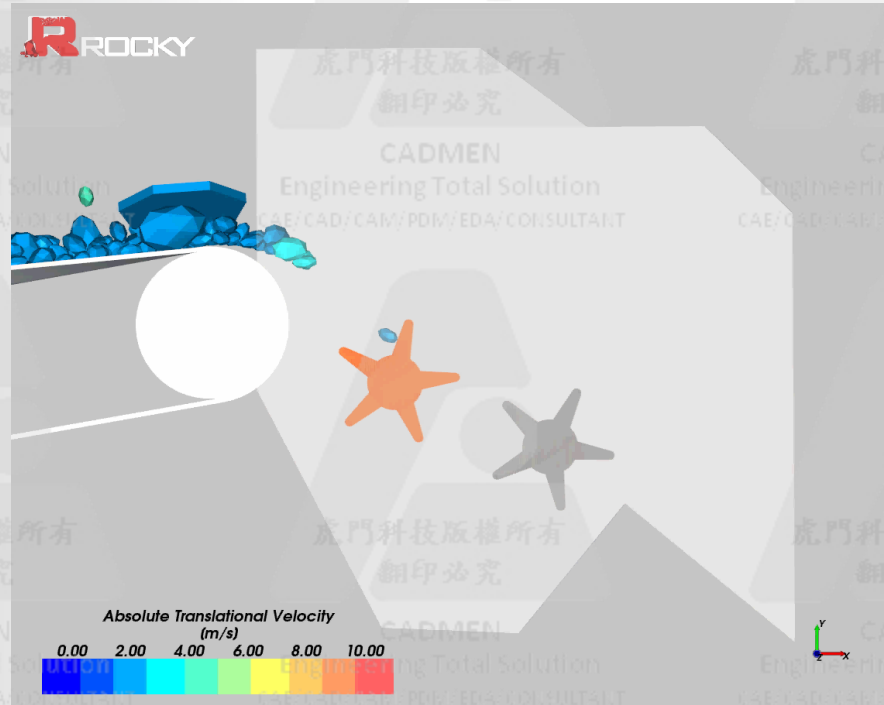
CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

ROCKY-DEM粒子輸送與ANSYS Fluent耦合應用

唯一使用精確粒子形態和進階破損與碎片模型的商用碼
與Fluent耦合

內建粒子、自訂粒子(STL)



One-way coupling example:
waste separator

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

流固耦合

工業用閥門流場與結構變形分析

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

Valve travel effect on field flow and deformation in valve

Project Name :

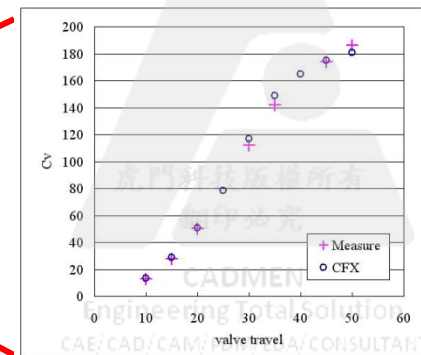
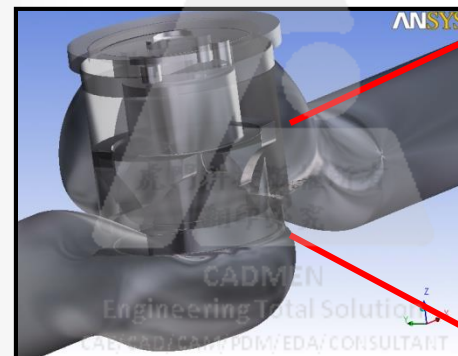
Flow Coefficient (C_v) Study and FSI Analysis of an Industry Valve

Problem description :

- Evaluate the flow coefficient (C_v) as the function of valve travel distance given a constant pressure decline.
- Verify the strength design of valve parts and check if any undesirable deformation occurs.

Analysis tools :

- flow simulation software :
 - pre-processor : ANSYS DesignModeler + CFX Mesh (1.6M tetra-grid)
 - solver : ANSYS CFX solver (Finite Volume CFD solver)
 - post-process : ANSYS CFX-post
- valve parts strength calculation : ANSYS (Finite Element Method)

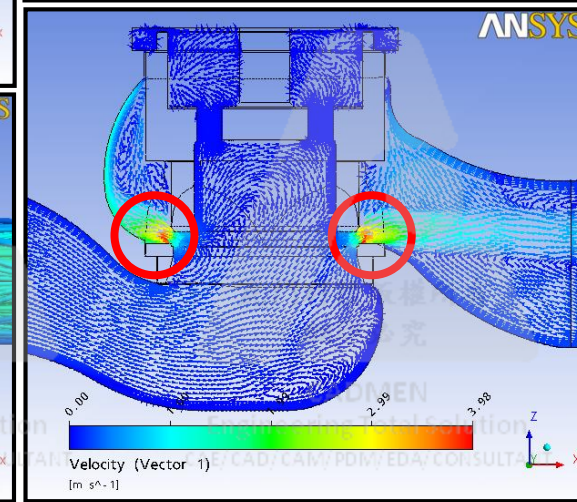
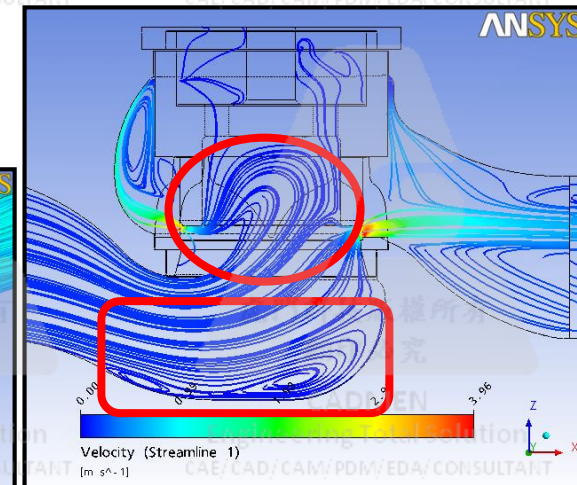
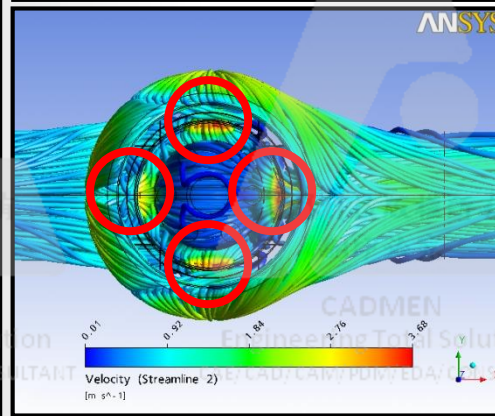
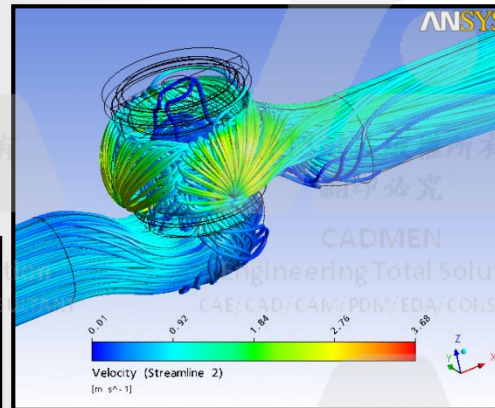
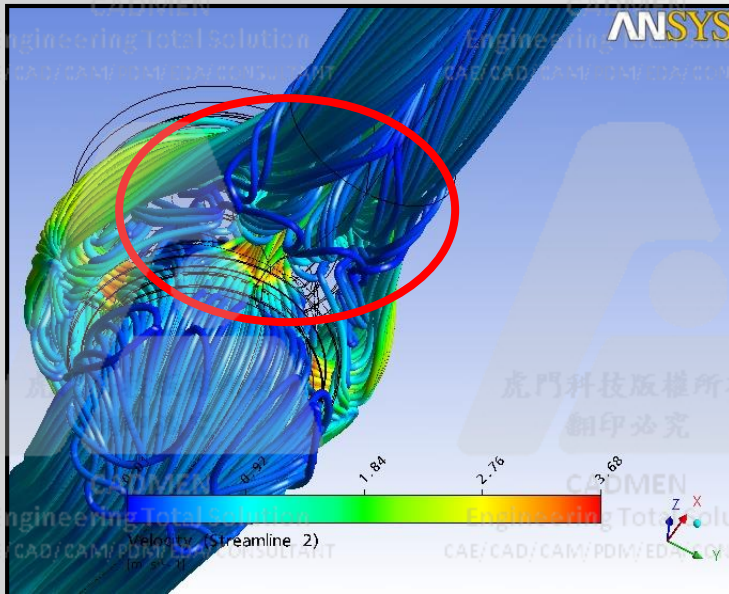
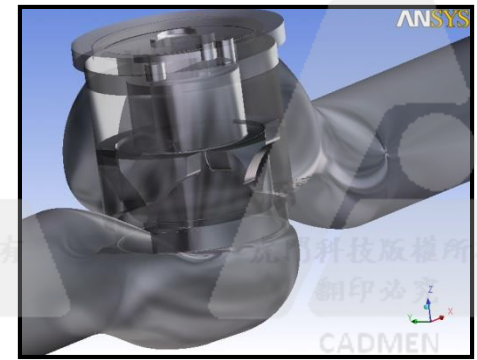


工業用閥門流場與結構變形分析

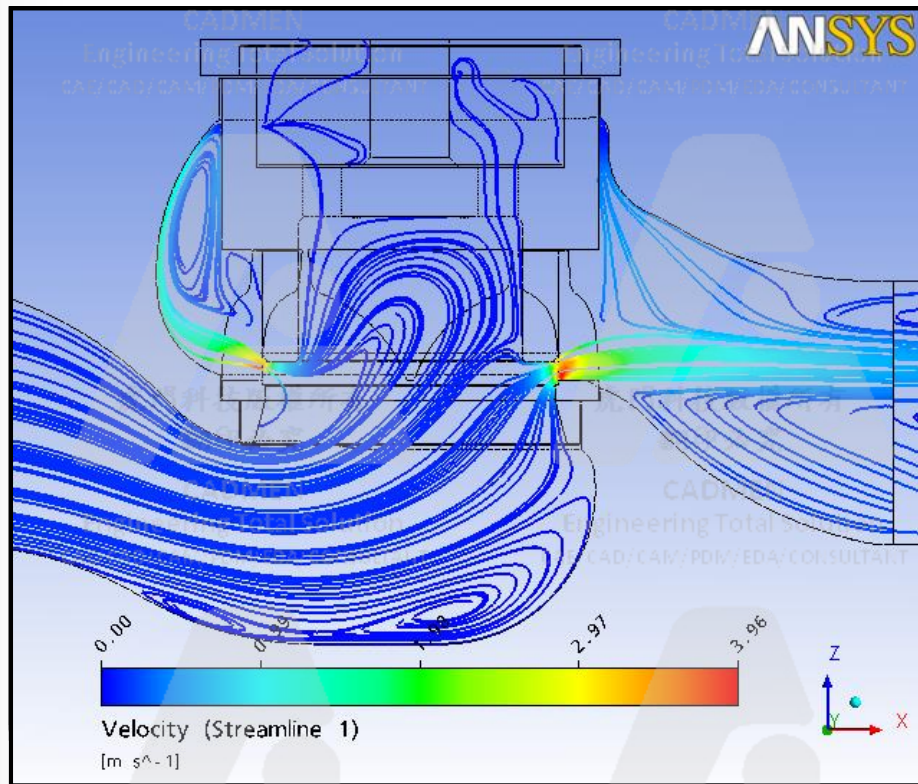
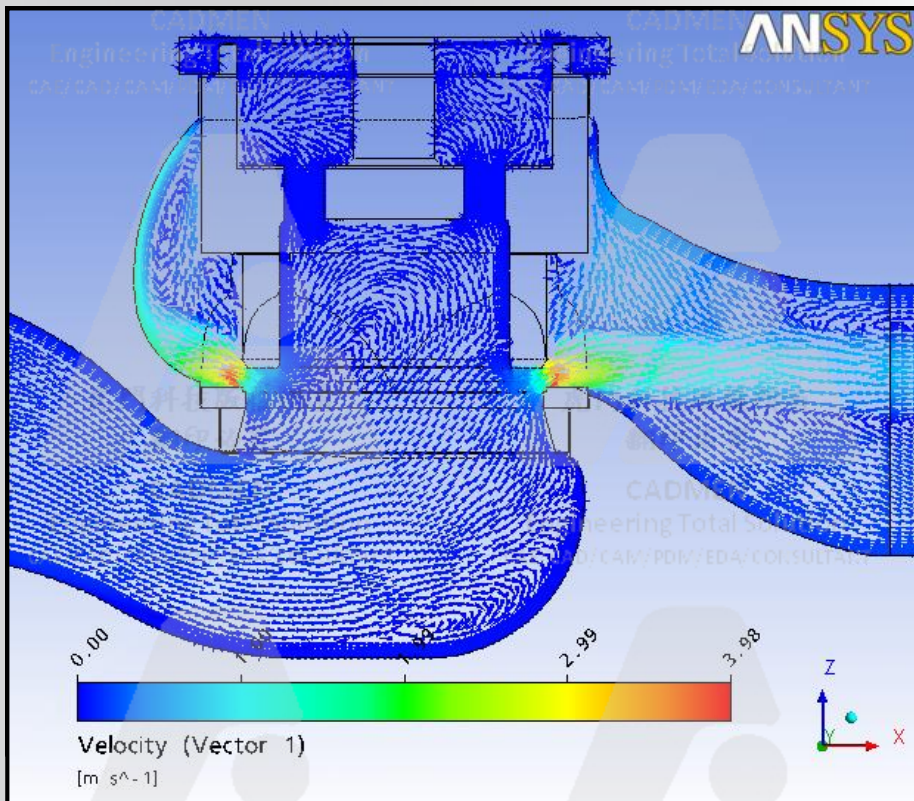
ANSYS

Flow Simulation Result

- Strong swirling flow occurs in the regions near
 1. bottom of the valve body
 2. top of the valve gate part
 3. outlet of the valve
- High speed flow occurs near the gate opening. Cavitation risk exist in these region.



50mm 40mm 30mm 20mm 10mm



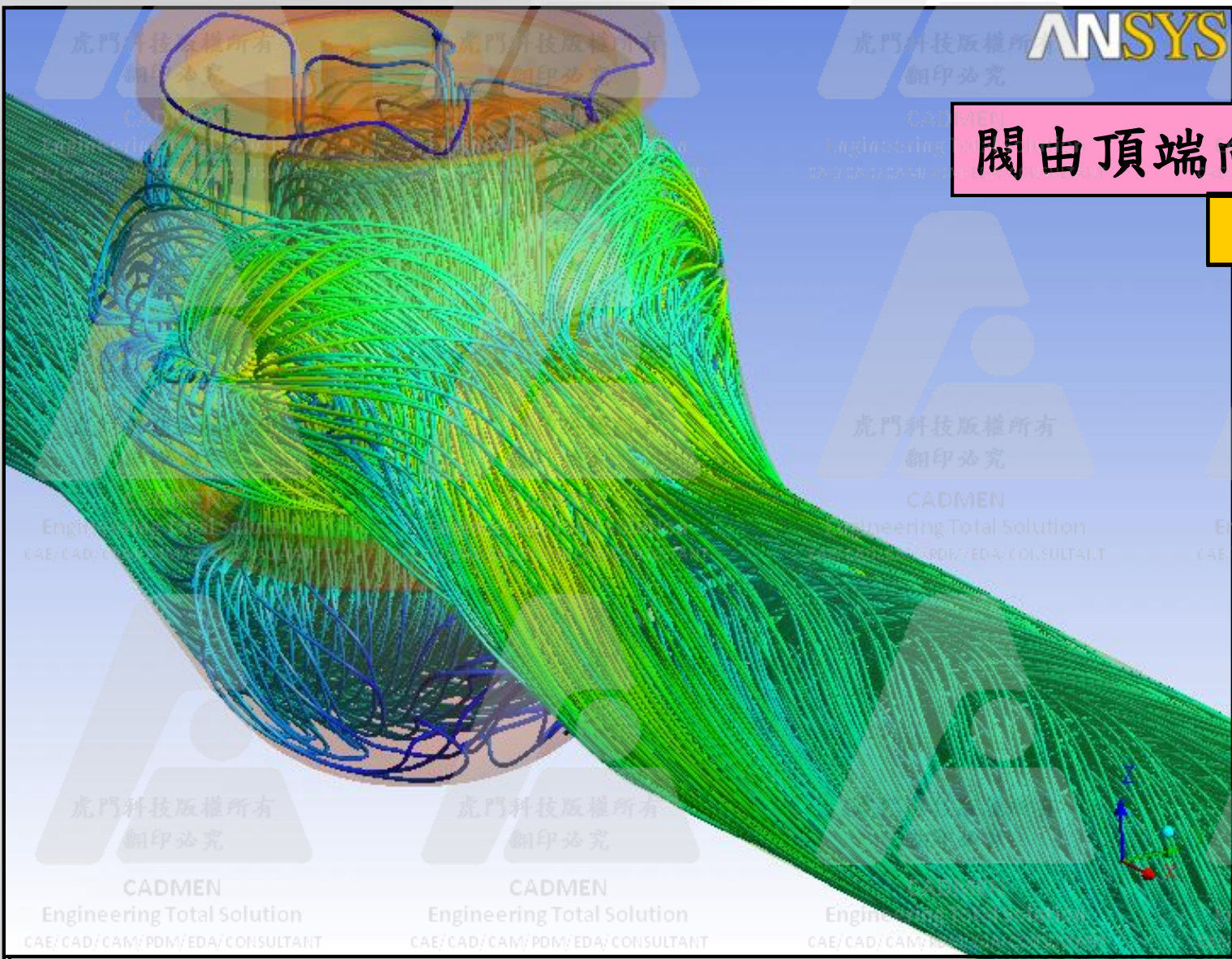
虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

參數化



閥由頂端向下移動

Travel : 40 mm

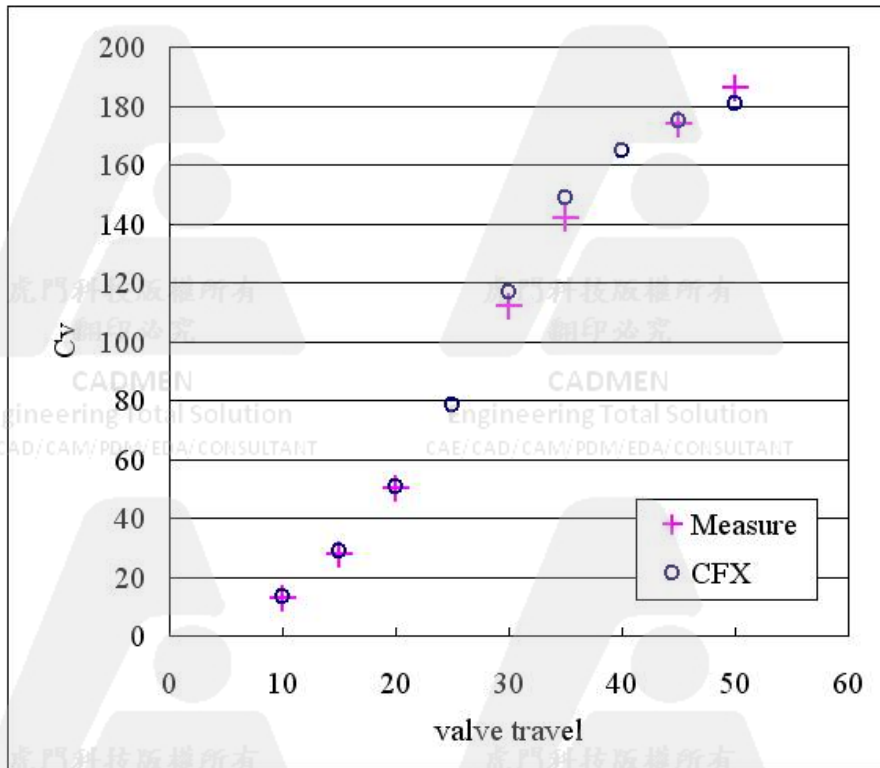
虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

Valve travel effect on field flow and deformation in valve

Flow Coefficient Study Result



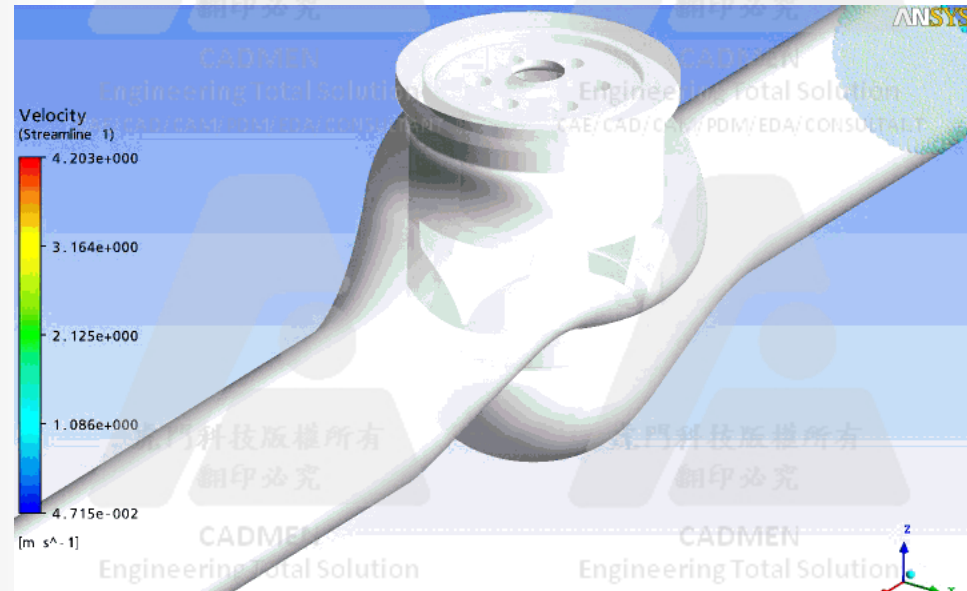
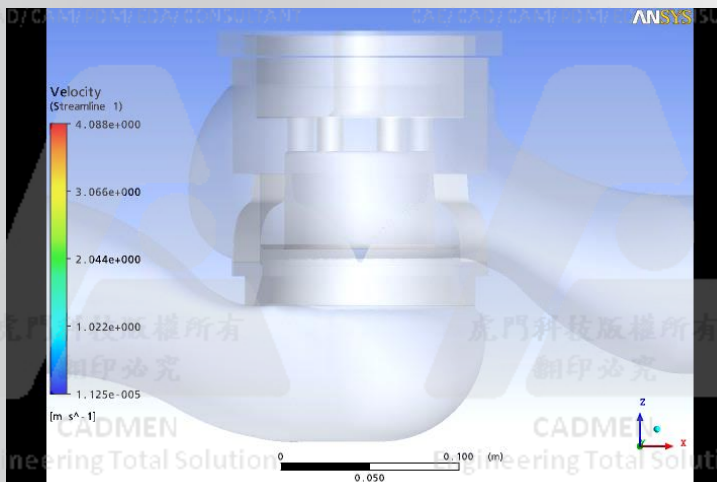
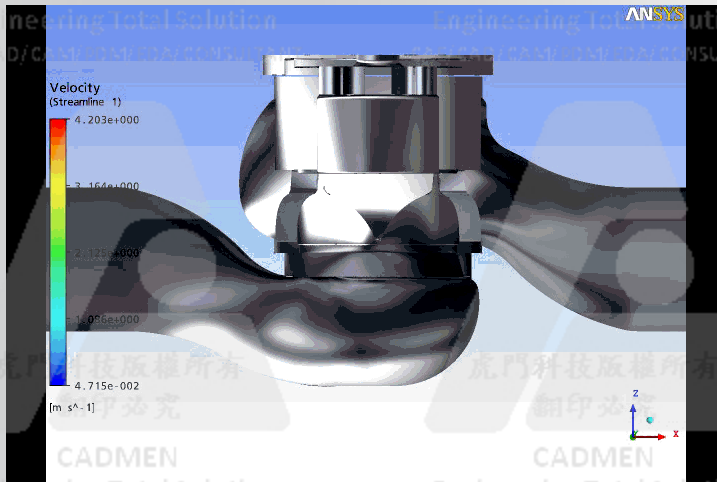
Flow Coefficient Cv as Function of Valve Travel given 0.07 pressure drop

$$C_v = \frac{1.167 Q \sqrt{G}}{\sqrt{\Delta P}}$$

Valve travel	Cv
10	13.1579
15	28.9473
20	50.8538
25	78.5938
30	116.5452
35	148.8508
40	164.5764
45	175.1532
50	180.9202

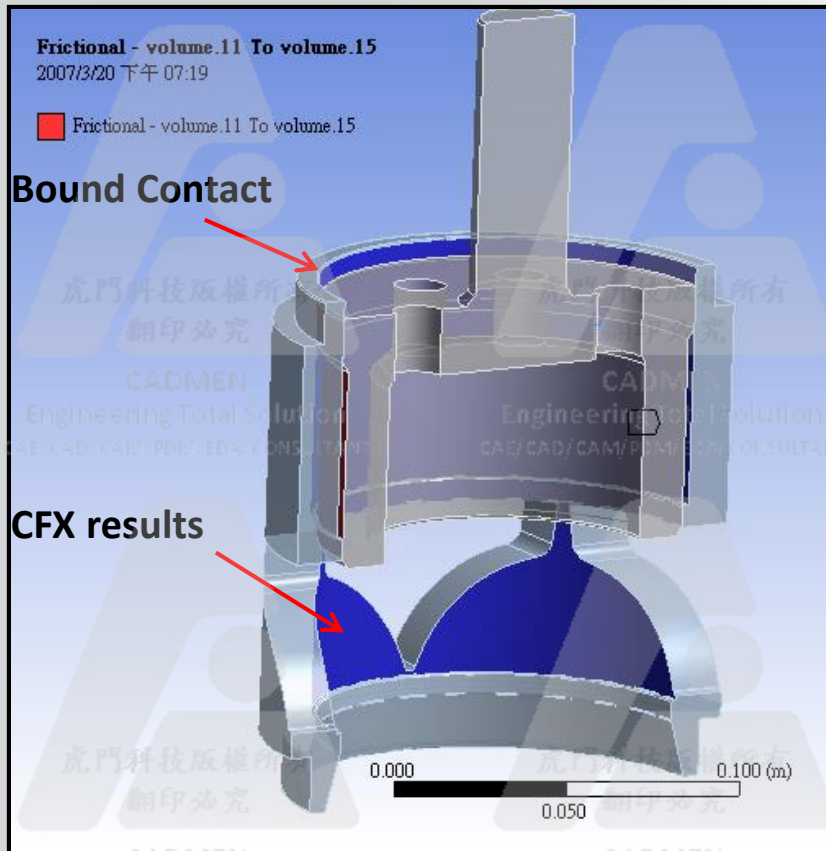
Particle Tracking inside Valve Assembly

- Longer particle duration happens with strong swirling flow except outlet region.
- Slurry build-up may happens during the valve operation life cycle.



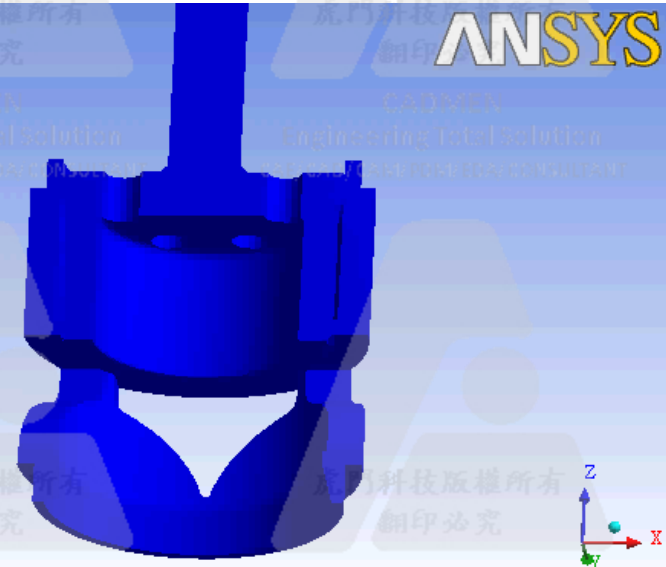
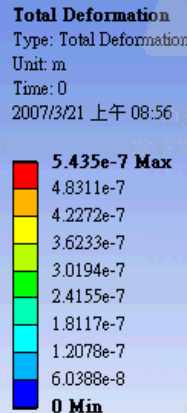
工業用閥門流場與結構變形分析

Stress Analysis of the Valve Parts

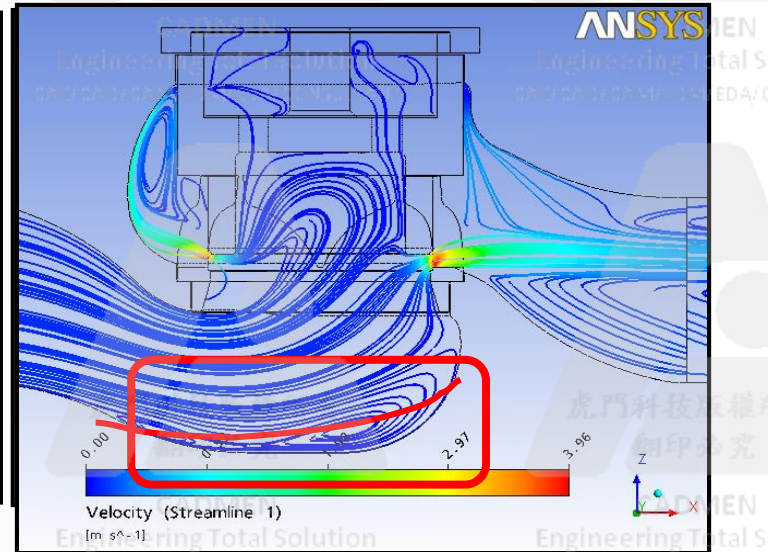
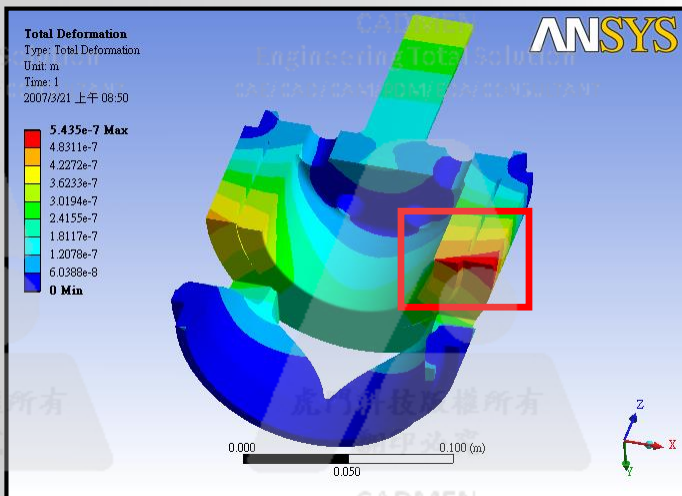
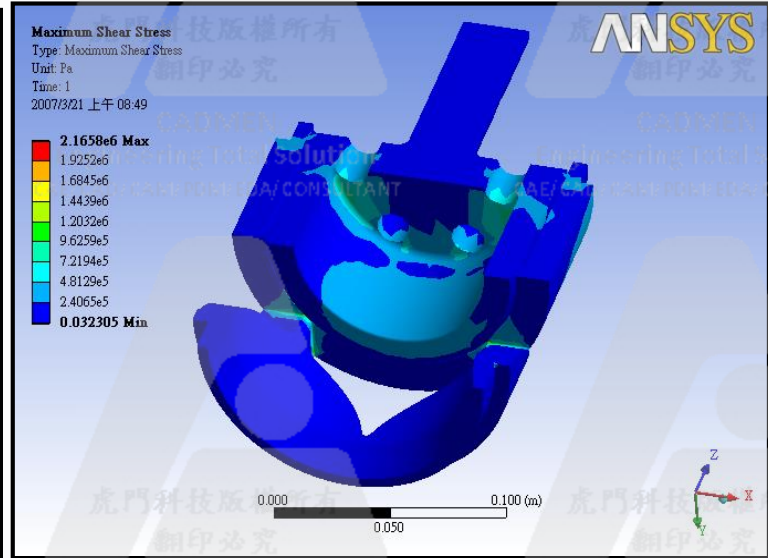
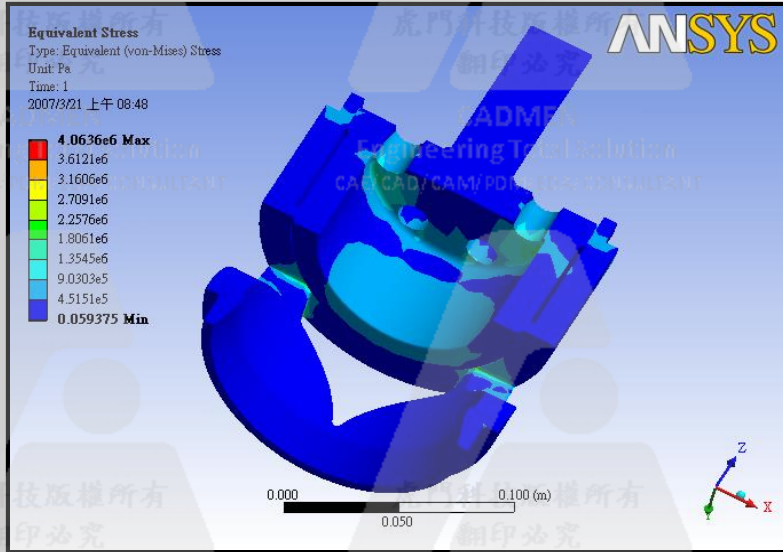


ANSYS

Pressure loading on the valve part surface contact with fluid can be extract directly from the flow solution.



工業用閥門流場與結構變形分析



虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

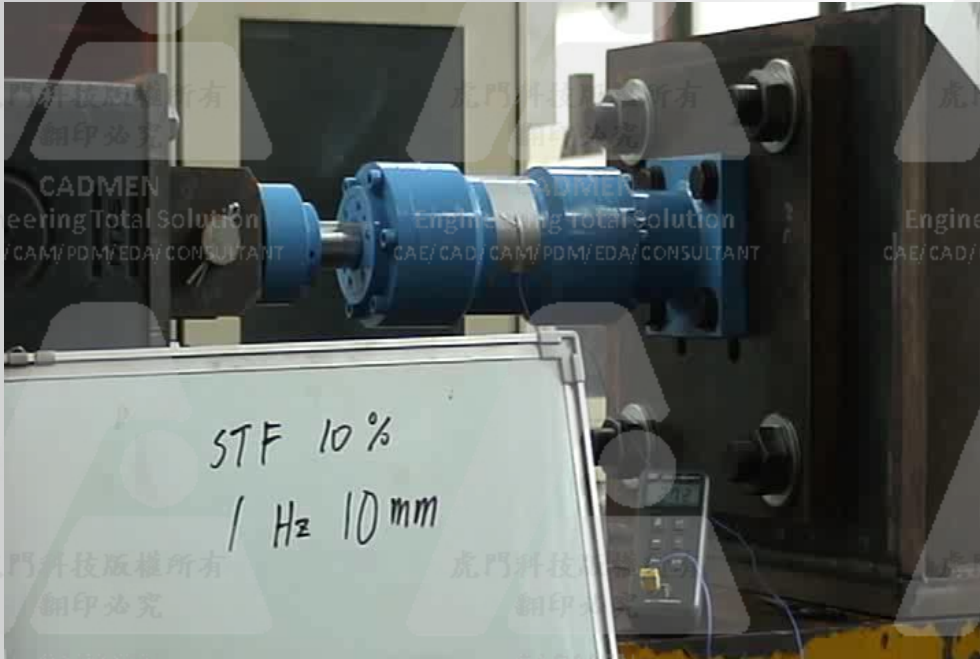
虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

油壓阻尼器 Hydraulic Damper – CFX Analysis



虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

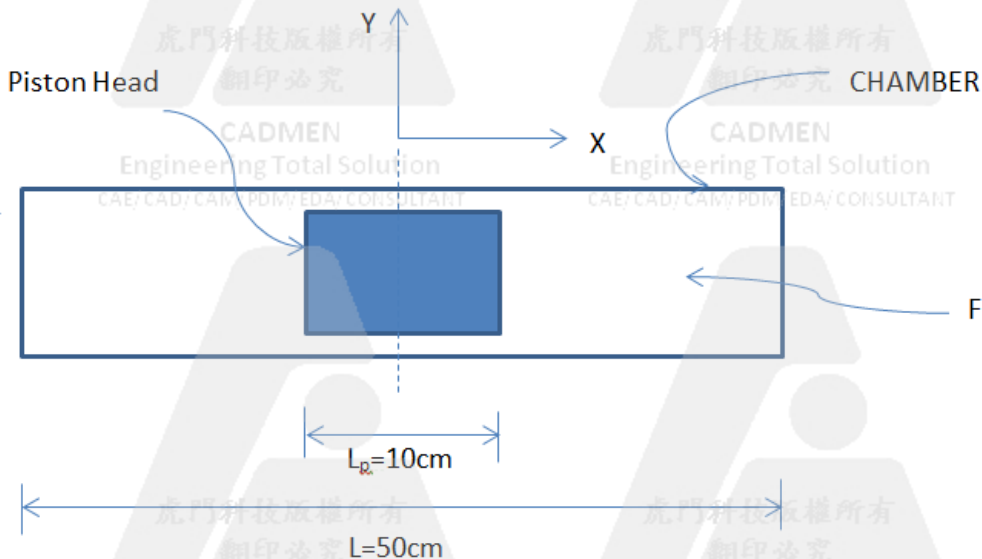
CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

需求條件

虎門科技版權所有
分析模型輪廓



虎門科技版權所有
翻印必究

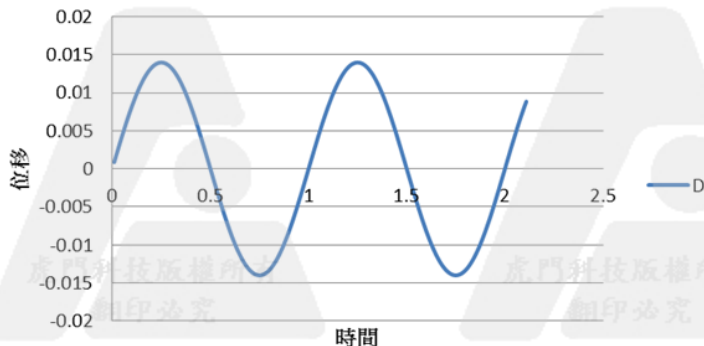
虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

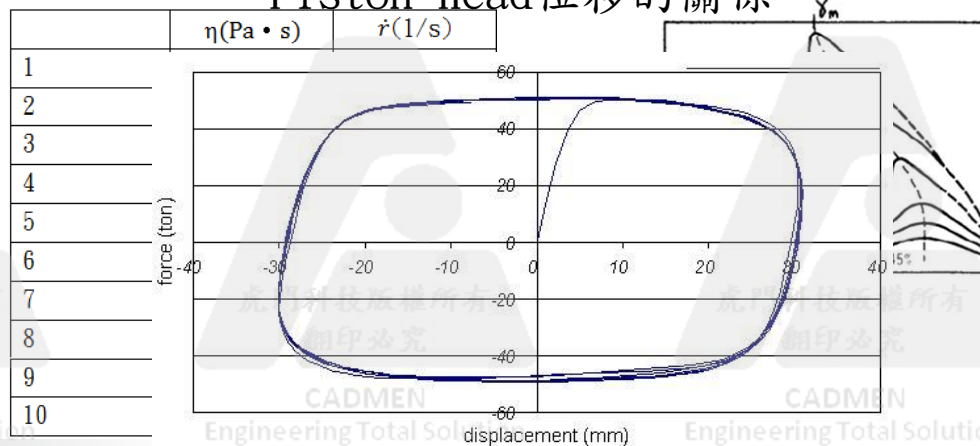
Piston Head運動方程

D



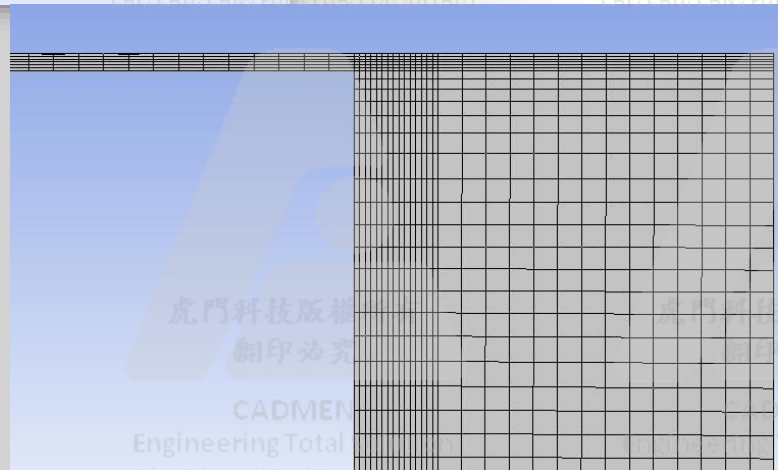
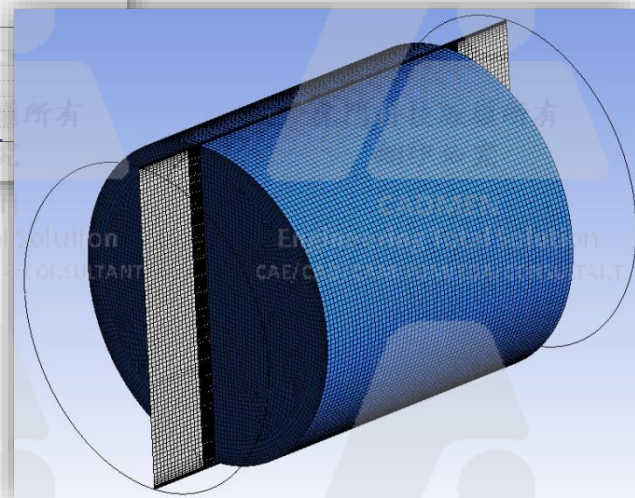
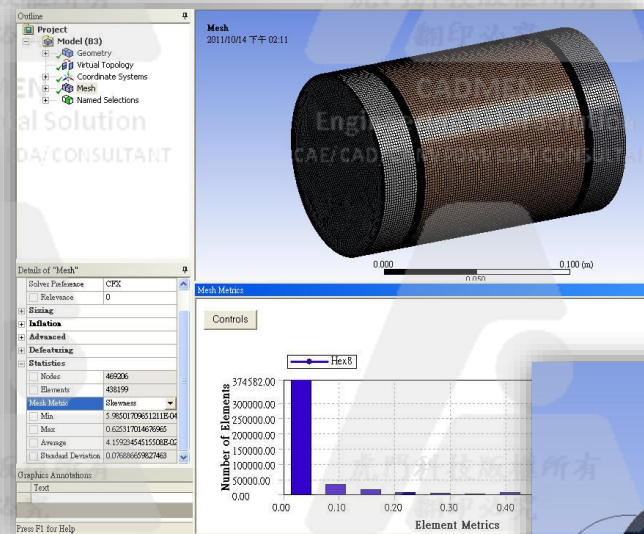
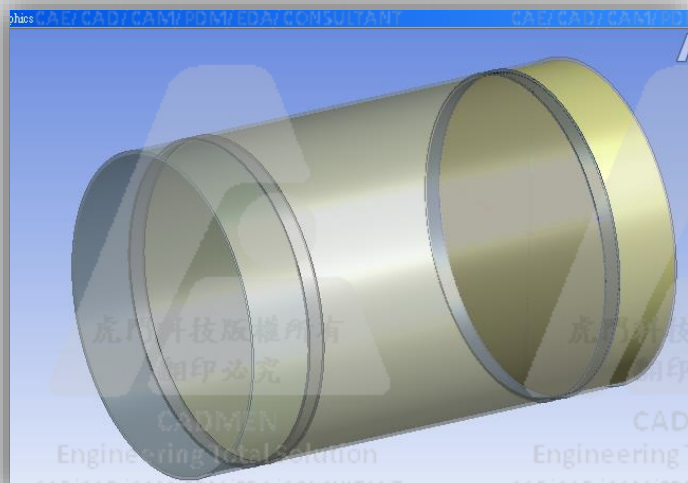
Fluid 為非牛頓流體

Piston Head的阻力與 Piston Head位移的關係



ANSYS MESHING

Design Modeler



動網格作動示意

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

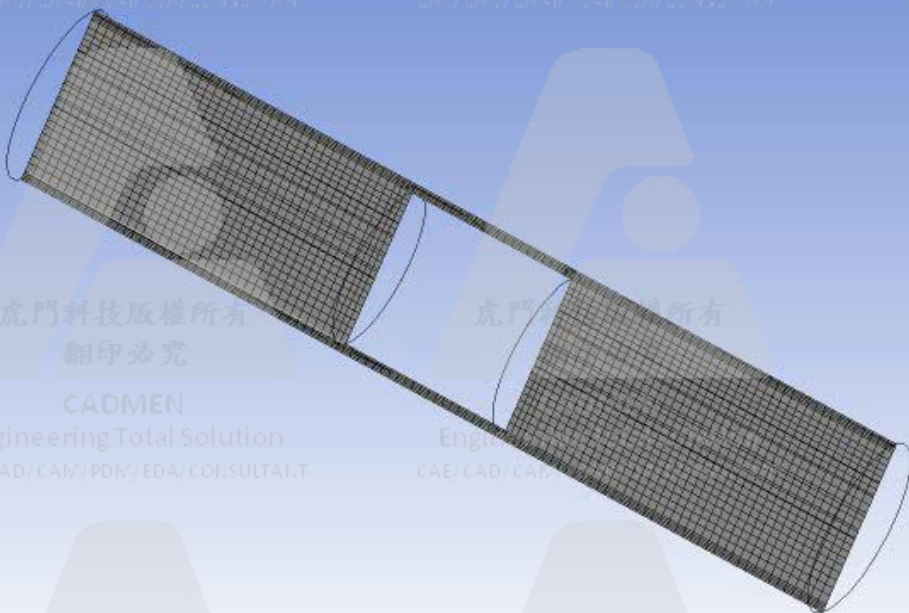
CADMEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

CADMEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

ANSYS
CADMEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

CADMEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

ANSYS



[Pa]



虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

CADMEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

CADMEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

CADMEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

CADMEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

CADMEN
Engineering Total Solution

CADMEN
Engineering Total Solution

CADMEN
Engineering Total Solution

CADMEN
Engineering Total Solution

虎門科技版權所有
翻印必究

CAD MEN

Engineering Total Solution

CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN

Engineering Total Solution

CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN

Engineering Total Solution

CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN

Engineering Total Solution

CAE/CAD/CAM/PDM/EDA/CONSULTANT

CFX Setting

虎門科技版權所有
翻印必究

CAD MEN

Engineering Total Solution

CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN

Engineering Total Solution

CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN

Engineering Total Solution

CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN

Engineering Total Solution

CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN

Engineering Total Solution

CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN

Engineering Total Solution

CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN

Engineering Total Solution

CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN

Engineering Total Solution

CAE/CAD/CAM/PDM/EDA/CONSULTANT

新增位移控制多項式

- 開啟CFX，如mesh呈閃電狀，須先按右鍵執行update
- 點擊Expression進入CEL介面，並點選右鍵新增多項式
- 新增活塞位移Expression
$$\text{deltaD} = -0.01[\text{m}] * \sin(2 * \text{pi} * 0.5 * \text{t} / 1[\text{s}])$$
- 切換為Plot並輸入預估之時間，以觀看定義是否正確

The screenshot displays the ANSYS CFX Expressions interface. On the left, the 'Expressions' panel shows a context menu with 'Expression' selected. The main window shows the 'Details of deltaD' dialog box with the 'Plot' tab active. The 'Number of Points' is set to 100, and the 'End of Range' is set to 12 [s]. The 'Expression Variables' section shows 't' checked. A 'Plot Expression' button is visible at the bottom. To the right, a plot shows the displacement 'deltaD [m]' versus time 't' as a red sine wave oscillating between -0.01 and 0.01 m over a 12-second period.

新增viscosity與Shear Strain Rate的Function Table

- 在User Function處按右鍵新增，並給定此Function之名稱
- Argument Units處輸入Shear Strain Rate之單位 $[s^{-1}]$ ，Result Units處輸入viscosity的單位 $[Pa \cdot s]$ ，並勾選Extend Min與Extend Max

Details of viscosity

Basic Settings

Option: Interpolation (Data Input)

Argument Units: $[s^{-1}]$

Result Units: $[Pa \cdot s]$

Interpolation Data

Option: One Dimensional

	Coordinate	Value
1	0.01009	1.892
2	0.01249	2.028
3	0.01565	2.109
4	0.02001	2.116
5	0.02509	2.207
6	0.03181	2.277

Coordinate:

Value:

Add Remove

Extend Min

Extend Max

User Functions

Insert

User Function

Edit in Command Editor

Paste

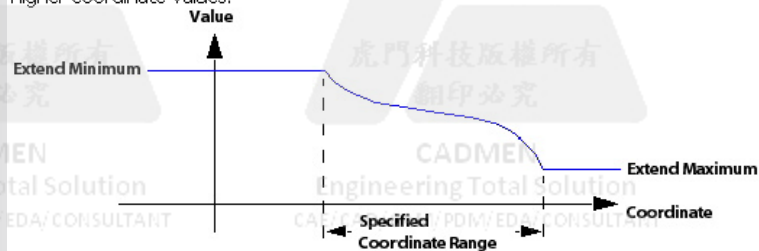
Insert Function

Name: viscosity

OK Cancel

28.1.1.1. Extended Minimum and Maximum

The **Extend Min** and **Extend Max** options enable you to increase the valid range of the interpolation function beyond the maximum or minimum specified coordinate values. The value the function will take at coordinate values lower than the minimum specified coordinate, which is equal to the value at the minimum specified coordinate. Similarly, the value at the maximum specified coordinate is extended for higher coordinate values.



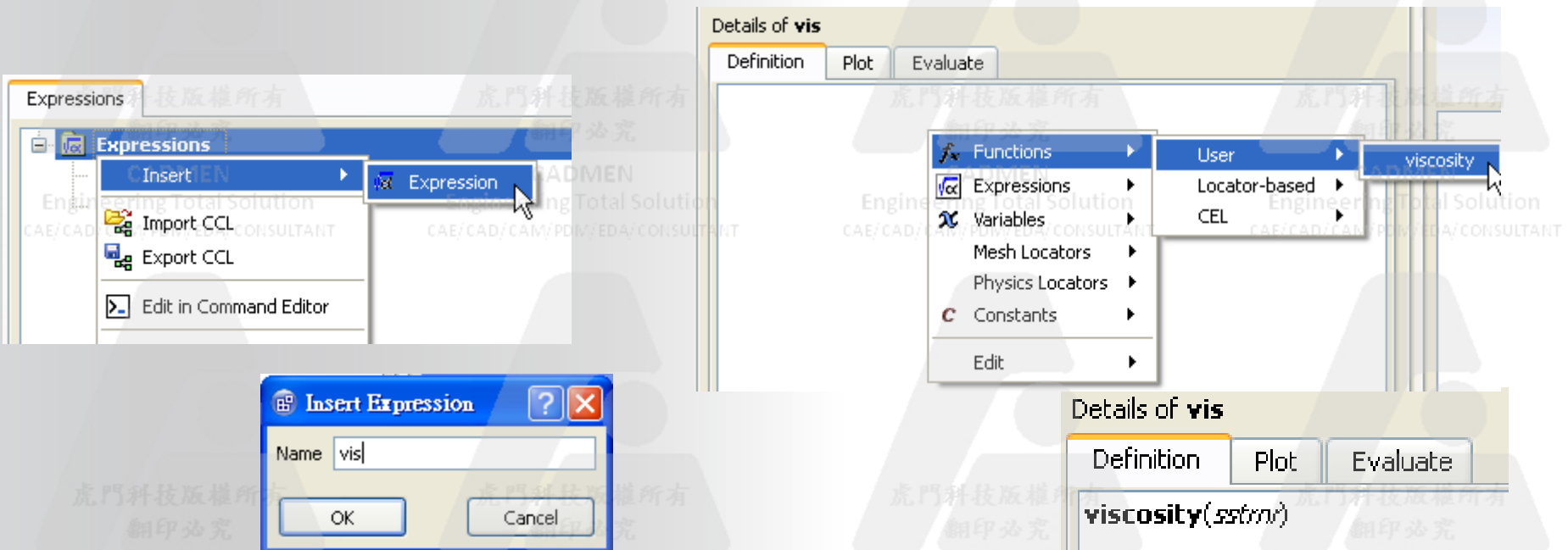
- 將viscosity與Shear Strain Rate的資料製作成txt檔，格式如下圖左為Shear Strain Rate，右為viscosity
- 按右鍵利用Import Data將所建立之txt檔匯入

The screenshot illustrates the process of importing data into ANSYS. It shows the 'Interpolation Data' dialog box with the 'Option' set to 'One Dimensional'. The 'Import Data...' option is selected in the context menu. A file explorer window shows the 'vis.txt' file selected in the '20110922_NTU_Dr.Chen' directory. A table on the right displays the data from the file.

Coordinate	Value
0.01009	1.892
0.01249	2.028
0.01565	2.109
0.02001	2.116
0.02509	2.207
0.03181	2.277
0.03981	2.302
0.04998	2.266
0.06303	2.217
0.07966	2.184
0.1001	2.157
0.1259	2.136
0.1586	2.072

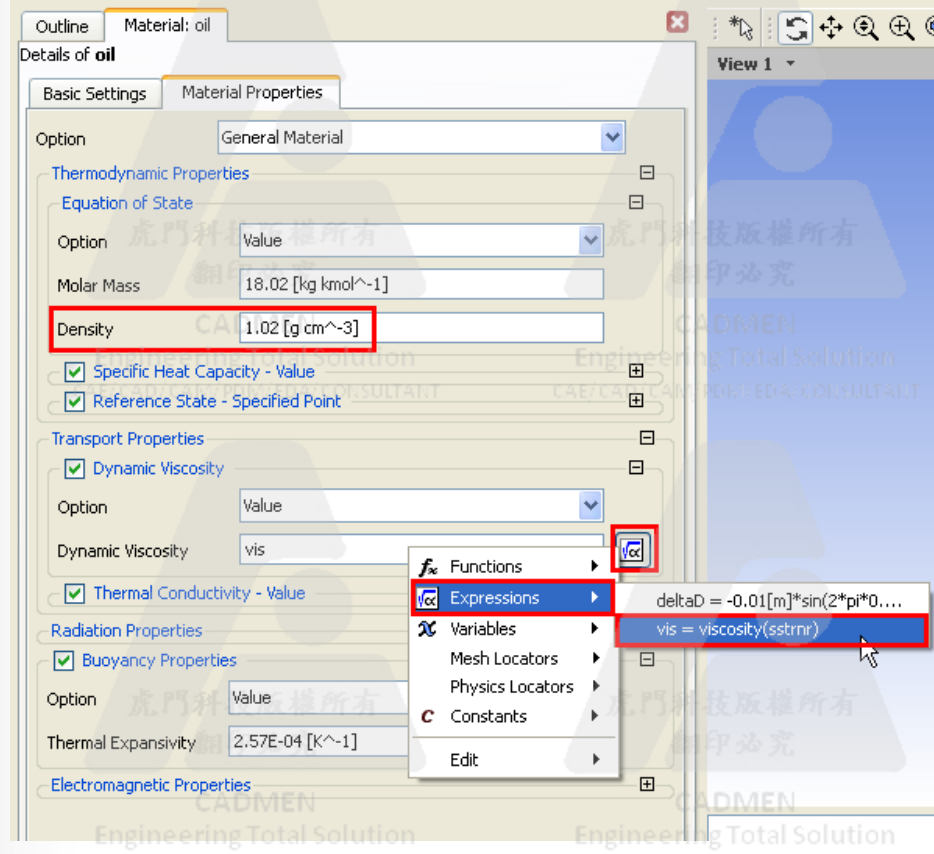
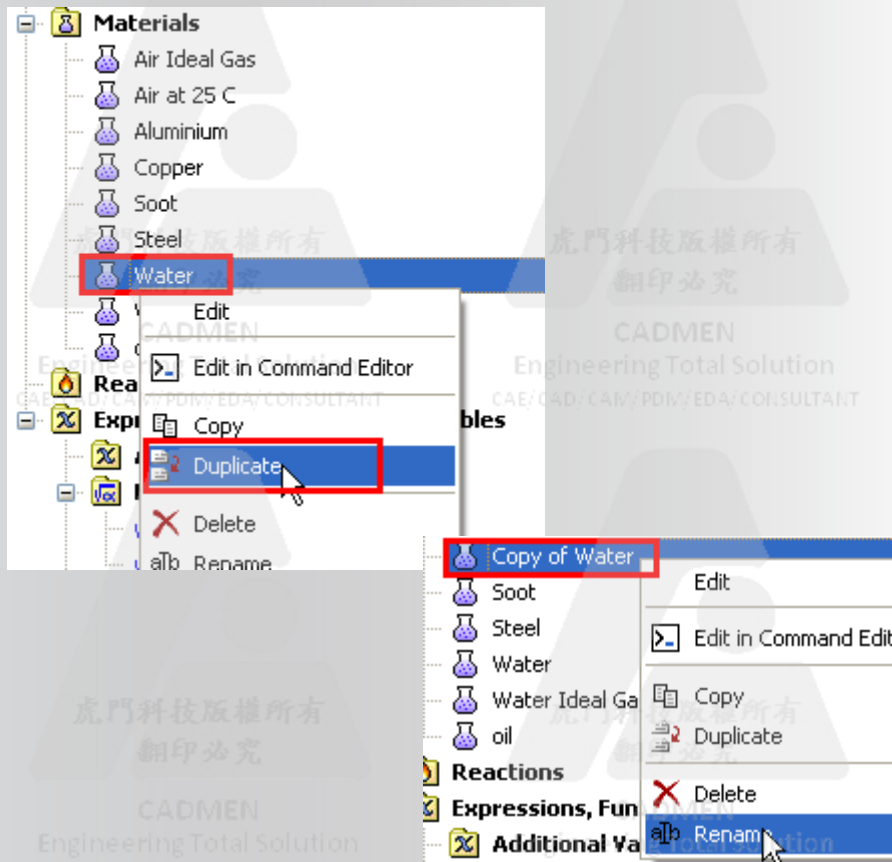
新增流體黏滯性之函式

- 再次進入CEL介面，並增加新的Expression名為vis
- 點選右鍵Functions->User->viscosity將所定義的Function讀入，並在viscosity()之框內給定sstrnr，如下圖，如此便能得到求解時變化之Shear Strain Rate所對應之viscosity

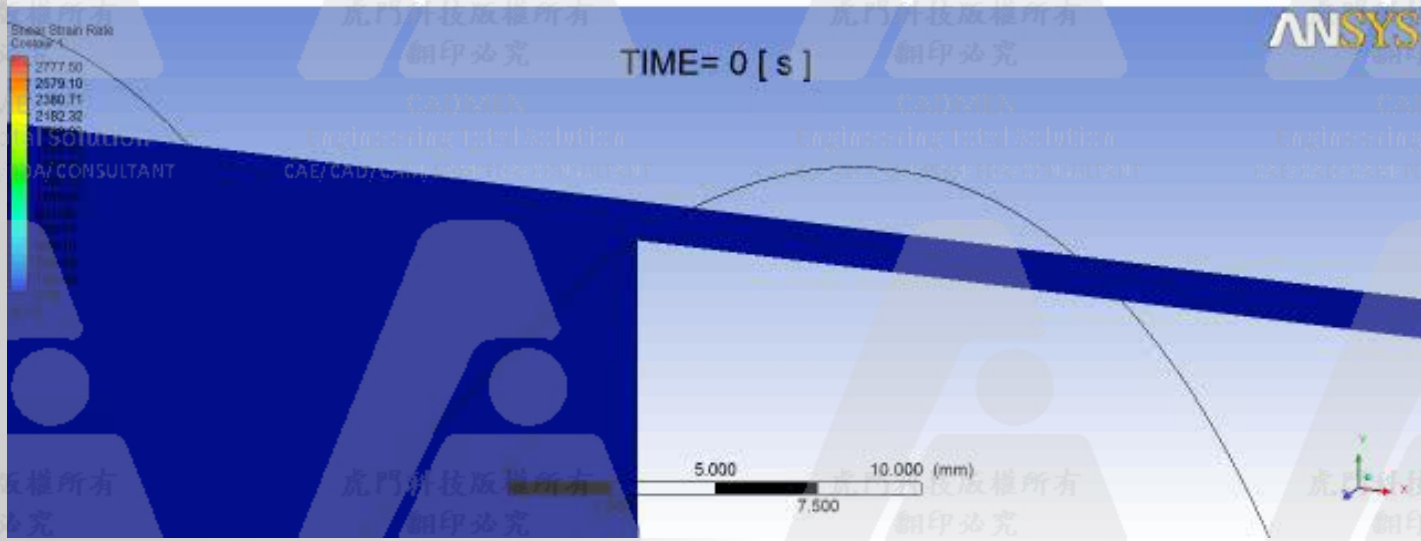
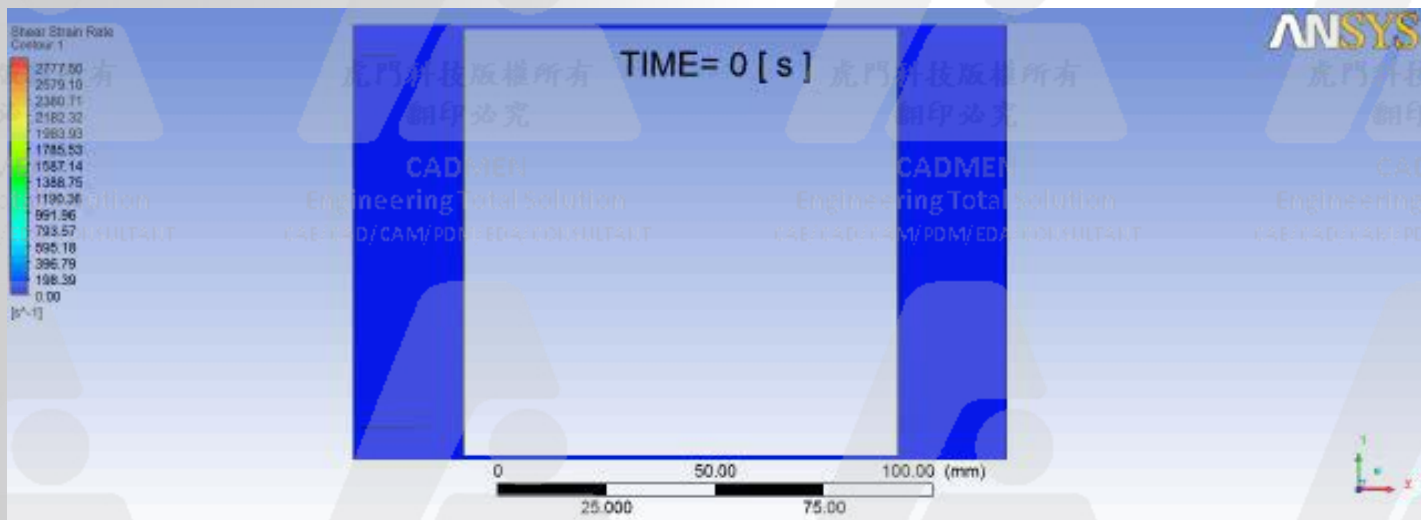


新增液體材料

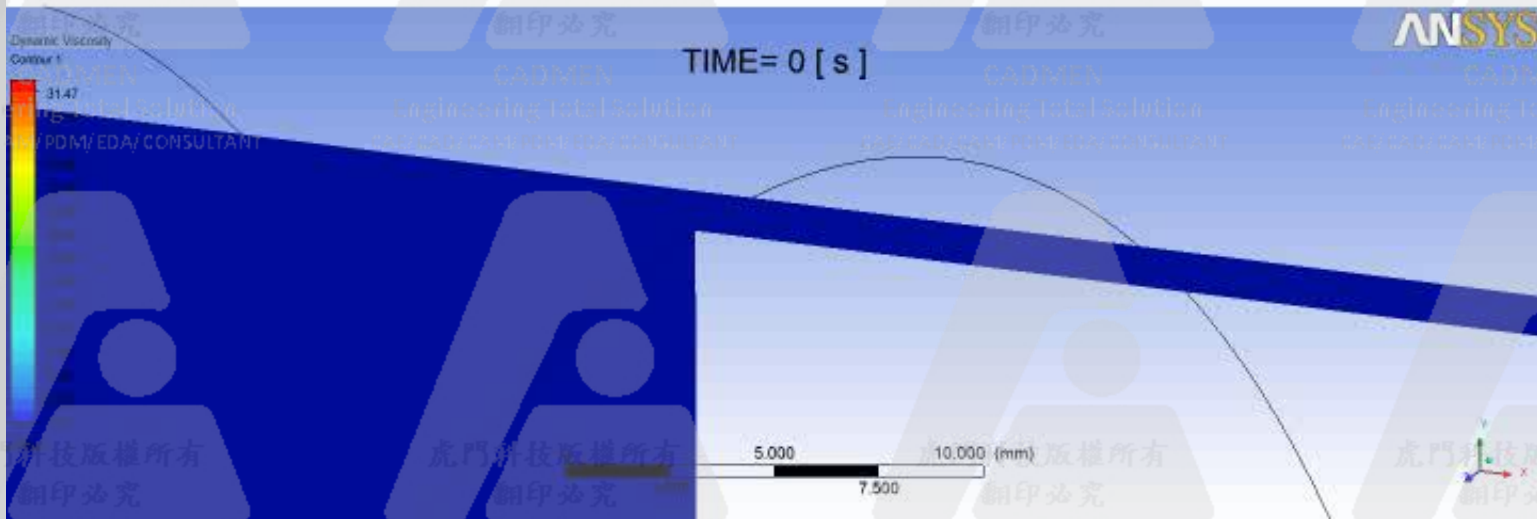
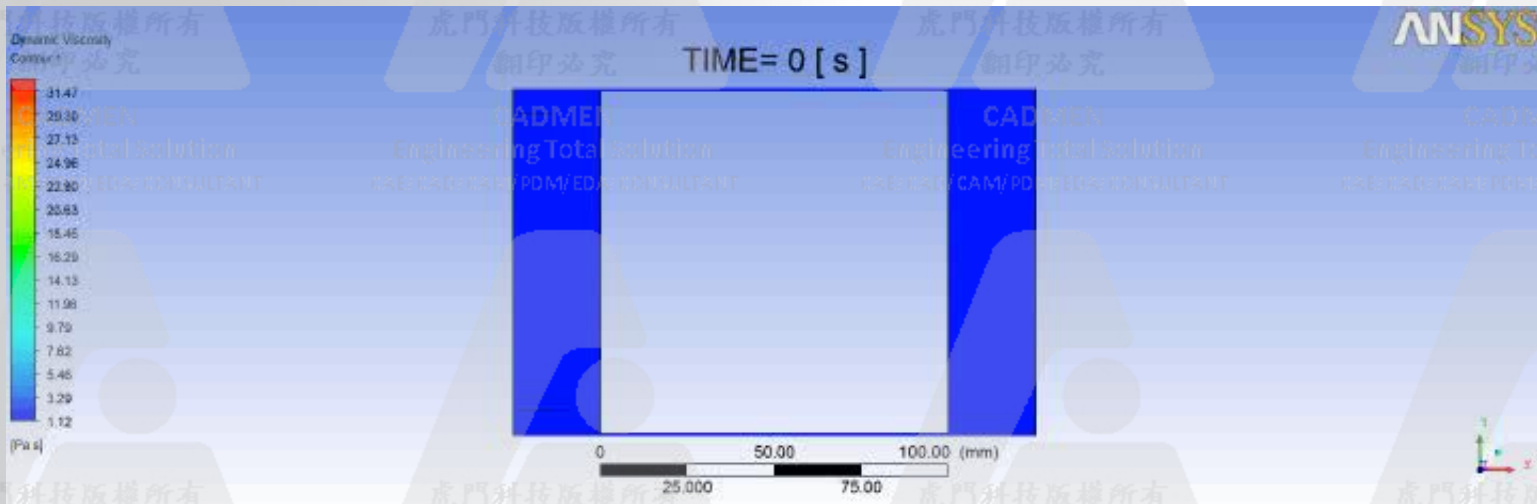
- 複製water材料，並按右鍵rename為oil
- 改變適當的參數，並將所新增的expression “vis”，選入此材料之 Dynamic Viscosity



Results - Shear Strain Rate

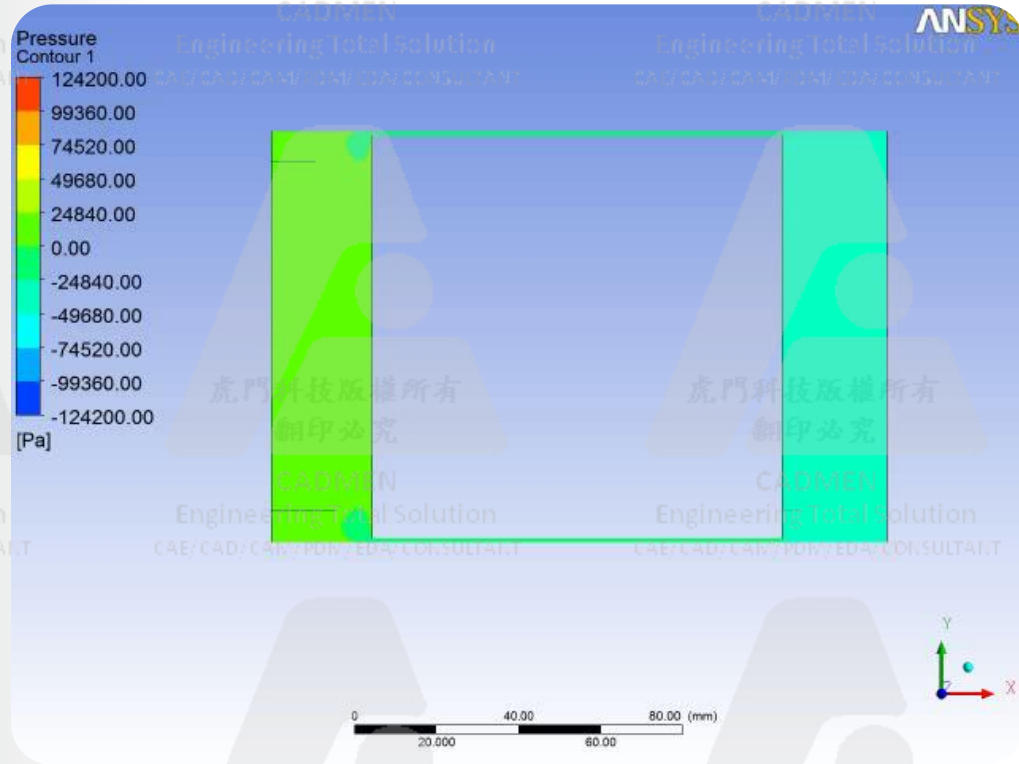
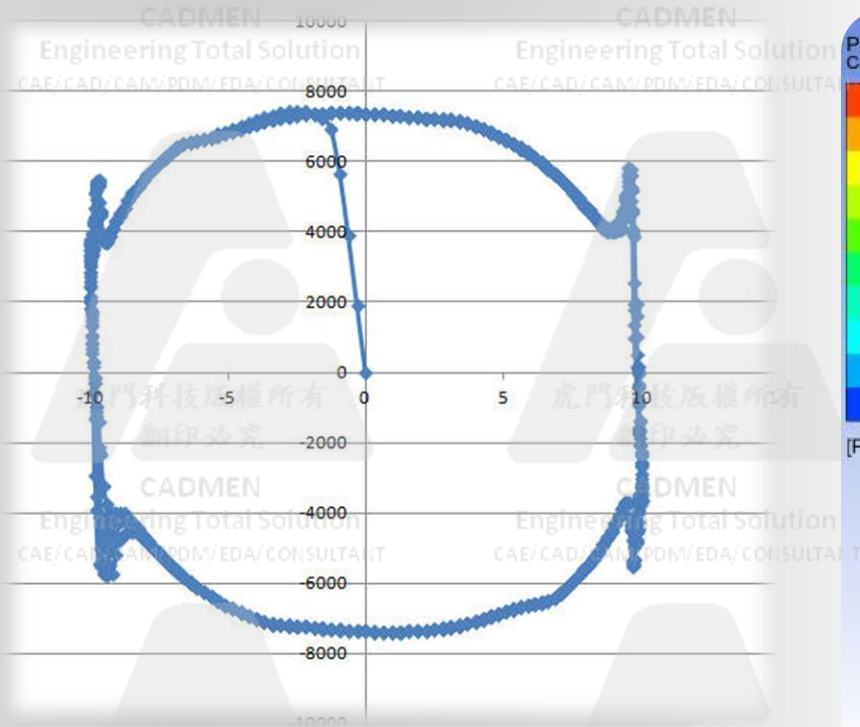


Results - Viscosity



Results – Pressure, Force and Displacement

Piston Head的阻力與Piston Head位移的關係



泵設計分析之需求

泵是一種通用機械，也是人類發明最早的將自然轉換成有用功的機械之一。曾經日本對泵的能源消耗進行了可信的統計，其結果表明泵在能源消耗方面出乎預料地佔全國總發電量的1/4。儘管如此，人們對泵內流動了解並不充分，或者說，人們還無法完全掌握其流動現象。

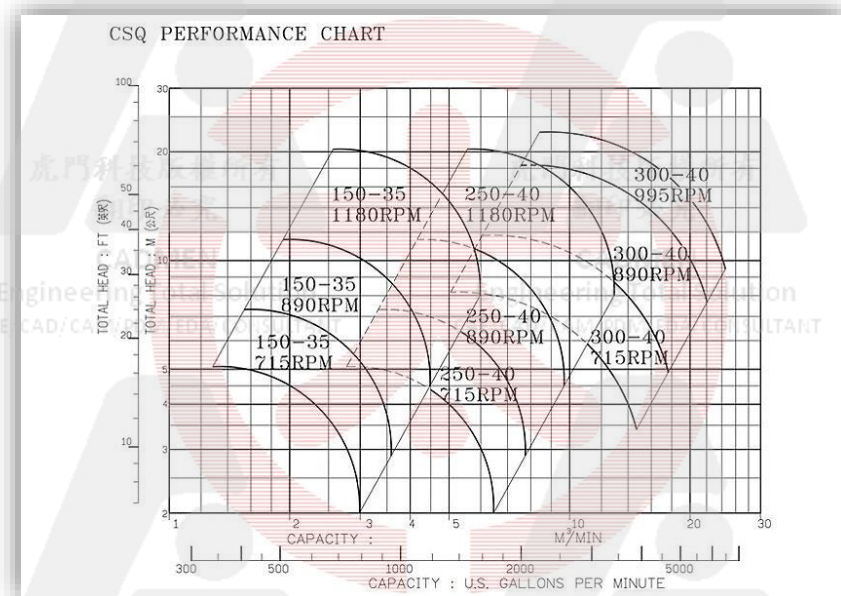
泵現有的常用設計方法，是配合理論計算模式、圖表，並輔以相似換算法或是速度係數法。這幾種方法都是以現有成功經驗為基礎的一種借鑒方式的設計方法，已難符合產業升級的設計需求。

結構強度

效能提升

震動噪音

馬達設計



泵設計分析之需求

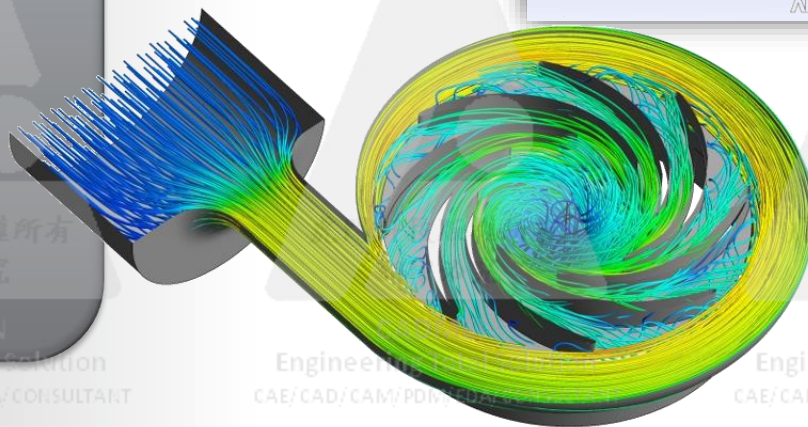
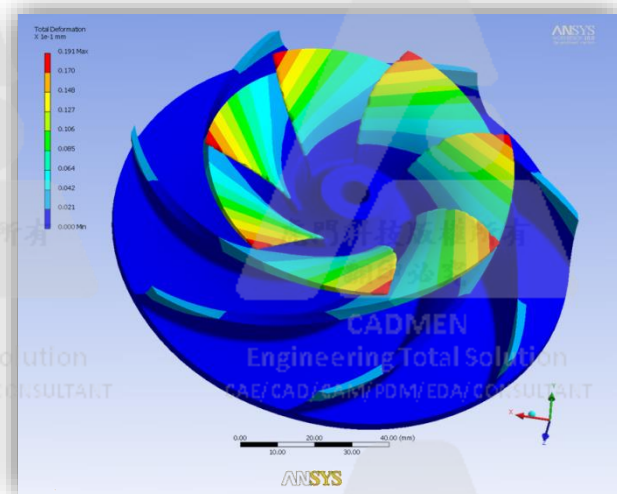
泵是一種通用機械，也是人類發明最早的將自然轉換成有用功的機械之一。曾經日本對泵的能源消耗進行了可信的統計，其結果表明泵在能源消耗方面出乎預料地佔全國總發電量的1/4。儘管如此，人們對泵內流動了解並不充分，或者說，人們還無法完全掌握其流動現象。

泵現有的常用設計方法，是配合理論計算模式、圖表，並輔以相似換算法或是速度係數法。這幾種方法都是以現有成功經驗為基礎的一種借鑒方式的設計方法，已難符合產業升級的設計需求。

ANSYS CFD 分析

提高設計效率、縮短設計時間、優化參數組合、
探討細部現象、提高泵的性能

- 流場分析
- 特性曲線
- 幾何設計變更
- 空蝕現象探討
- 結構耦合分析

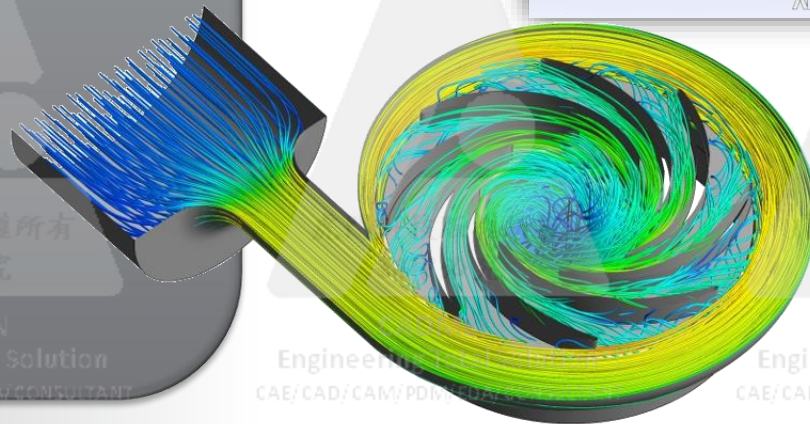
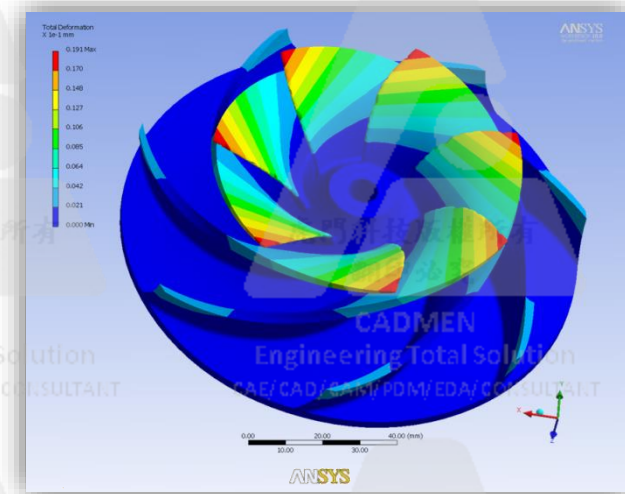


泵設計分析之需求

泵是一種通用機械，也是人類發明最早的將自然轉換成有用功的機械之一。曾經日本對泵的能源消耗進行了可信的統計，其結果表明泵在能源消耗方面出乎預料地佔全國總發電量的1/4。儘管如此，人們對泵內流動了解並不充分，或者說，人們還無法完全掌握其流動現象。

泵現有的常用設計方法，是配合理論計算模式、圖表，並輔以相似換算法或是速度係數法。這幾種方法都是以現有成功經驗為基礎的一種借鑒方式的設計方法，已難符合產業升級的設計需求。

- CPD(Centrifugal Pump Design)
- 豐富紊流模型
- 旋轉流體分析
- 動態網格分析
- 參數化、最佳化分析
- 多相流空蝕分析模組
- 離散項 DPM 顆粒模組
- 氣動噪音
- FSI 流固耦合分析



Leading Companies Use ANSYS for Rotating Machinery Simulation

ANSYS customers include.....

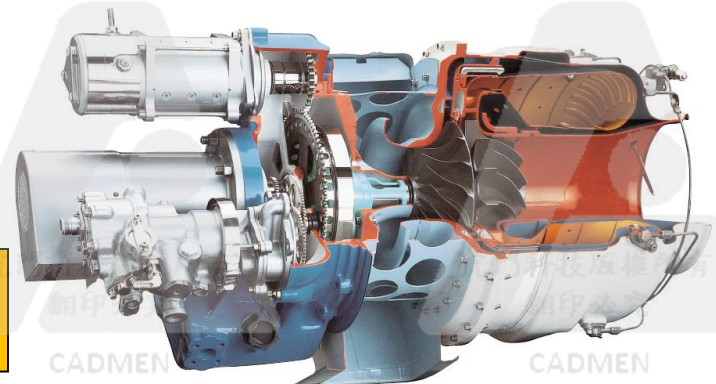
- All 5 of the top 5 largest **aircraft engine** manufacturers
- All 7 of the top 7 largest **gas turbine** manufacturers
- All 7 of the top 7 largest **steam turbine** manufacturers
- All 5 of the top 5 largest **turbocharger** manufacturers
- 8 of the top 10 largest **pump** manufacturers

.....*in the world!*

ANSYS software is the most commonly used CAE tool for.....

- **Hydraulic (water) turbine** simulation
- **Wind turbine** simulation

**Auxiliary
Power Unit**



Honeywell

Widespread Usage of ANSYS Across Industry Sectors for Rotating Machinery Simulation

Aircraft & Defence

- GE
- Hamilton Sundstrand
- Honeywell
- ITP
- MTU
- NASA
- Pratt & Whitney
- PW Rocketdyne
- Rolls Royce
- Snecma
- Teledyne
- Turbomeca
- Volvo Aero



Energy

- Alstom
- Andritz
- Dresser-Rand
- GE
- Hitachi
- IMPSA
- Mitsubishi
- Rolls Royce
- Parker
- Siemens
- Solar Turbines
- Toshiba
- Vestas
- Voith

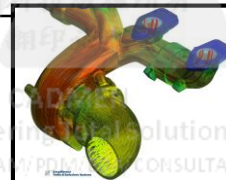
Courtesy
Siemens AG



Ground/Marine Transportation

- ABB Turbo
- Borg Warner
- Bosch Mahle
- Continental
- Cummins Turbo
- Ford
- GM
- Honeywell
- IHI Turbochargers
- Luk
- Napier
- Pierburg
- Rolls-Royce Marine
- Voith Turbo

Courtesy
Borg Warner



Chemical Process/HVAC

- Allweiler
- Cameron
- Carrier
- Clydeunion
- Dresser-Rand
- Ebara
- Emerson
- Grundfos
- Hitachi
- KSB
- MAN
- McQuay
- Praxair
- Trane
- York

Courtesy
Dresser Rand



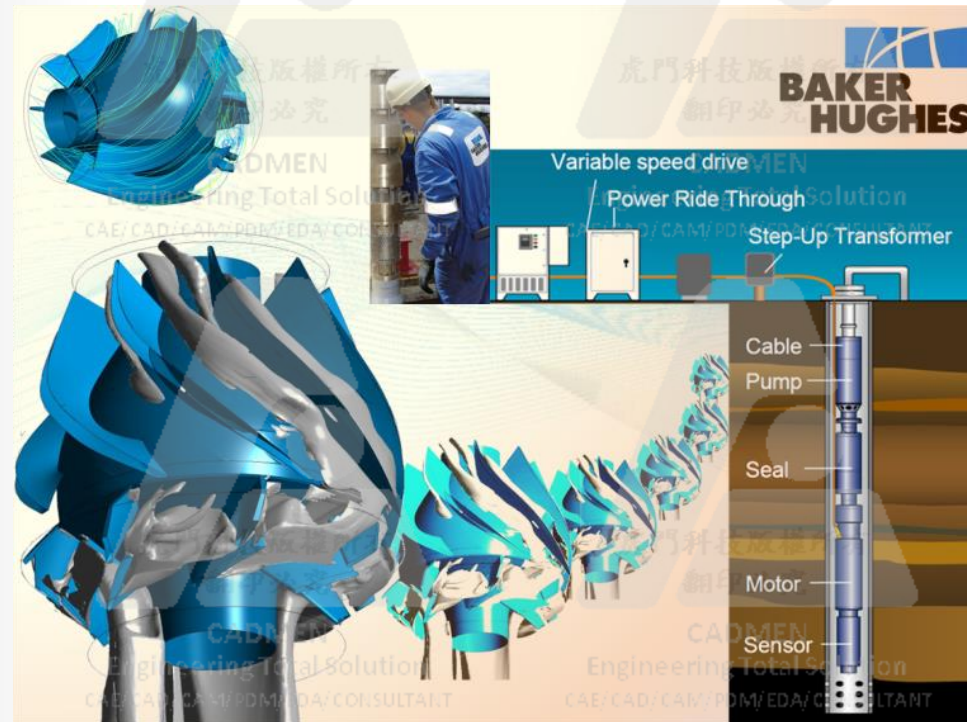
特殊專利沉水泵 --- Baker Hughes

Problem

Baker Hughes produces a special patented Electrical Submersible Pump, called the MVP, that handles up to 70% gas by volume.

Solution

Baker Hughes uses ANSYS Fluent to simulate **the two phase flow** in the MVP pump to show how the fluid behaves inside the pump and how to improve the product.



By using ANSYS Fluent, Baker Hughes received a **better understanding** of their Electrical Submersible Pump and were able to **improve it's performance**.

Baker Hughes Inc. 貝克休斯
全球第三大油田服務公司

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

Centrifugal Pump 設計應用

1D初步設計 ~ 3D流場分析

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

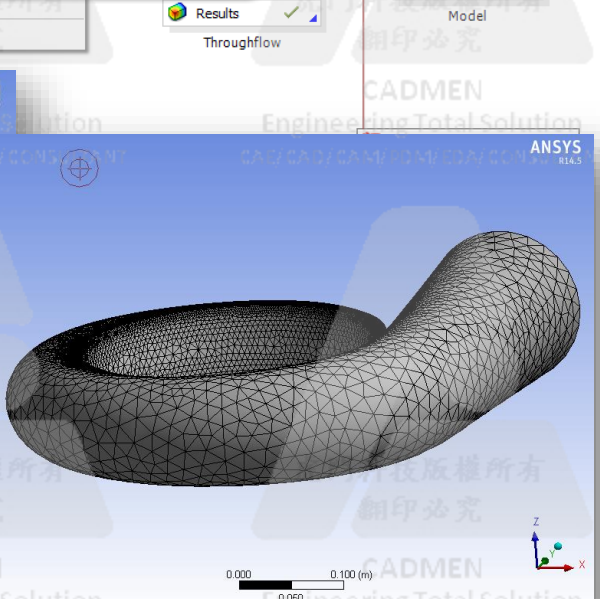
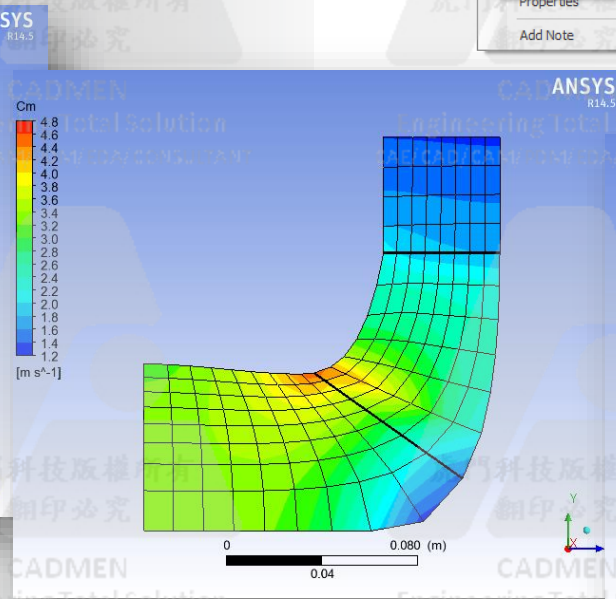
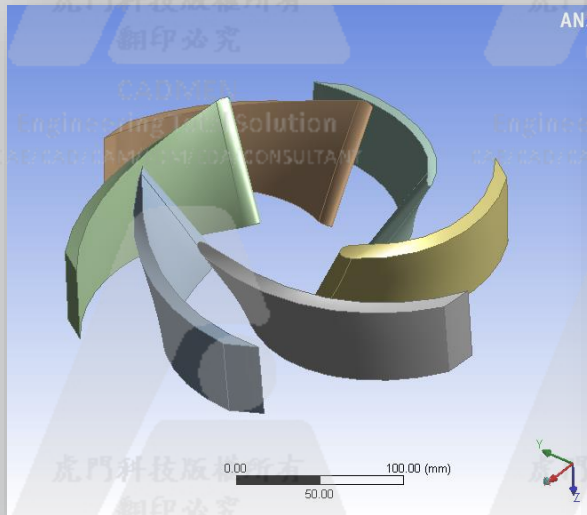
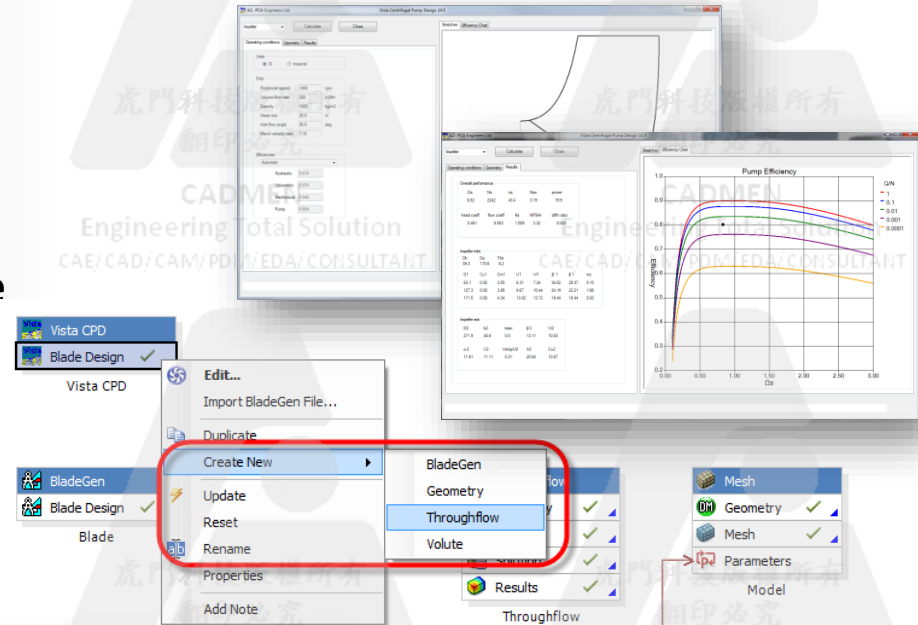
虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

Workbench Integration of Vista CPD

Vista CPD (Centrifugal Pump Design)

- Native Workbench application
- Ability to use Vista CPD directly create
 - Blade geometry model
 - Throughflow analysis
 - Volute geometry and mesh



Workbench Integration of Vista CPD

Vista D2: PCA Engineers Ltd 版權所有 Vista Centrifugal Pump Design 15.0

Volume Calculate Close

Operating conditions Geometry Results

Casing rotation angle 14 deg

Section Type

- Elliptical / circular
- Rectangular

Aspect ratio

Diffuser

- User defined diam
- User defined leng

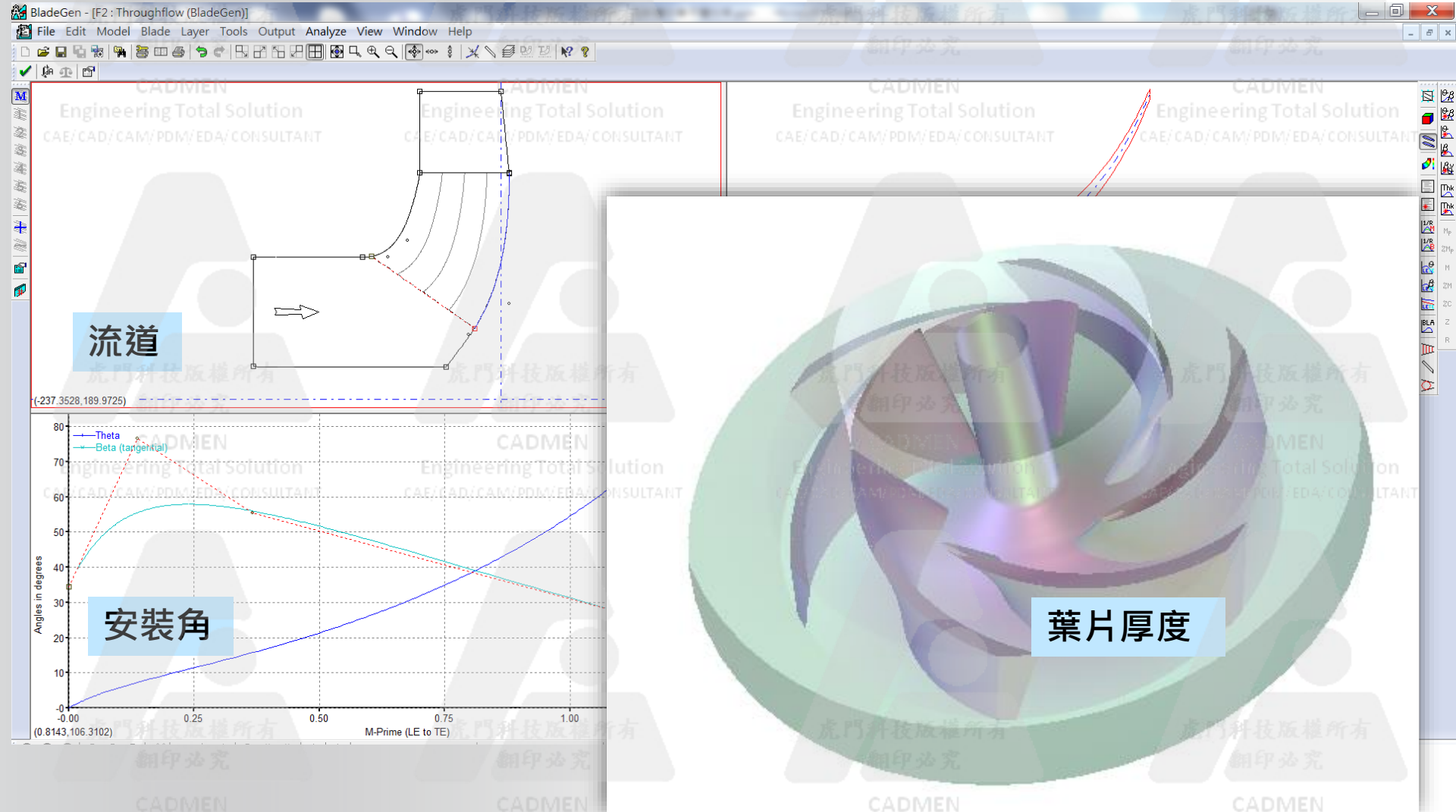
Operating conditions Geometry Results

Overall performance

Ωs	Ns	nq	Nss	power (kW)
0.82	2242	43.4	3.15	19.5
head coeff	flow coeff	Ks	NPSHr (m)	diffn ratio
0.461	0.053	1.009	3.32	0.040

Sketches Efficiency Chart

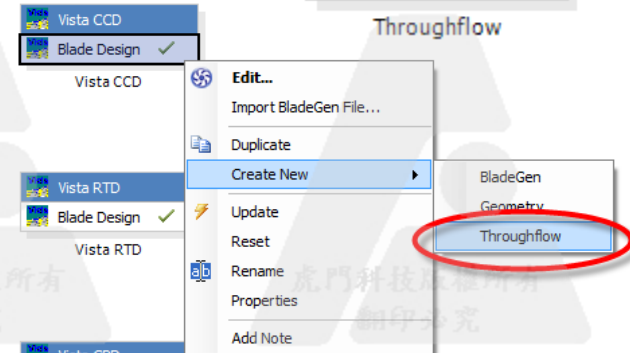
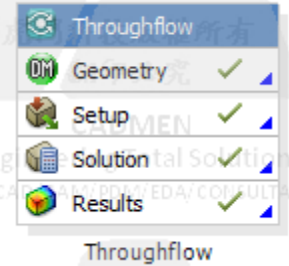
Workbench Integration of Vista CPD



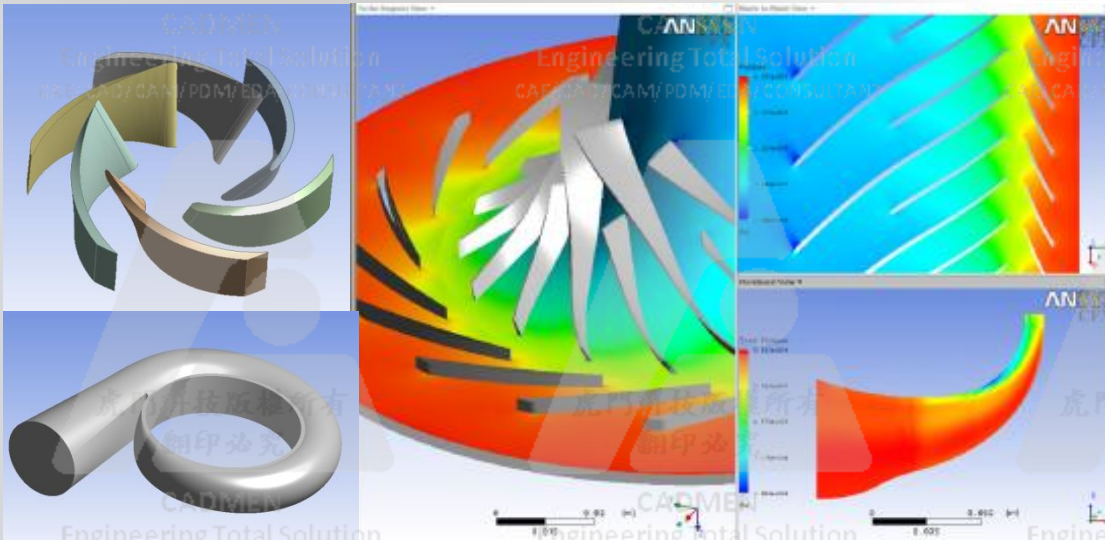
Turbomachinery Workflows in Workbench

New Throughflow System in Workbench

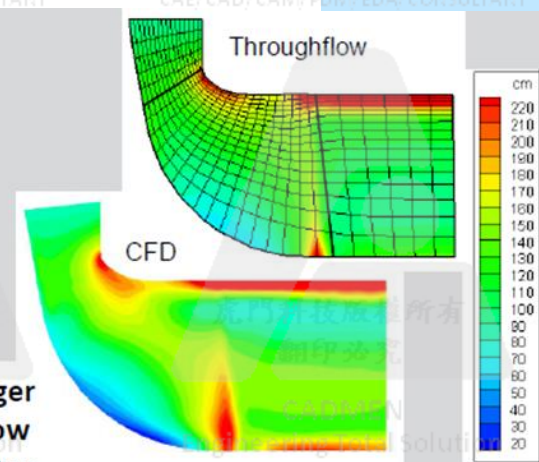
- Combination of geometry and Vista TF
- Ability to create directly from Vista preliminary sizing tools
 - Vista RTD/CCD/CPD
- Improves ability to explore and analyze geometry generated with Vista preliminary sizing tools, using throughflow analysis



3D CFD Analysis



軸向速度



Turbocharger radial inflow turbine rotor

性能曲線分析



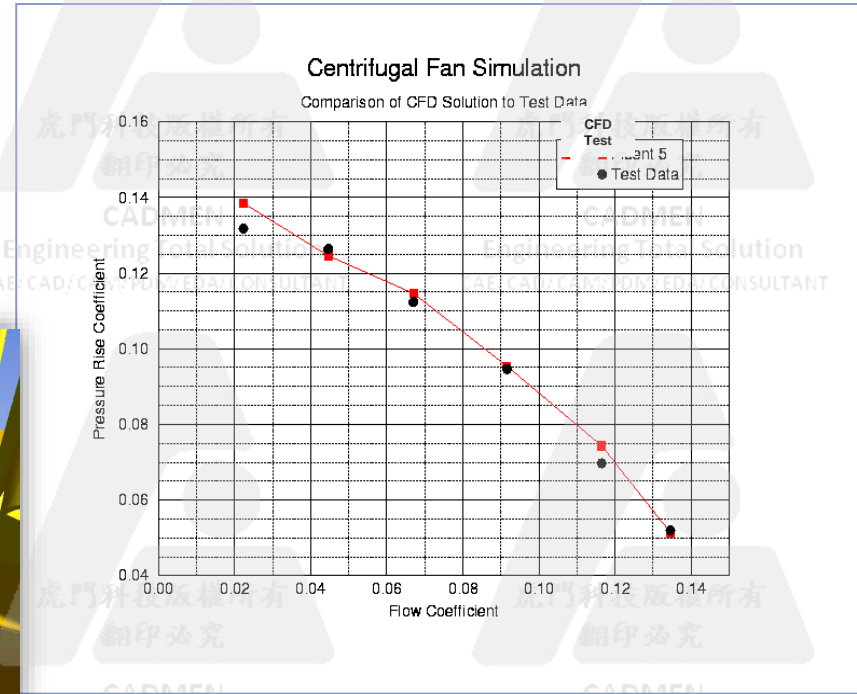
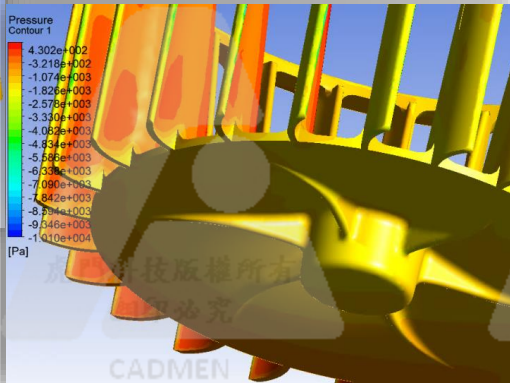
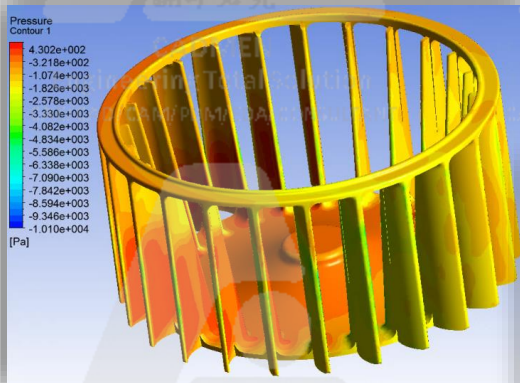
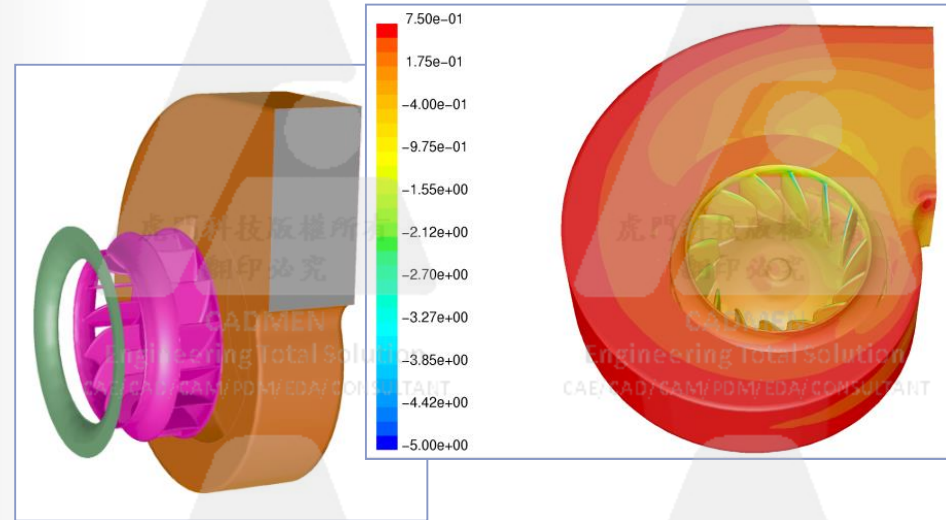
Industrial backward-inclined centrifugal fan

15 blade, shrouded wheel

Scroll volute with rectangular outlet

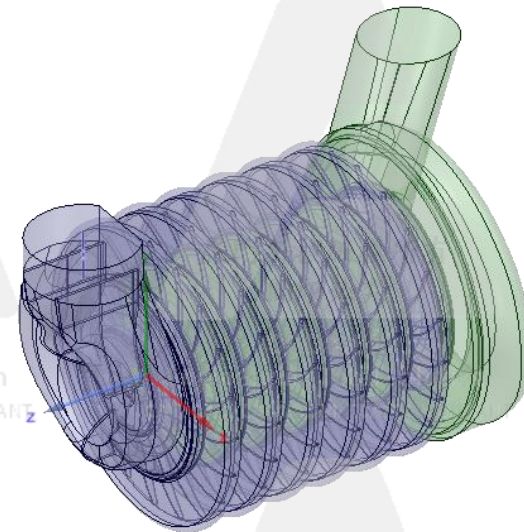
Numerical model

- ANSYS FLUENT
- Steady-state (MRF), incompressible flow (air)
- Realizable $k-\epsilon$ turbulence model with wall functions
- Steady-state solutions obtained over range of flow rates at constant speed (fan curve)

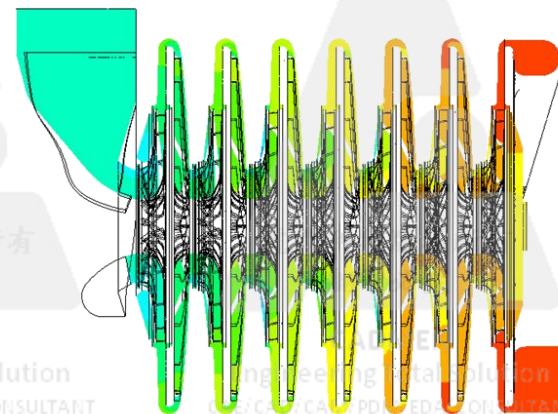
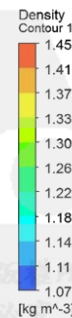
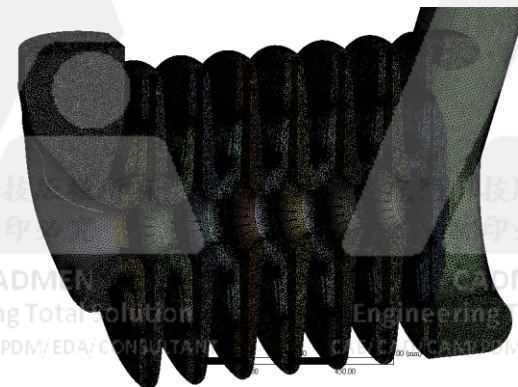
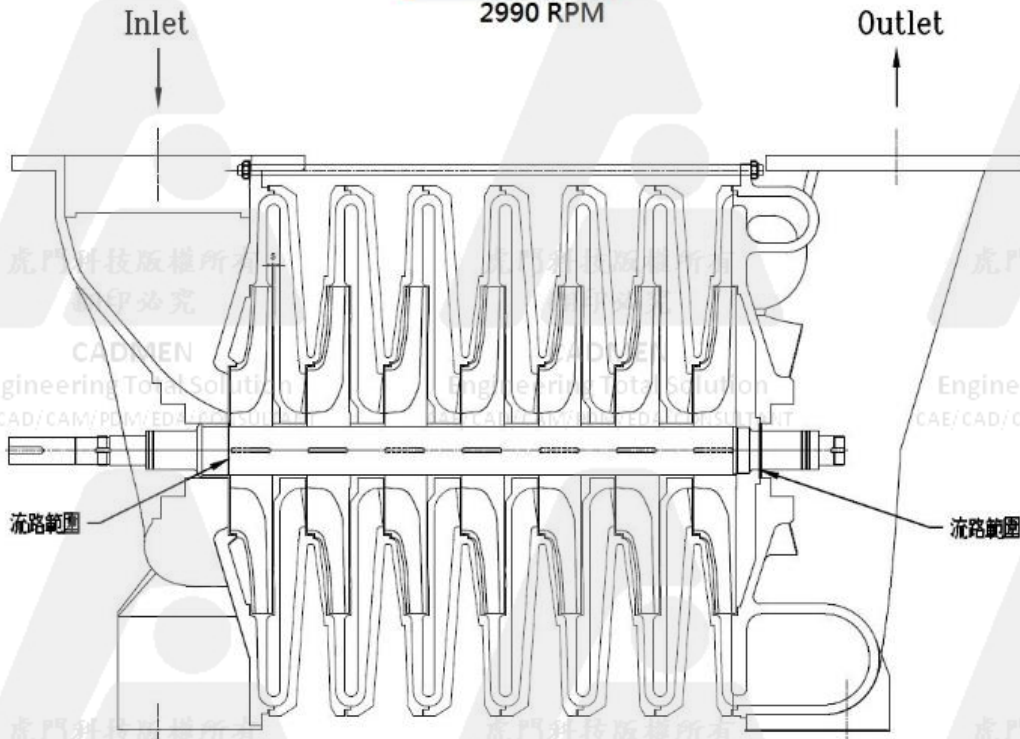


多級離心風機流場分析

利用ANSYS SCDM、Mesh、Fluent及CFD-Post，來分析此多段離心機之性能與流場現象。



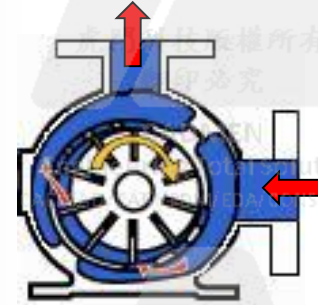
多段離心機 轉速: 3588 RPM 和 2990 RPM



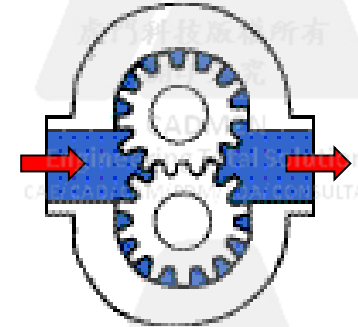
Positive Displacement Pumps: Types

Vane Pumps

- A rotor with sliding vanes positioned off-center in a housing. Pumping action is caused by the expanding and contracting volumes contained by the rotor, vanes and housing.



Vane pump



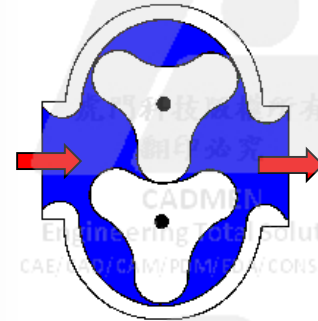
Gear pump

Gear Pumps

- Gears rotate in opposite directions and mesh at the point in the housing which is between inlet and outlet. Liquid trapped between gear teeth and housing, and carried two separate paths.

Lobe Pumps

- Operates like a gear pump. Lobed rotors spin in the same direction.



Lobe pump



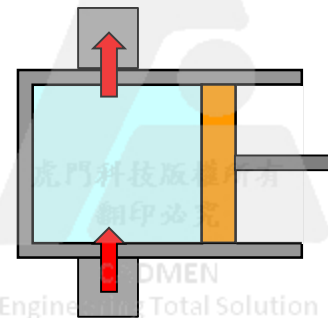
Gerotor pump

Gerotor Pumps

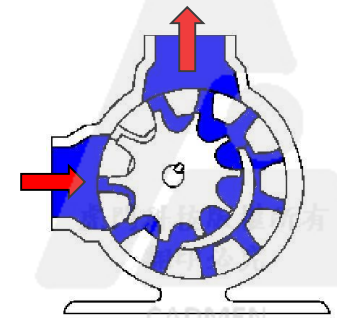
- Fluid drawn into and squeezed out of cavity formed by two rotating, intermeshing gears. Has smooth pumping action, and works well with wide range of fluid viscosities.

Piston Pumps

- Reciprocating piston pressurizes fluid.



Piston pump



Crescent pump

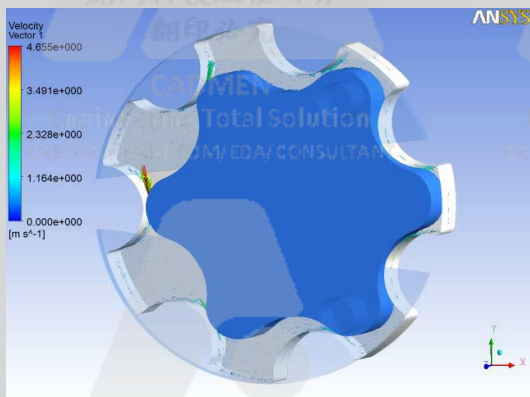
Crescent Pumps

- Consists of two rotating gears separated by a crescent-shaped divider.

容積式壓縮機案例

ANSYS

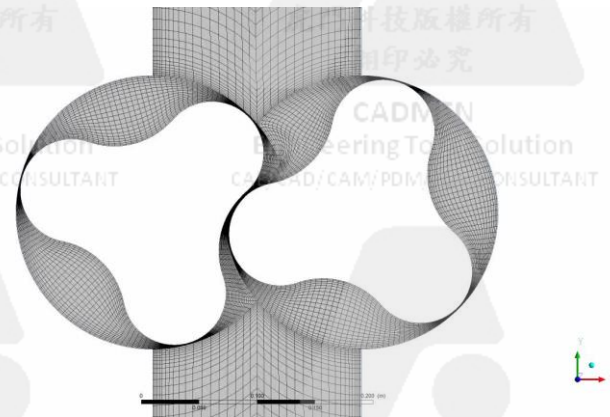
Gerotor



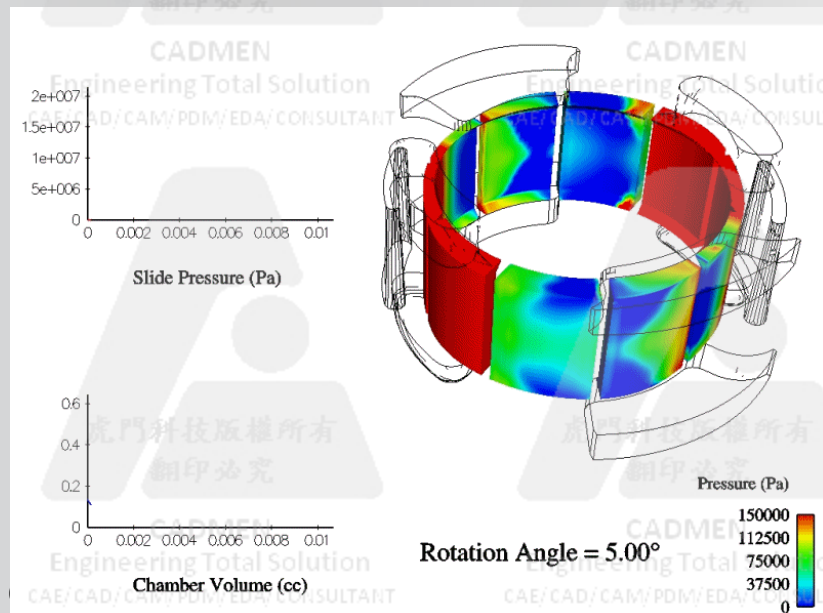
Gear Pump



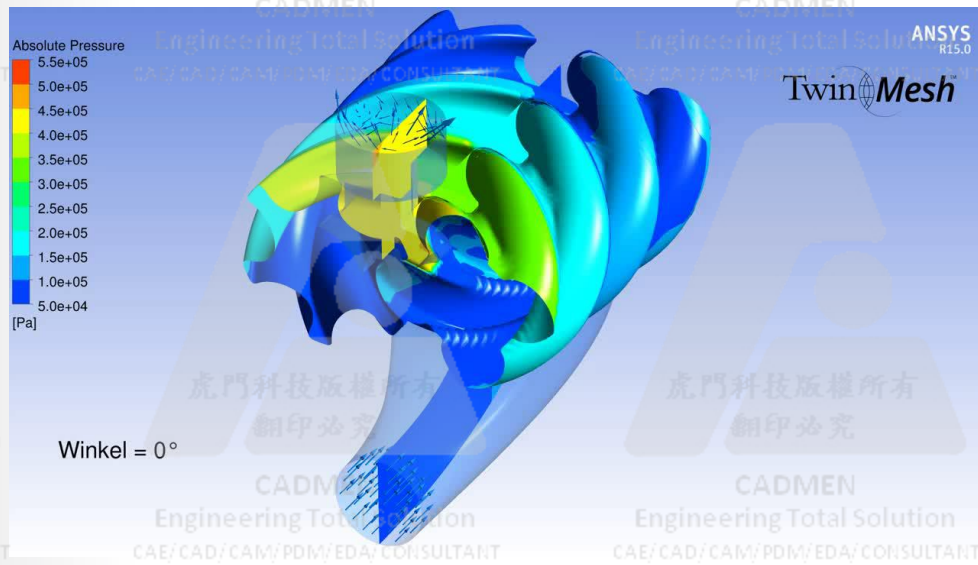
Lobe Compressor



Vane Pump



Screw Compressor



Twinmesh

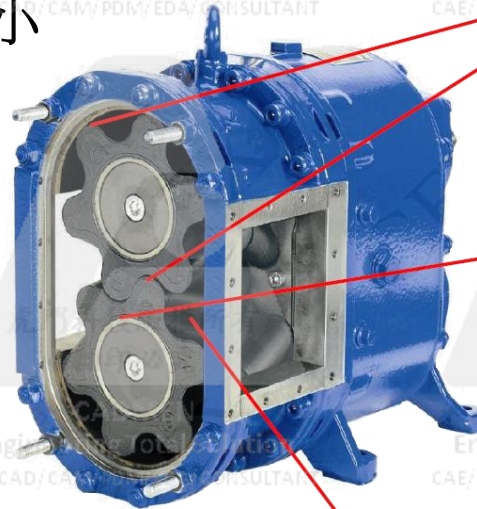
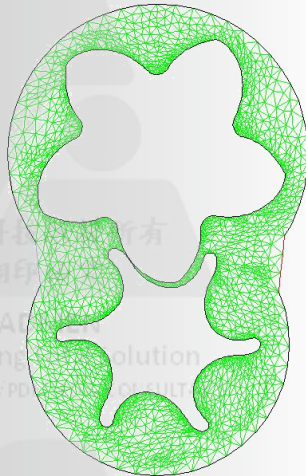
Rotary Positive Displacement Machines

複雜幾何

- 連鎖轉子(通常會有螺旋狀)
- 公母轉子的間隙和轉子與外殼的間隙非常小
- 體積變化差異大

複雜的流體特性

- 空蝕(多相流)
- 可壓縮性
- 紊流
- 真實氣體特性
- ...



轉子間隙

出入口間隙

體積變化大

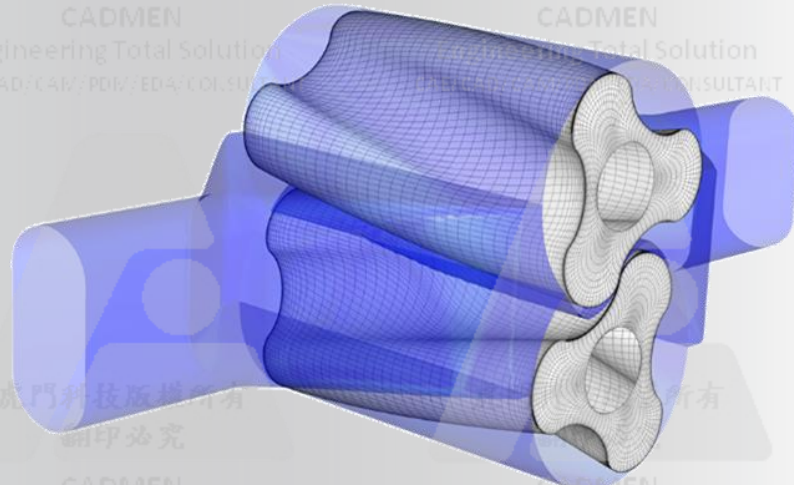
Grid (Time=8.0200e-03)

Oct 21, 2005

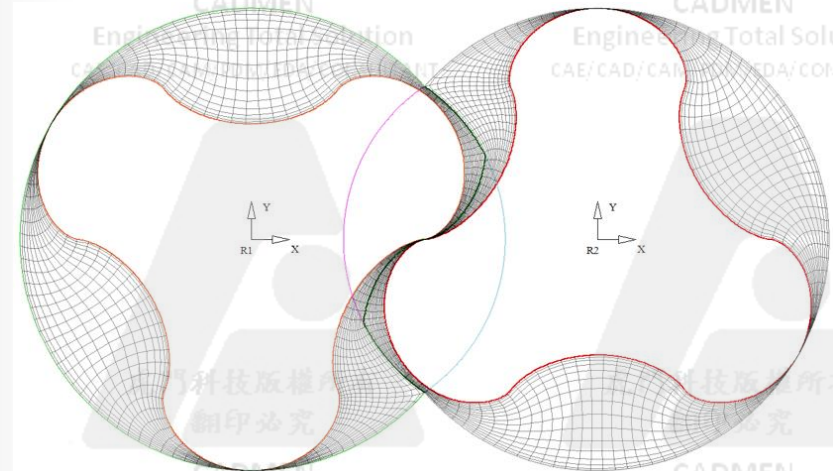
FLUENT 6.2 (2d, segregated, dynamesh, ske, unsteady)

考慮到前面的各種因素，網格的需求對於模擬相當重要，好的網格能夠使結果更趨近於真實現象

Twinmesh Rotary Positive Displacement Machines



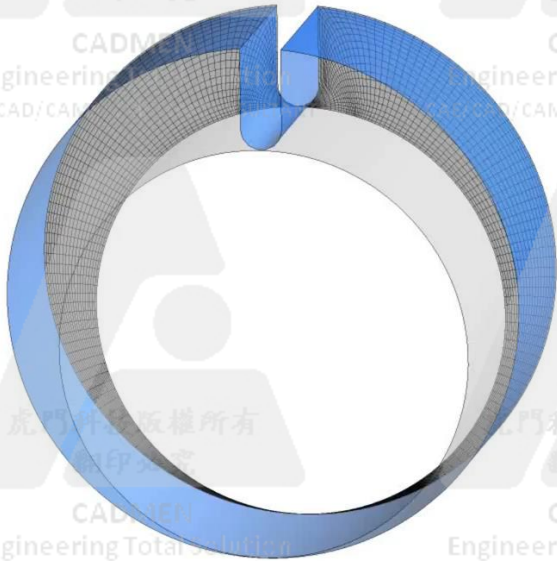
自動化生成高品質六面體網格



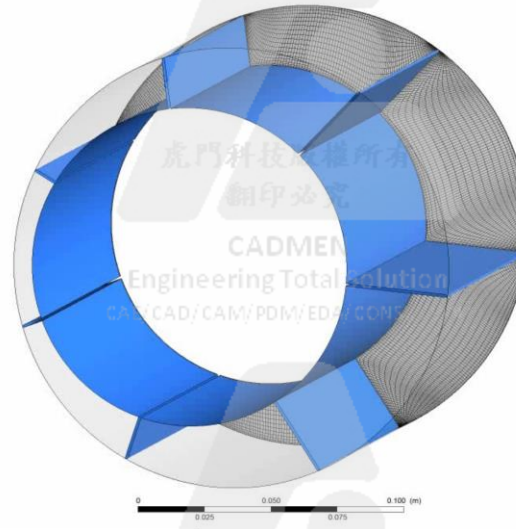
結構化的工作流程及介面



Twinmesh Rotary Positive Displacement Machines



Rolling piston



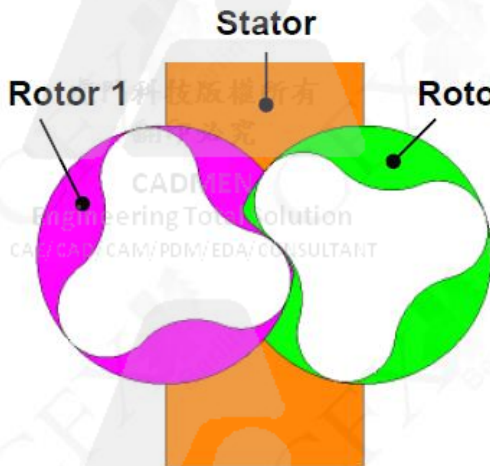
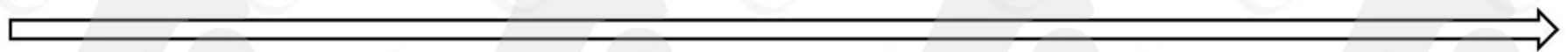
Vane pump

TwinMesh

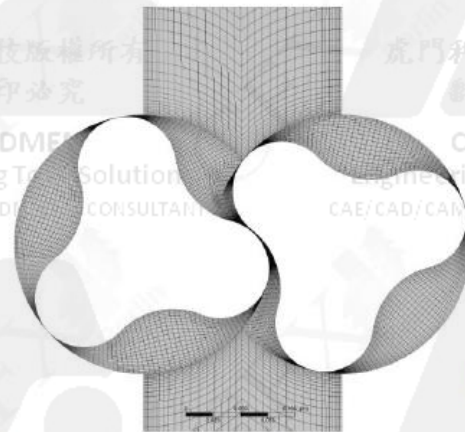
Seven steps from CAD to Mesh

- TwinMesh is a novel software, developed by CFX Berlin Software GmbH which generates high-quality hexahedral meshes for the rotating parts of axis parallel rotary positive displacement machines.

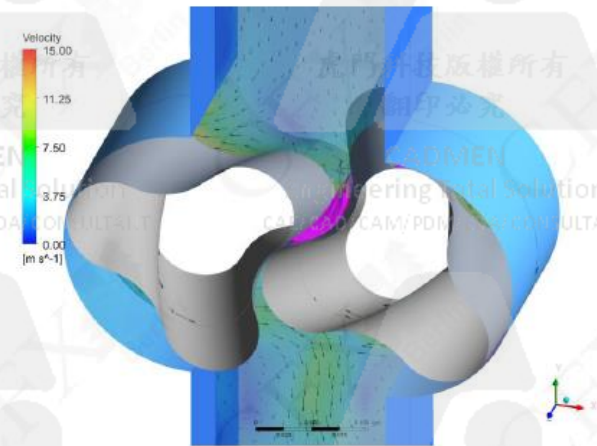
Simulation Workflow



Split of the simulation domains into steady and rotating parts



Grid generation for the rotors with **TwinMesh** and for the Steady parts with ANSYS ICEM CFD or ANSYS Meshing



Numerical calculation with ANSYS CFX

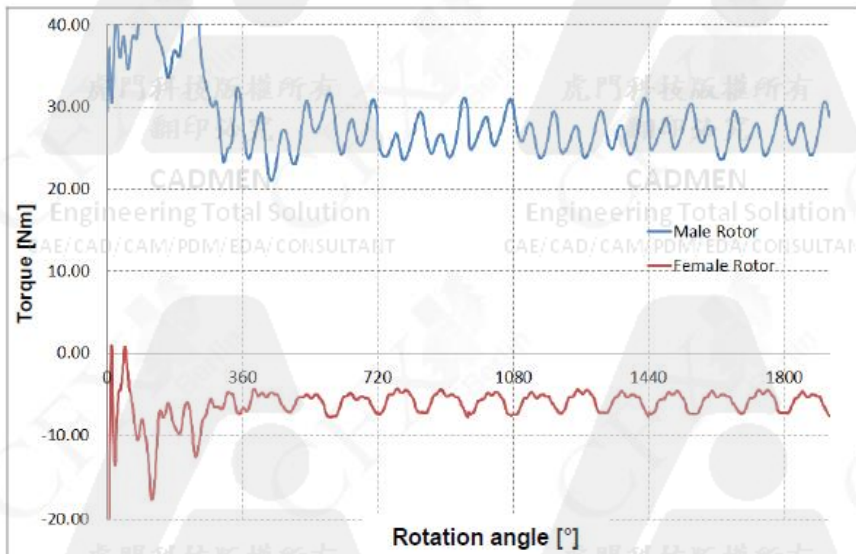
Simulation results

Screw compressor

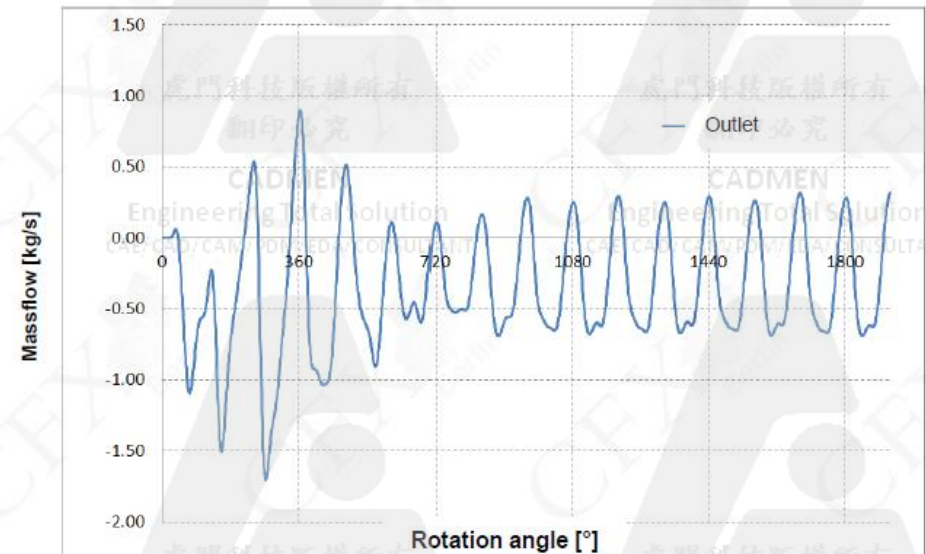
- General analyses (Torque, Power and massflow)

- Power: 41.2 kW
- Averaged volume flow: 890 m³/h

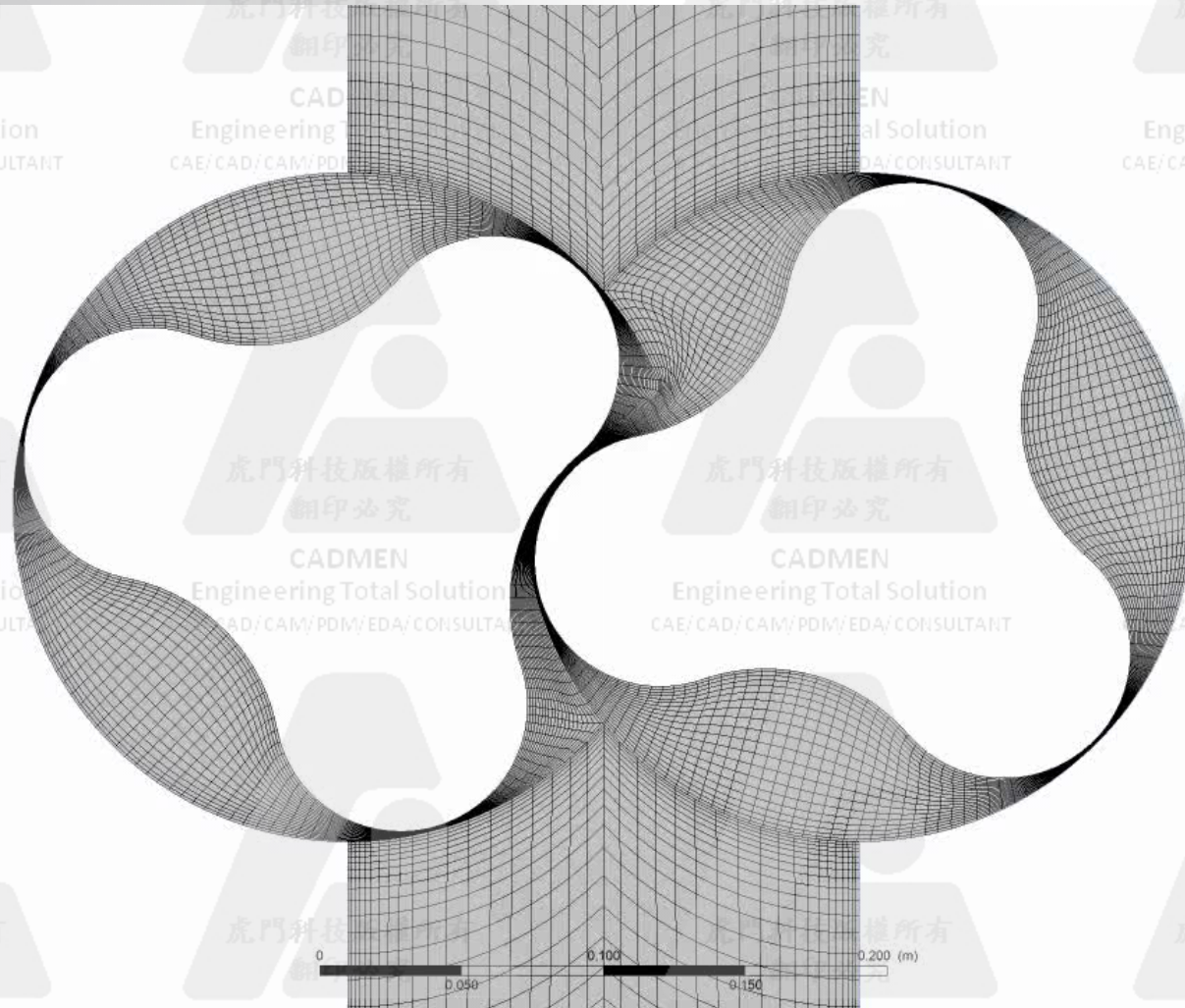
Torque



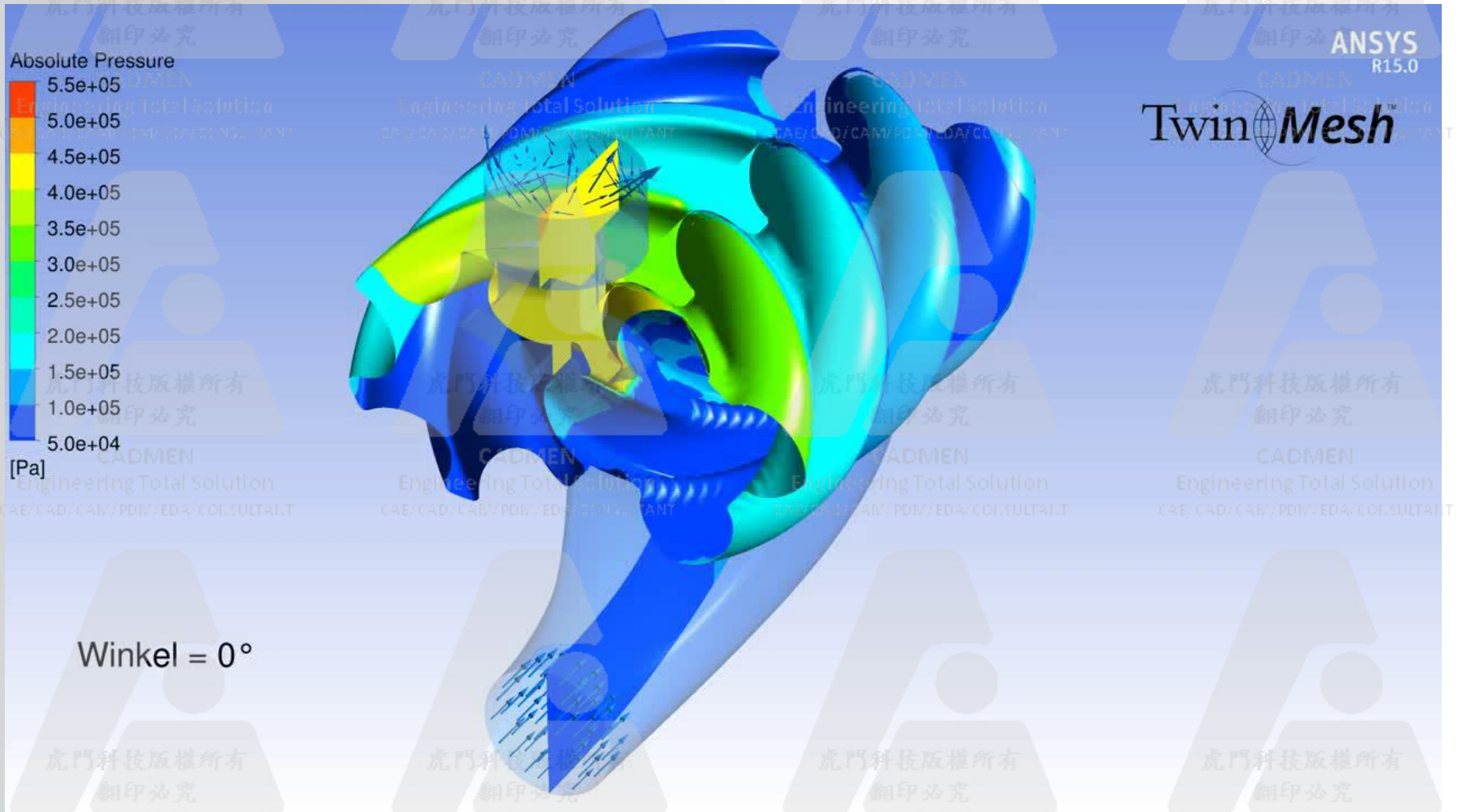
Massflow



Results-Mesh



Results-Pressure



Results-Animation



虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

高效能操作平台

ANSYS Workbench

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

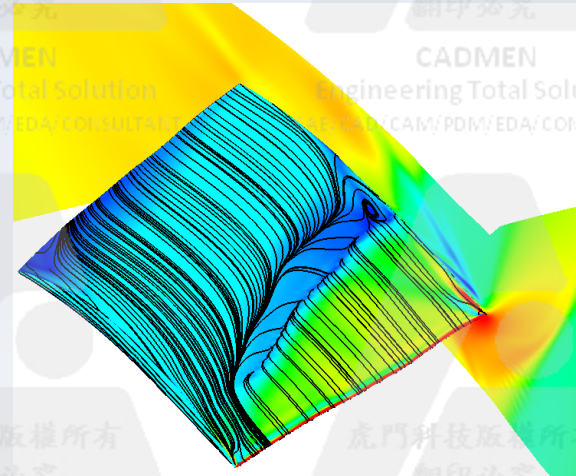
CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

耦合分析應用



虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

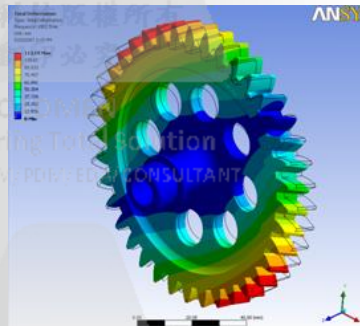
CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

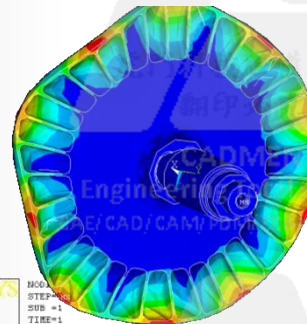
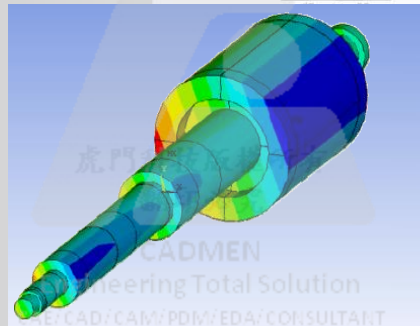
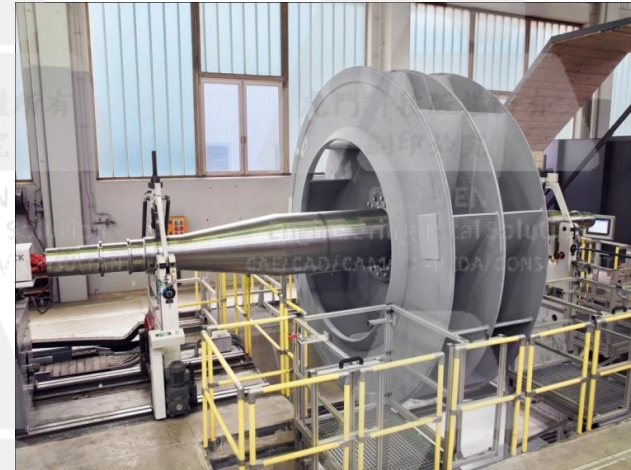
ANSYS Mechanical

- 結構強度、變形
- 震動噪音
- 模態、頻譜
- 疲勞壽命
- 轉子動力
- 多體動力
- 流固耦合分析

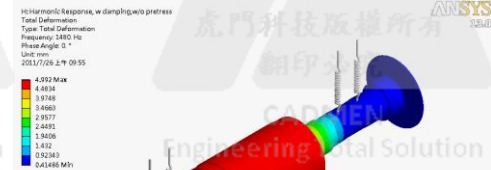
Static Structure



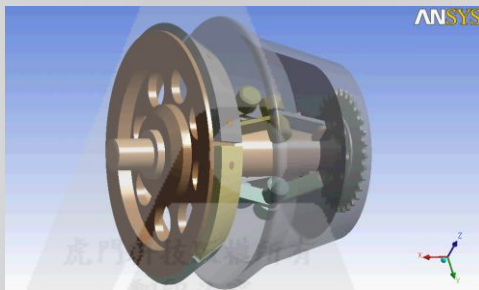
Rotational vibration deformation in a gear



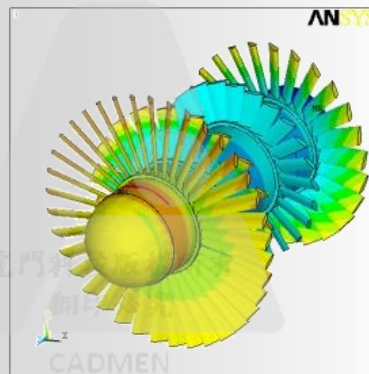
Industrial fan (Venti Oelde)



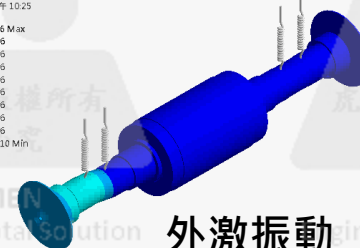
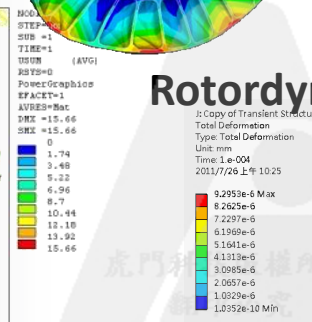
不平衡激振



Rigid Body Dynamic



Rotordynamics

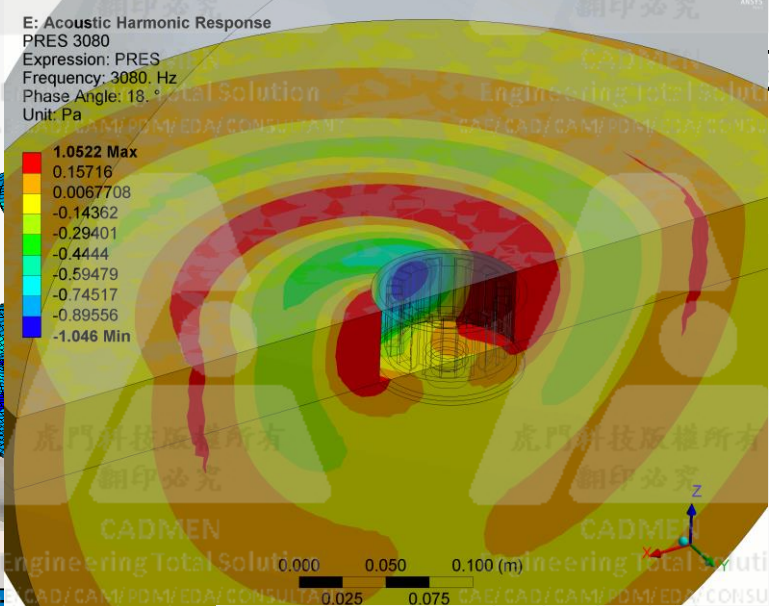
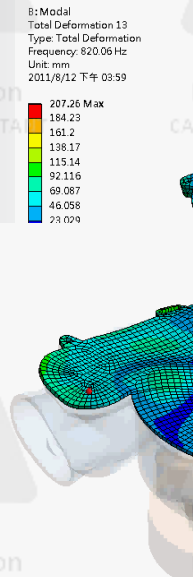
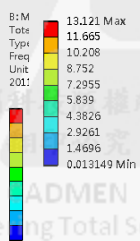
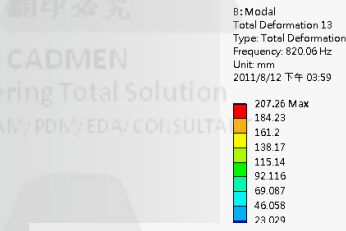
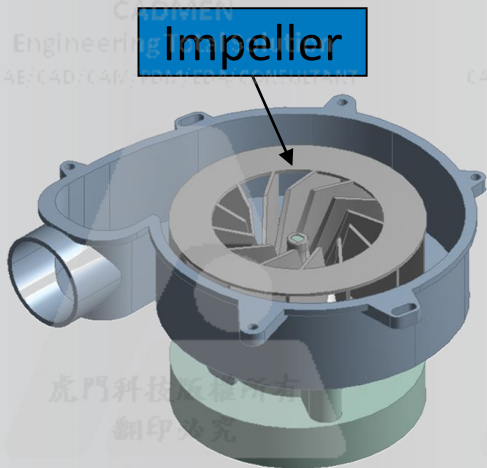
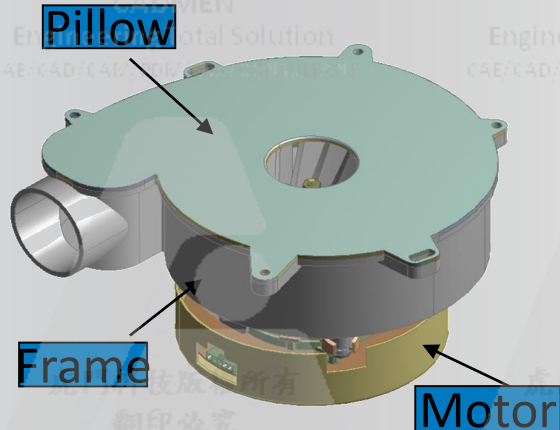


外激振動

振動噪音預測

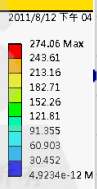
風機在工作頻率(845Hz)下之振動行為。

• 模態分析結果發現工作頻率
使用 Harmonic 附進行噪聲分析與振型
工作頻率如果在845Hz時因外力作用在模



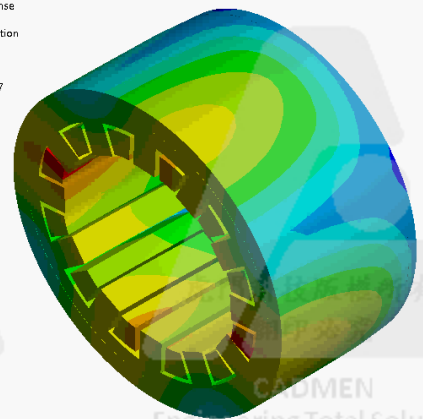
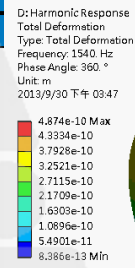
工作頻率：845Hz

854.06Hz



872

E	
1	Harmonic Response
2	Engineering Data ✓
3	Geometry ✓
4	Model ✓
5	Setup ✓
6	Solution ✓
7	Results ✓
8	Parameters ✓

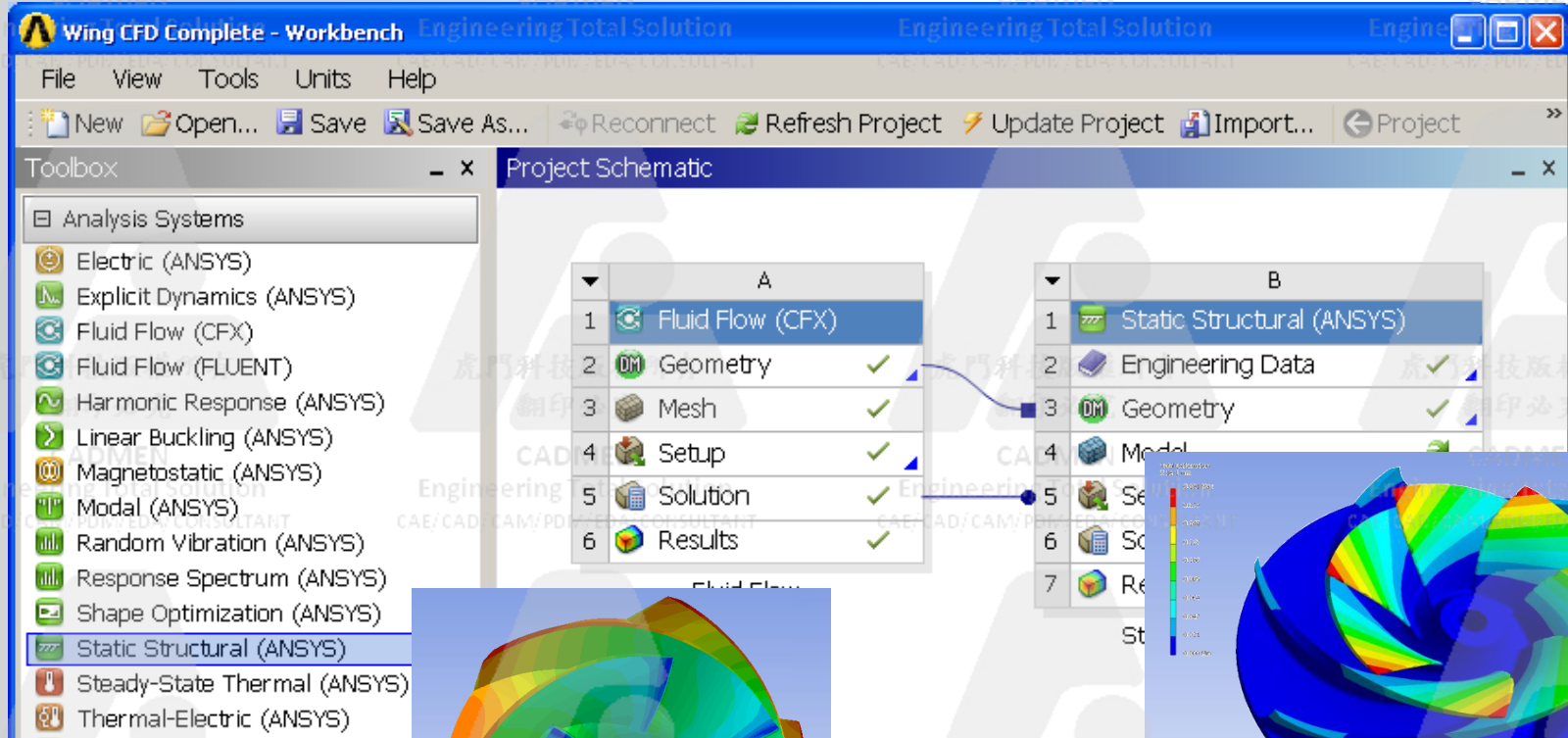


簡易的耦合分析程序控制

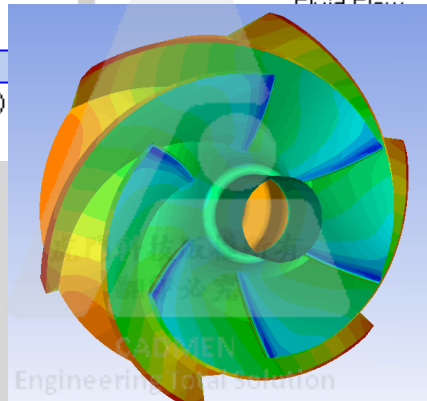
ANSYS

Engineered Scalability

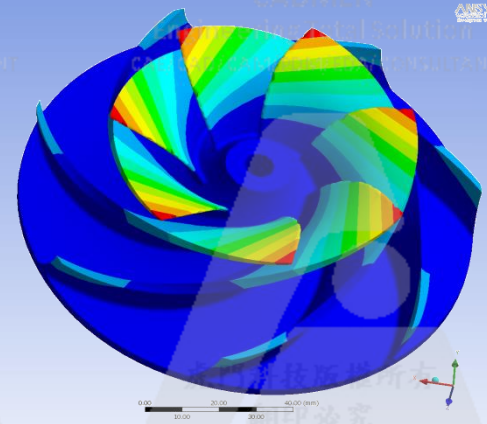
Flexible model setup enabled by the scalable, adaptive architecture of ANSYS Workbench



Pressure contours on a pump impeller

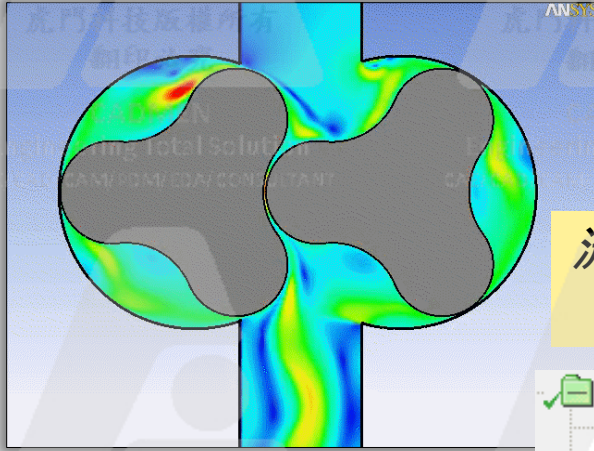


Contours of total deformation on a pump impeller in a coupled structural and flow analysis

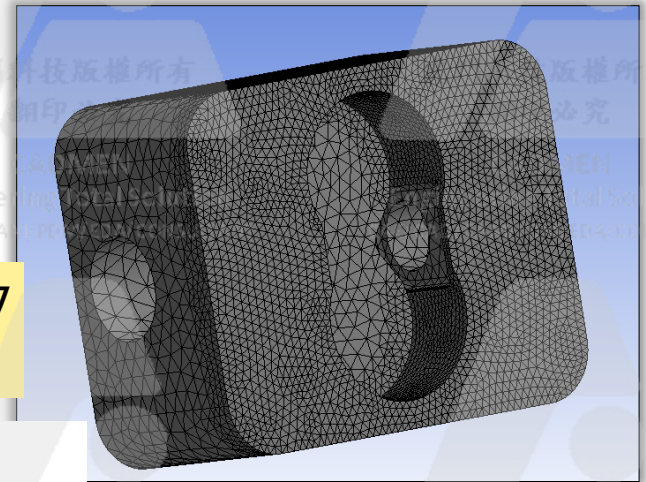


耦合分析 - 魯式泵面對更高操作條件時結構強度分析

Roots Pump



流體作用於壁面之壓力
Load Transfer



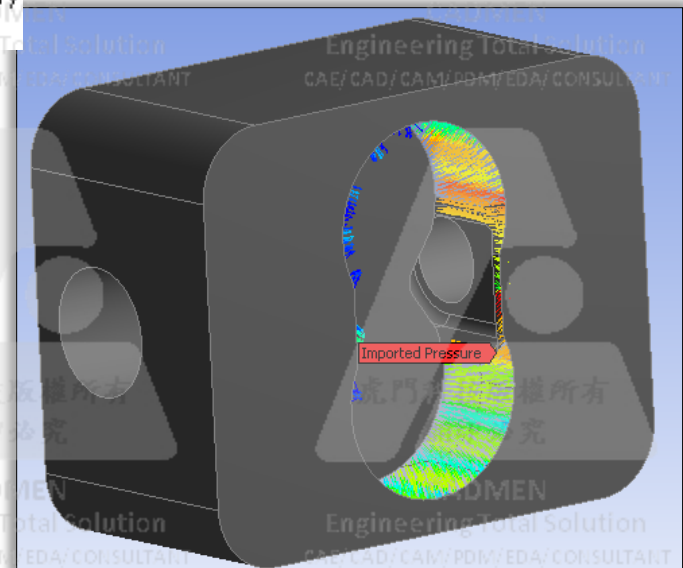
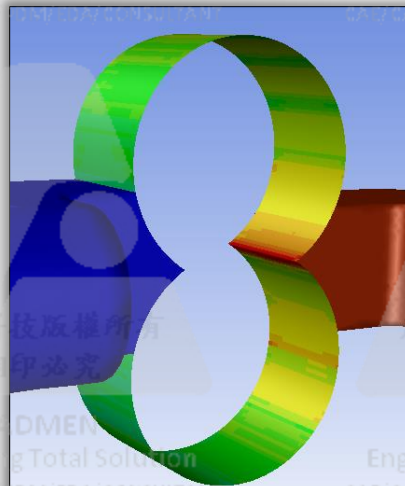
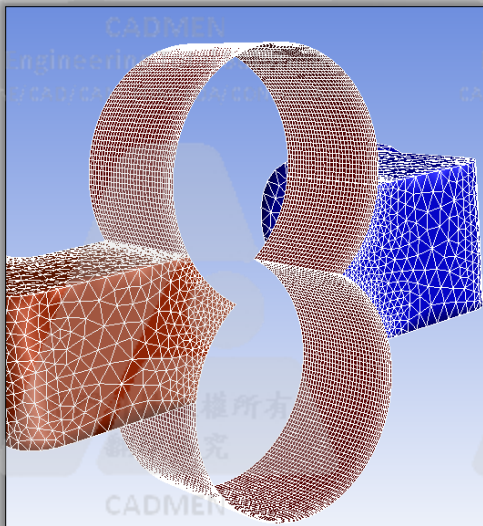
CFD



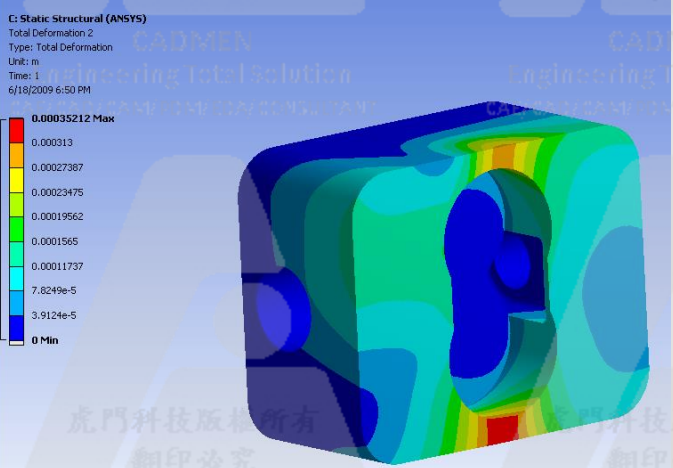
- Static Structural (C5)
 - Analysis Settings
 - Fixed Support
 - Imported Load (Solution)
 - Imported Pressure
 - Imported Load Transfer Summary
- Solution (C6)



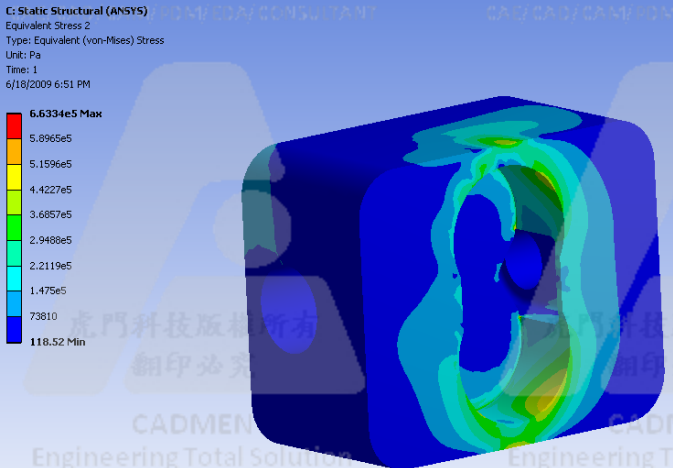
Structural



Total Deformation

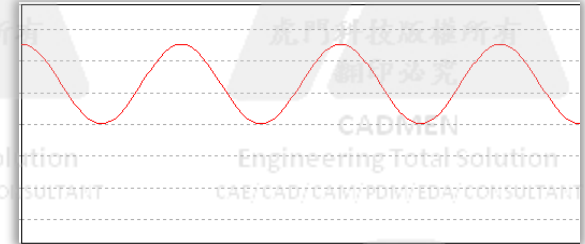


Equivalent (Von-Mises) Stress

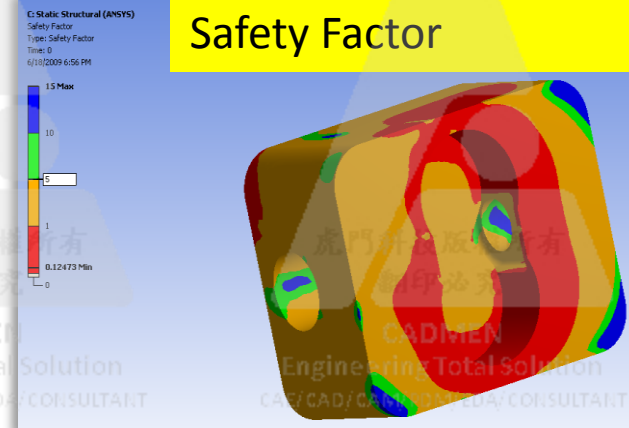


Fatigue Analysis

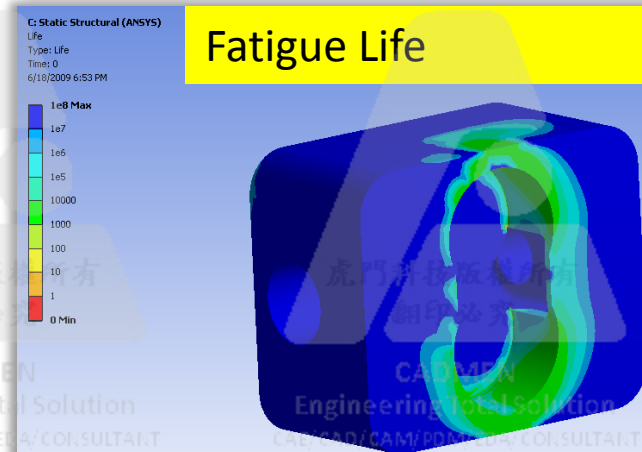
- Stress Based
- Constant Amplitude Load – Zero Based



Safety Factor



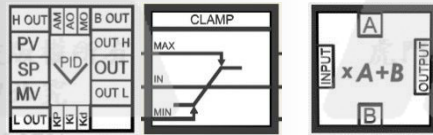
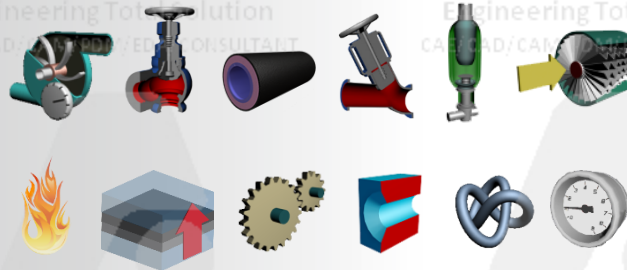
Fatigue Life



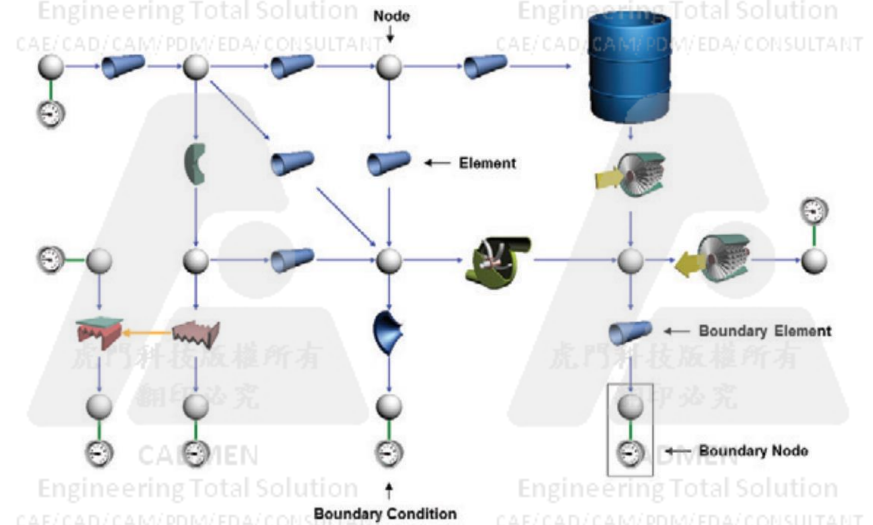
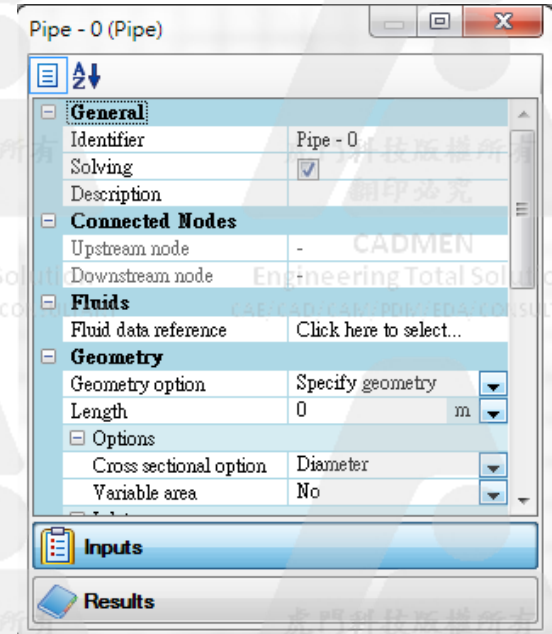
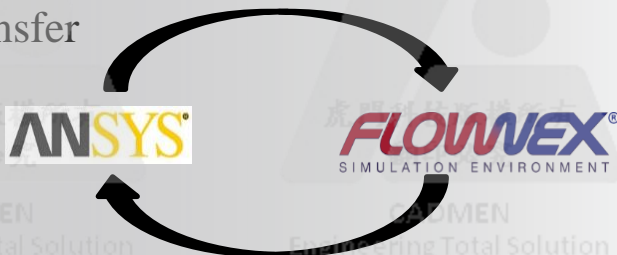
FlowNex於冷卻散熱系統性CFD分析技術



- ❑ Library of components defined through lumped parameters
 - Pipes, Bends
 - Fans, Pumps
 - Heat exchangers
 - Nozzles
 - Valves
 - Accumulator
 - Controllers, Scripts
 - Turbines & combustor
 - Gear pumps



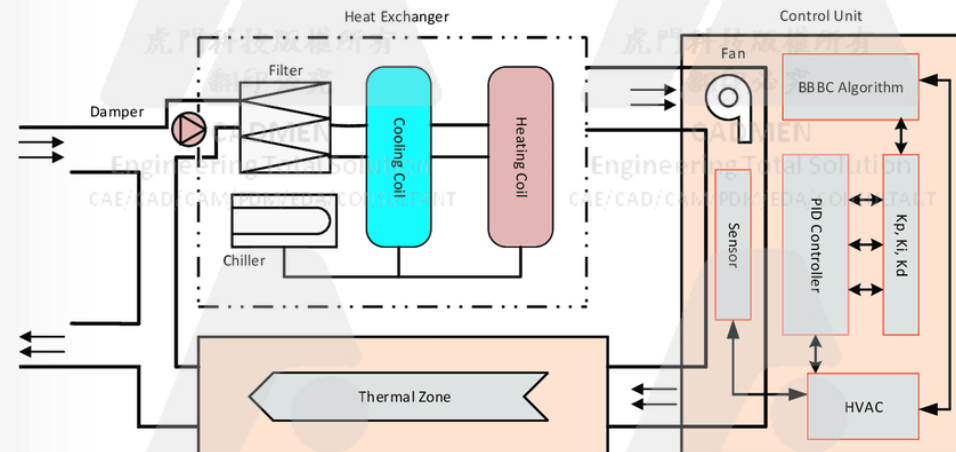
- ❑ Components are connected in a network
 - Flow distribution
 - Heat transfer
 - Mass transfer



- 若採三維CFD軟體進行全冷卻系統分析，擴日費時且極消耗成本
- 將系統內設備元件視為簡易流程方塊，進行熱力學流程分析，係為可行且合理的操作方式
- 採用一維CFD軟體(Flownex®SE)分析，可達到成本效率跟精確度的平衡



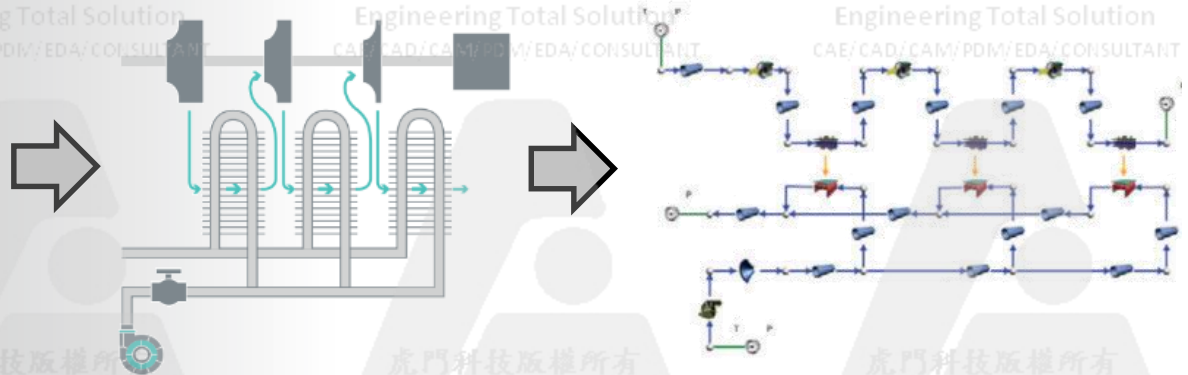
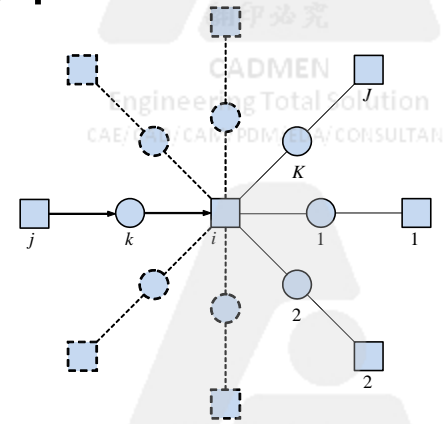
inthebigroom.com/



Creative Commons Attribution 4.0 International

Flownex的功用

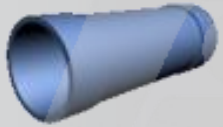
- 大規模廠務熱流系統模擬分析，節省時間與成本
- 利用流體網路模型架構，快速組成複雜系統
- 採用符合工程實況的流體資料庫，如冷媒
- 求解系統及元件壓力、溫度、流量.....的分佈
- 可執行參數設計、敏感分析及優化功能
- 可與其它軟體如ANSYS與Excel....作耦合分析或功能整合



Flownex熱流元件庫

□ 管件、容器、閥門、旋轉機械、流阻、噴嘴、熱交換器、熱傳模型、氣液過濾、流量計機械傳動.....等

Pipe



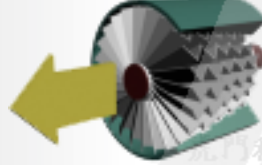
Two-phase tank



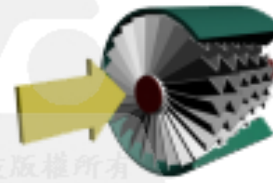
Valve



Turbine



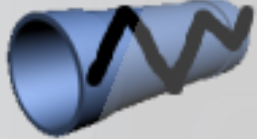
Compressor



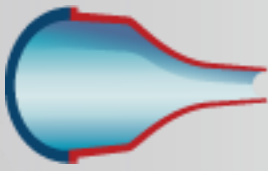
Centrifugal pump



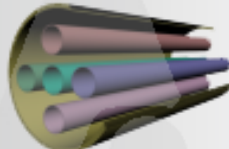
Flow resistance



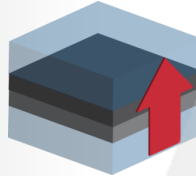
Nozzle



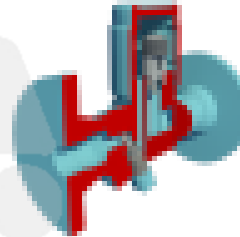
Shell-tube heat exchanger



Composite heat transfer



Steam/water trap



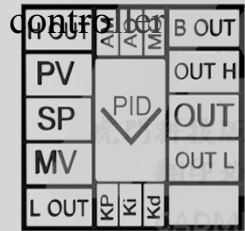
Venturi flow meter



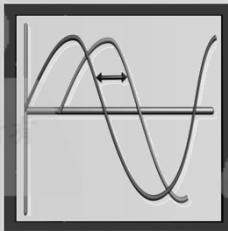
Flownex控制元件庫

□ 控制器、延遲器、脈衝器、波型器、函數器、開關、計數器、邏輯控制、比較器、積分器和輸入器.....等

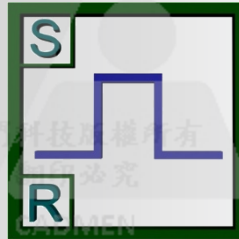
PID



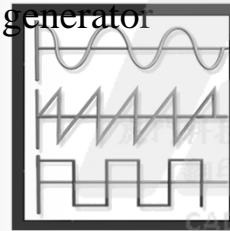
Time delay



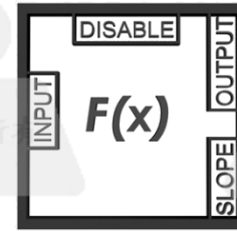
Pulse timer



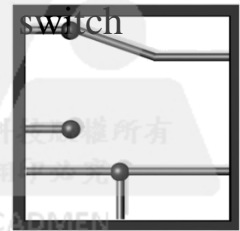
Wave generator



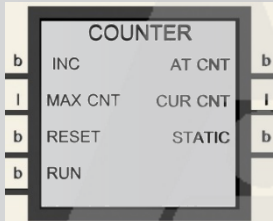
Function generator



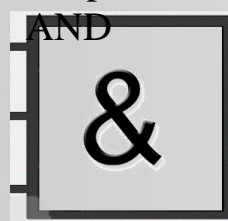
Toggle switch



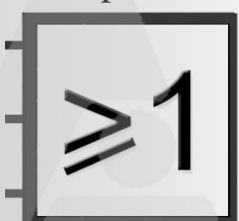
Counter



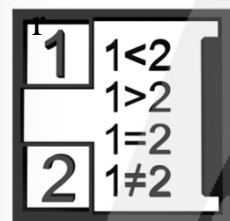
4 input AND



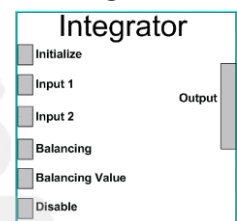
4 input OR



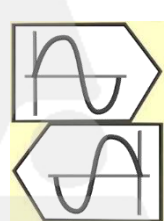
Comparator



Integrator



DCS



□用以觀察參數的暫態過程或程度上的控制

Push button



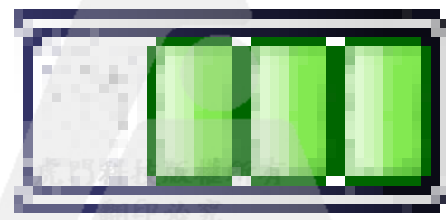
Dial



Track bar



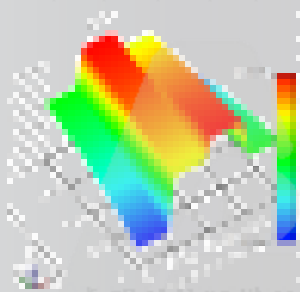
Progress bar



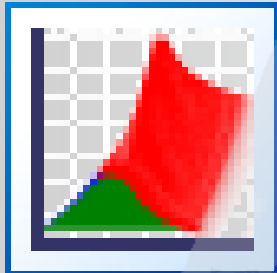
2D increment



3D increment



Fluid property graph



Scripting tool



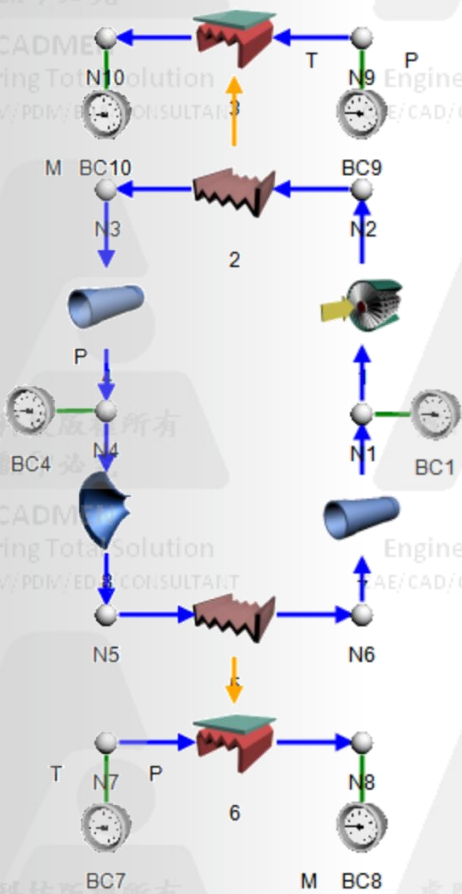
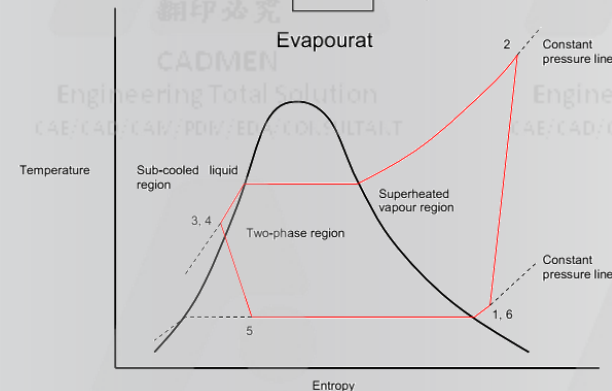
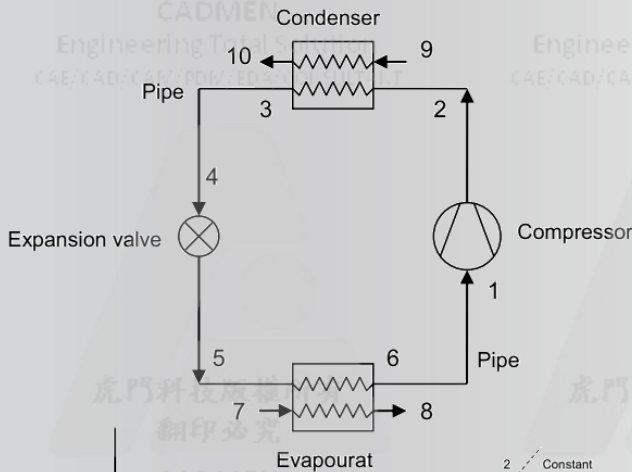
Pie graph



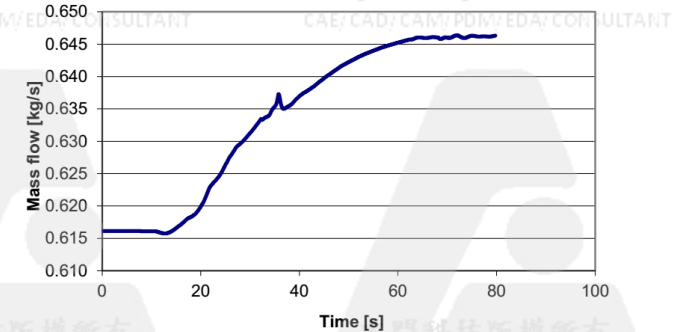
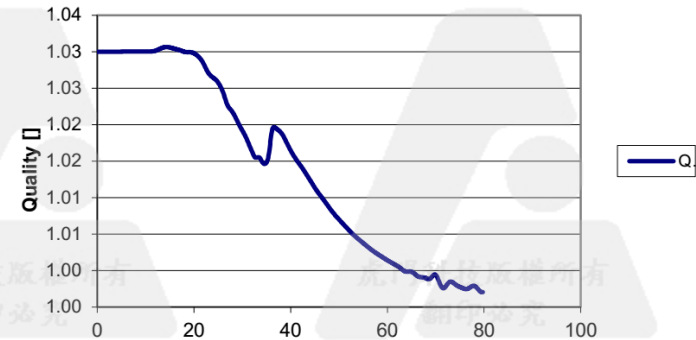
Toggle button



範例：蒸氣壓縮冷凍循環



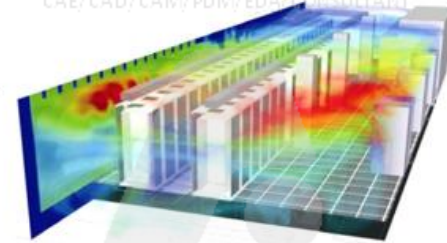
不同階段時的流體的氣液比
及狀態改變下的流量變化



虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究



- 由於大陸5G雲計算的強力推動，華為將擴建計算中心規模
- 於廊坊、深圳、西安等地的計算中心將有著更多的伺服器房
- Flownex用於分析伺服器房的冷卻系統管線規劃，及一三維耦合分析

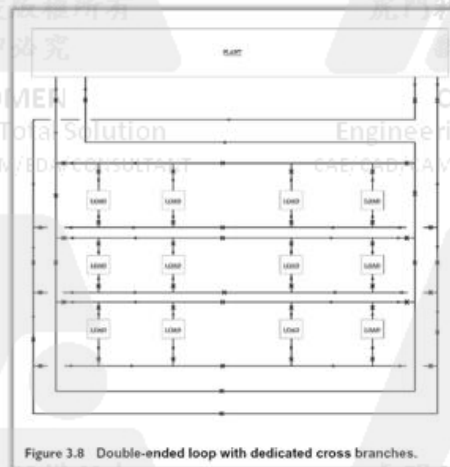
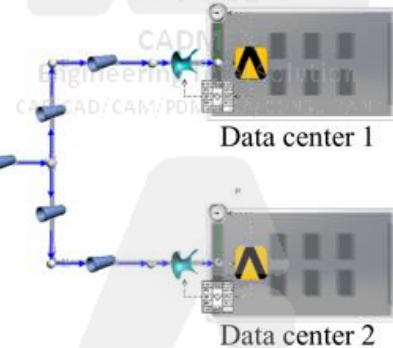
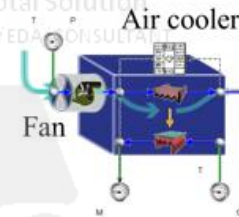


Figure 3.8 Double-ended loop with dedicated cross branches.



虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

翻印必究

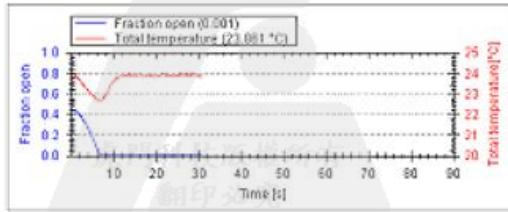
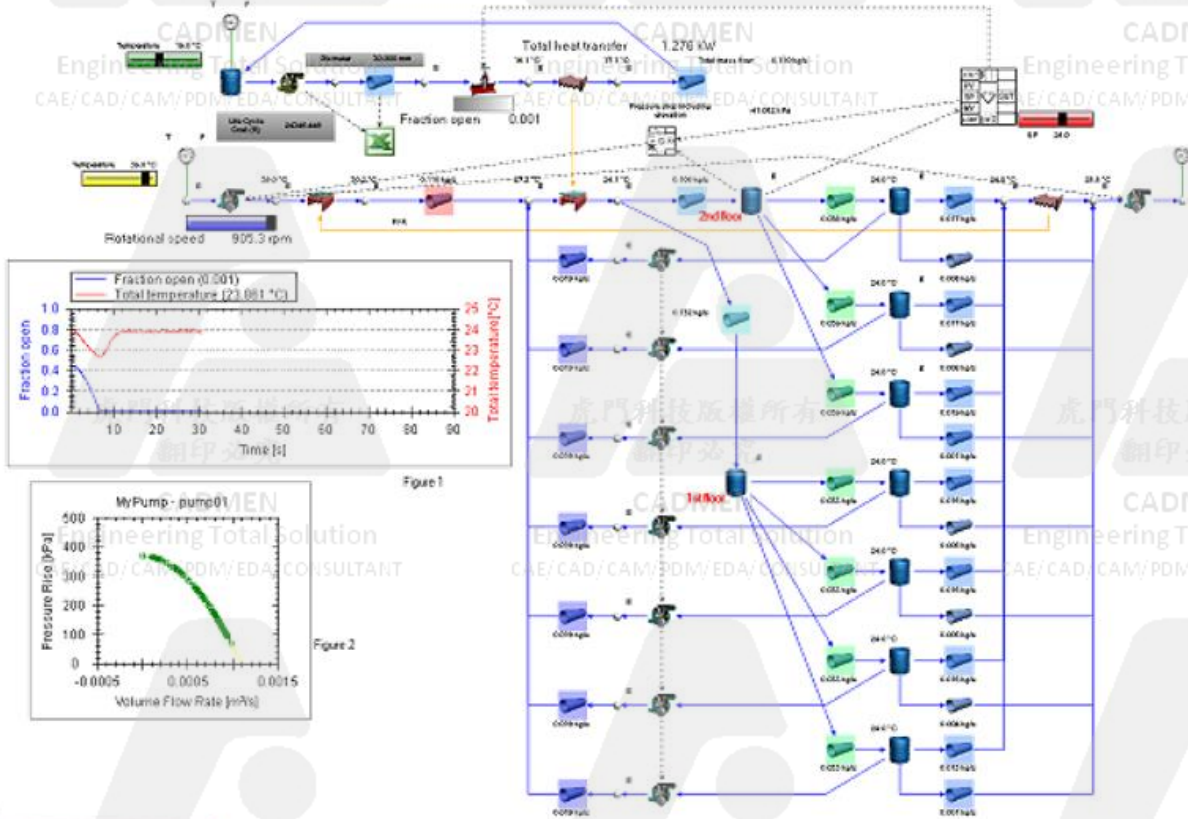


Figure 1

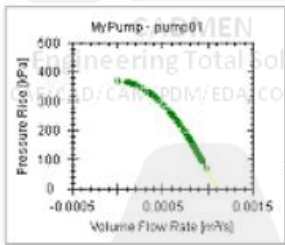


Figure 2

- 7間房的空調系統模擬
- 冷卻水及換氣系統組成
- 熱交換器在冷卻水的中央處，另一只在換氣系統的進排氣端中間
- 冷卻水流量由pump轉速決定
- 換氣系統由PID控制器控制其運作

株式会社計算力学研究センター
Research Center of Computational Mechanics, Inc

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

電池散熱片應用

虎門科技版權所有
翻印必究

CADMEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CADMEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CADMEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

CADMEN
Taiwan Auto-Design Co.
CADMEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

200 x 150 x 1 (mm³)



電池散熱量 0.03 kW

200 x 150 x 10 (mm³)

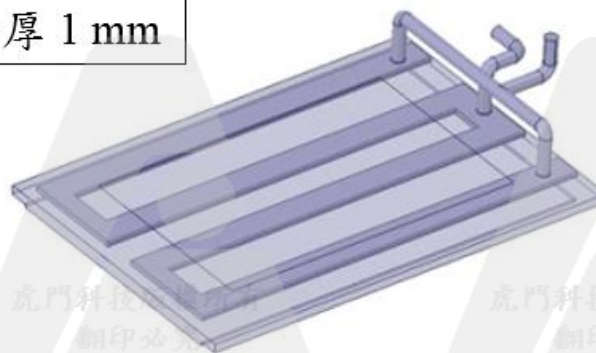
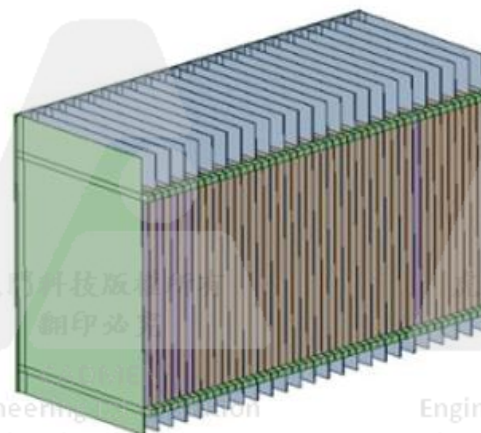
570 x 12 x 390 (mm³), 導熱層厚 1 mm



冷卻水

Mass flow rate = 0.005 kg/s

T = 18°C



電池散熱片應用

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

CADMEN
Engineering Total Solution

CADMEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

CADMEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

CADMEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

CADMEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

電池1

電池2

電池3

導熱片

水冷片

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

CADMEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

CADMEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

CADMEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

CADMEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

CADMEN
Engineering Total Solution

CADMEN
Engineering Total Solution

CADMEN
Engineering Total Solution

CADMEN
Engineering Total Solution

電池散熱片應用

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

CADMEN
Taiwan Auto-Design Co.

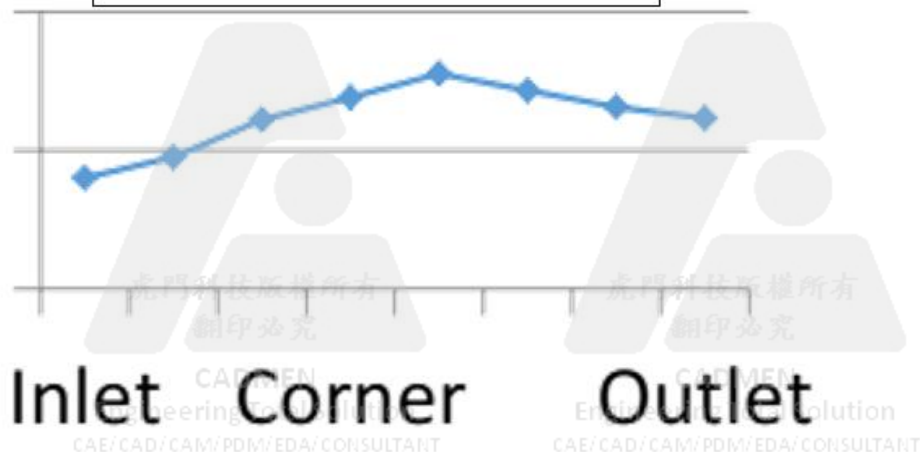
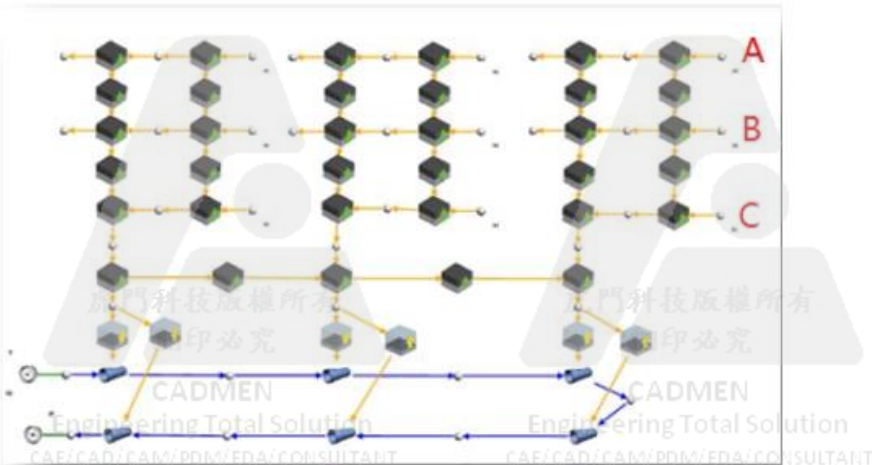
CADMEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

CADMEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

CADMEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

CADMEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

冷卻水管沿途溫度 (°C)



電池表面溫度(°C)	電池1	電池2	電池3
A(頂部段)	27.3	29.2	30.1
B(中部段)	25.5	27.4	28.4
C(底部段)	22	23.9	24.8

虎門科技版權所有
翻印必究

CAD MEN

Engineering Total Solution

CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN

Engineering Total Solution

CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

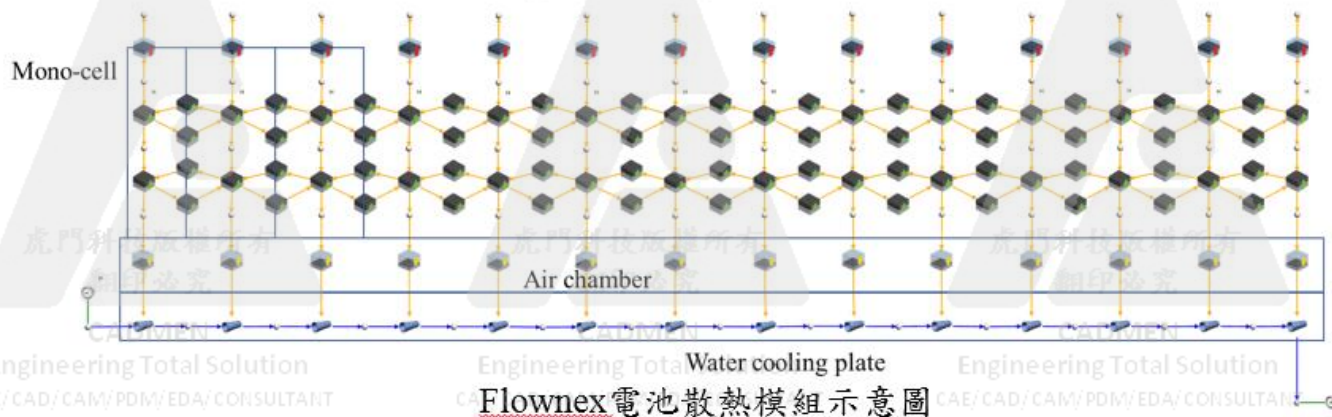
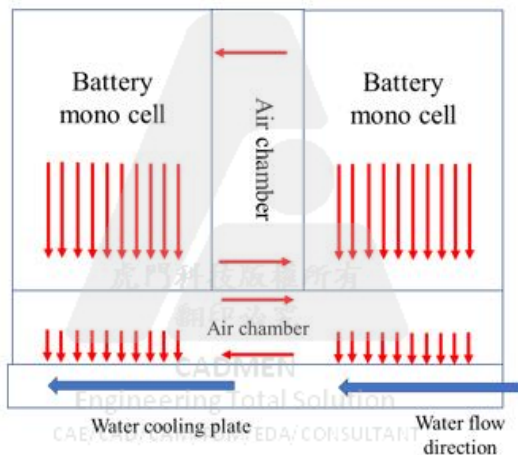
Engineering Total Solution

CAE/CAD/CAM/PDM/EDA/CONSULTANT

CAD MEN
Taiwan Auto-Design Co.

Engineering Total Solution

CAE/CAD/CAM/PDM/EDA/CONSULTANT



- 一維的模型範例，上面有14個方芯串連形成一個模組，各方芯之間的交互熱傳導由中間的熱管進行，再傳導至下方的均溫板，均溫板與電池皆有交互熱傳，然後再經由均溫板下方的水冷板進行對流散熱
- 於0.2 kg/s條件下，最高溫度約23.31 °C

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

CAD MEN

Engineering Total Solution

CAD MEN

Engineering Total Solution

CAD MEN

Engineering Total Solution

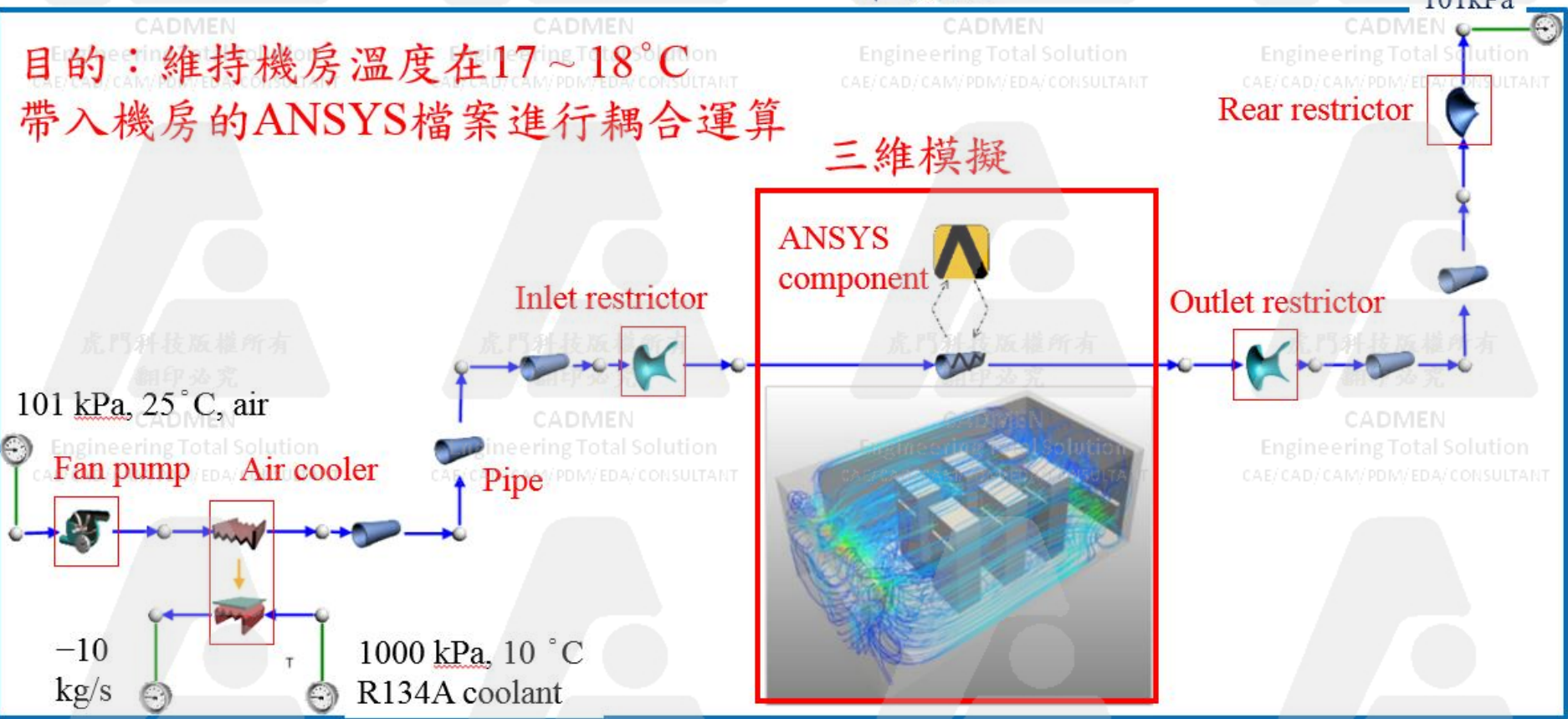
CAD MEN

Engineering Total Solution

一維模擬

目的：維持機房溫度在 $17 \sim 18^{\circ}\text{C}$
帶入機房的ANSYS檔案進行耦合運算

三維模擬

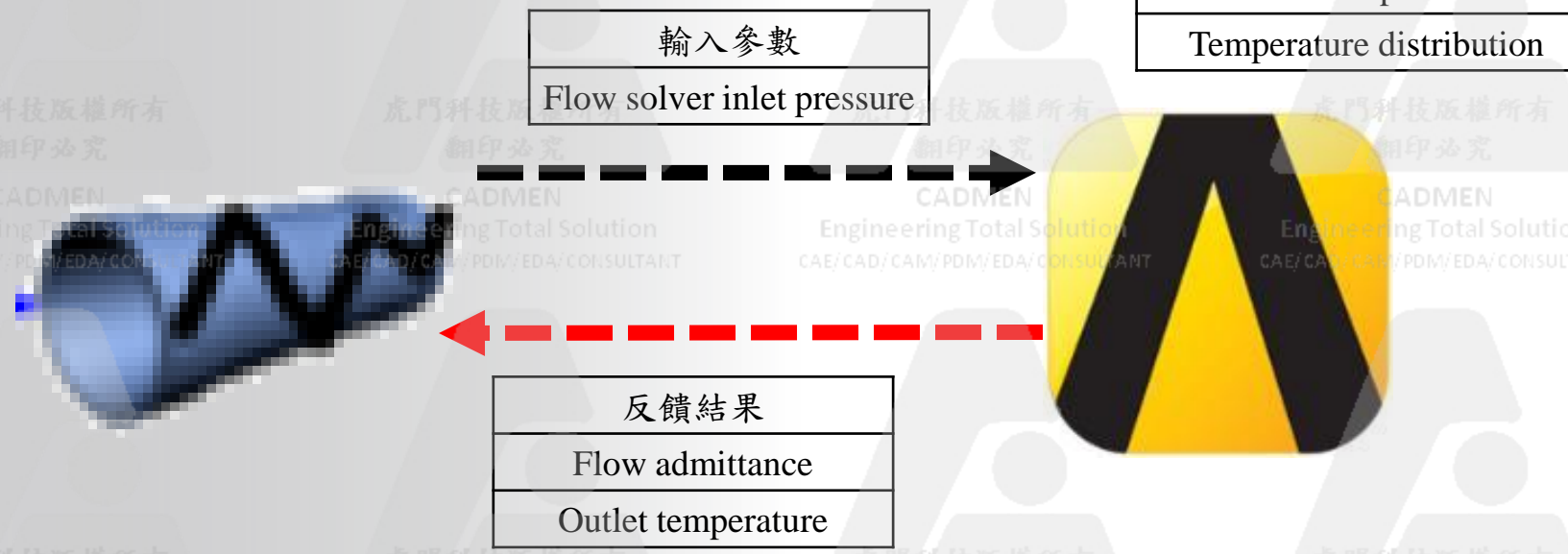


伺服機房空調系統

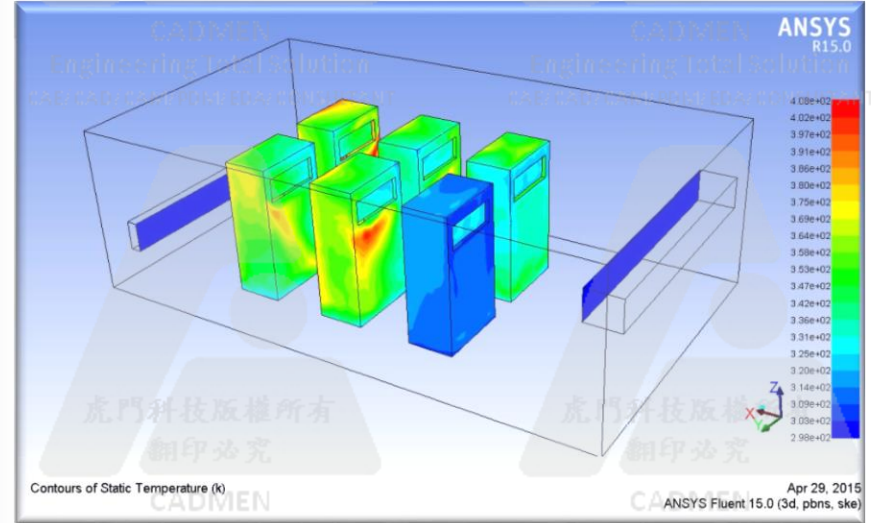
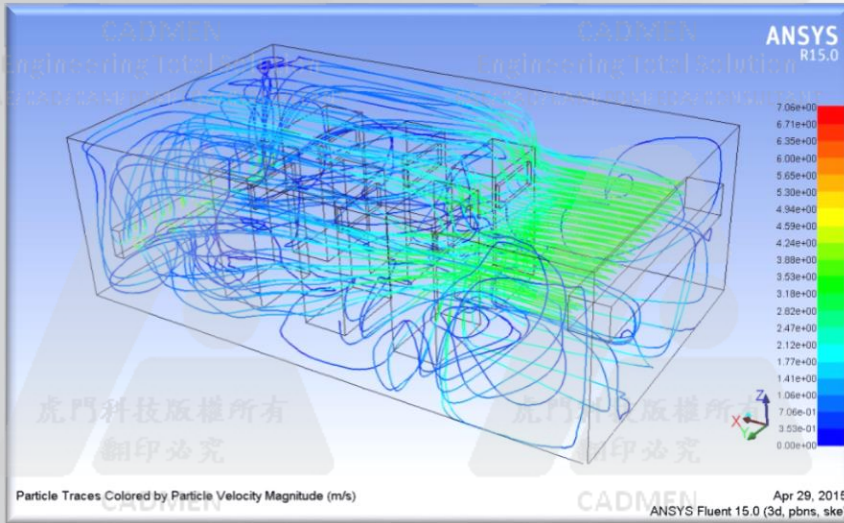
Flownex計算入口壓力並傳遞至ANSYS

ANSYS求解溫度、壓力與流量

求解後ANSYS得出admittance與出口溫度反饋至Flownex



伺服機房空調系統

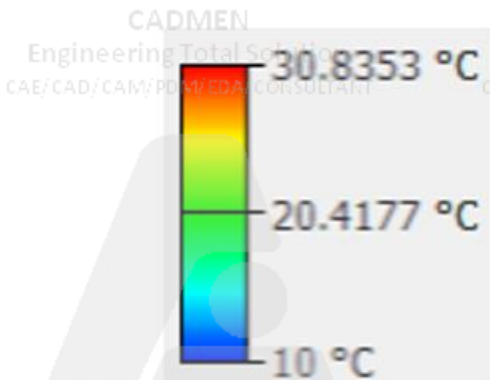


計算參數	結果
Inlet mass flow rate	5.734 kg/s
Outlet total pressure	713.24 kPa
Inlet total pressure	737.26 kPa

反饋參數	結果
Flow admittance	1.3704
Outlet temperature	290 K (17 °C)

伺服機房空調系統

虎門科技版權所有
翻印必究



虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

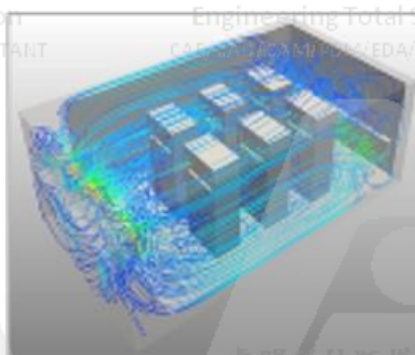
虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT



虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

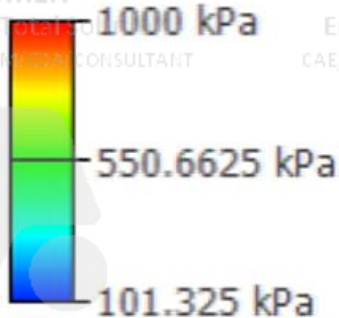
CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

伺服機房空調系統

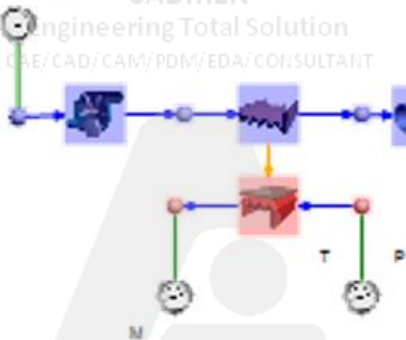
虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT



虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT



虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

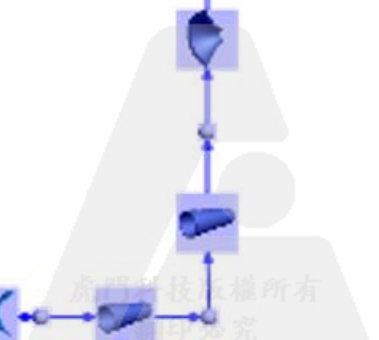
CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

CAD MEN
Taiwan Auto-Design Co.

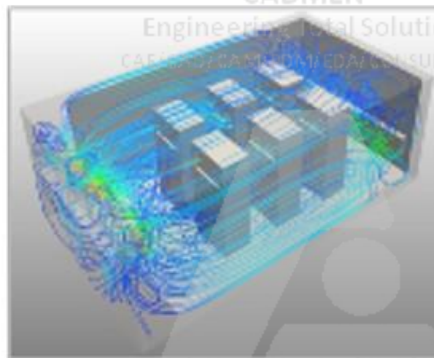
CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

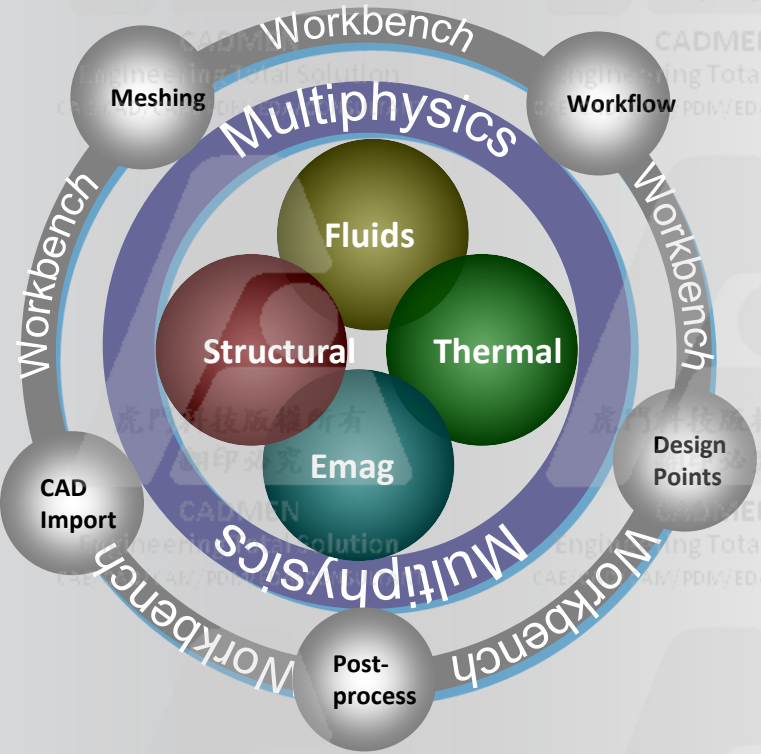


CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT

虎門科技版權所有
翻印必究

CAD MEN
Engineering Total Solution
CAE/CAD/CAM/PDM/EDA/CONSULTANT





EnSight



Thank you for your attention!