PIAnO SIG

AI-Aided MDO Software

PIDOTECH

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PIAnO Signature Outline

PIAnO SIG

Multidisciplinary Design Optimization

Software enhanced with AI Technology

PIAnO
Composer
2024
AIDesigner
sim
2024

PIAnO Signature is an AI-enhanced MDO[1] software
that combines PIAnO Enterprise, powered by PIDO[2] technology,
with AIDesigner sim, leveraging AADO[3] technology.

PIAnO Signature autonomously analyzes design results using DAVIS[4] technology, generating Excel reports that include summarized design outcomes and visually intuitive charts and graphs.

[1] Multidisciplinary Design Optimization

[2] Process Integration and Design Optimization

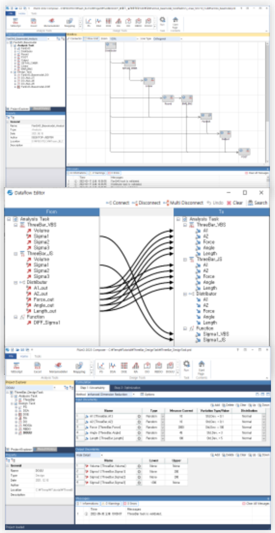
[3] AI-Aided Design Optimization

[4] Data Analytics, Visualization and Interactive Storytelling

PIAnO Signature Composition

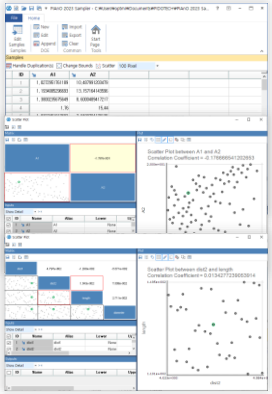
- Consists of 5 independent applications
- Can be utilized independently or in an interconnected manner according to the design objectives.

Composer



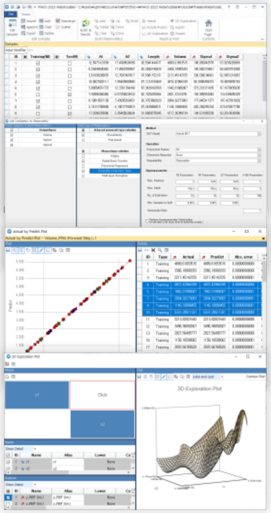
- Process Integration and Automation
- Multidisciplinary design optimization
- Data Analysis/Visualization

Sampler



- Sample points generation
- AI-based Autonomous recommendation of Sampling techniques

Metamodeler



- Metamodel generation
- Autonomous Hyperparameter Optimization
- AI-based autonomous recommendation of metamodels

Reviewer

- Data Analysis/Visualization
- AI-based key design factor analysis

AIDesigner sim

- Autonomous optimization based on automated analysis procedures
- Data Analysis based on data-storytelling
- Automatic generation of Excel reports

Composer

Integrates CAD, CAE, metamodels, in-house code, and Excel to establish an automated analysis process and executes Design optimization (DO) and design of experiments (DOE) to achieve optimal design solutions.

1 **Analysis Task**
(자동화 해석 프로세스)

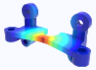
2 **Design Tasks**

3 **Execution and Monitoring**

4 **Result comparison and Comprehensive validation**

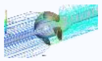
Process integration

구조해석



ABAQUS
ADINA
CAESAR II
Hyperworks
Nastran
. . .

유동해석

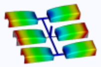


ANSYS CFX
ANSYS Fluids
CFD
COMSOL
FanDAS
. . .

동역학해석

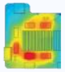
ADAMS
AMESim
CarSim
CarMaker
Recurdyn
. . .

사출해석



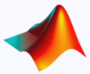
MAPS-3D
Moldflow
. . .

열해석



Altair flux
FloTHERM
. . .

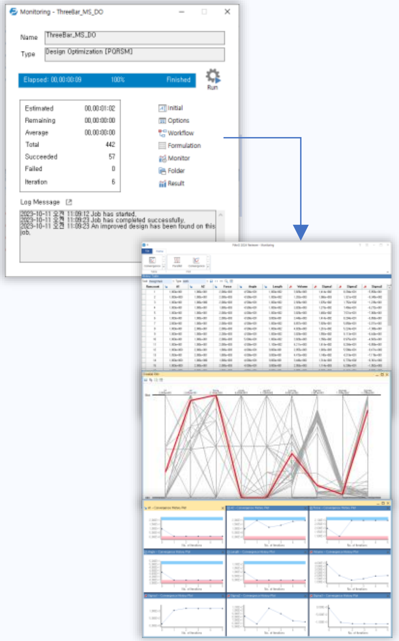
기타



Matlab
JScript
VBScript
BeanShell Script
In-house Code
Excel
. . .

Design optimization

PS
DSA
DOE
RA
DO
RBDO
DOUU



Monitoring - ThreeBar_MS_DO

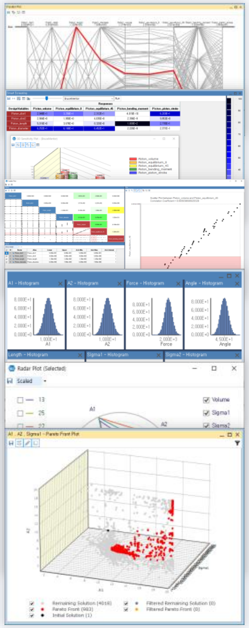
Name: ThreeBar_MS_DO
Type: Design Optimization [PQRSM]

Elapsed: 00.00:00:09 100% Finished

Estimated	00.00:01:02
Remaining	00.00:00:00
Average	00.00:00:00
Total	442
Succeeded	57
Failed	0
Iteration	6

Log Message

```
2023-10-11 오전 11:09:12 Job has started.
2023-10-11 오전 11:09:23 Job has completed successfully.
2023-10-11 오전 11:09:23 An improved design has been found on this job.
```



Composer

Analysis Task Integrates CAD, CAE, metamodels, in-house code, and Excel to establish an automated analysis process

Embedded Tools - Basic

Script
- Visual Basic Script
- Java Script
- Bean Shell Script
- Python Script

Excel

Matlab

Mapping
- Mapping Wizard
- Mapping Script

Remote Job Wizard
- LSF
- PBS
- SGE

Utility

Functions
- Function1
- Function2
- Function3

Distributor

Embedded Tools - Metamodel

- Autonomously selects the optimal Metamodel type by utilizing BruceMentor for Metamodeling
- Exports the generated Metamodel in PIAnO Composer, Executable file, and Excel formats.

AI Based Automatic Selection
- BruceMentor for Metamodeling
- Rule based metamodel selection

Machine Learning
- EDT
- MLP
- Hyper parameter Optimization
- Network Architecture Optimization

Regression
- PR
- RBFr

Interpolation
- Kriging
- RBFi

Composer

Design Task

Formulates design problems and provides appropriate design optimization techniques to achieve optimal solutions

DO (Design Optimization)

State-of-the-art optimization algorithms specialized for various design problems

Local Optimization
- PQRSM
- STDQAO

Global Optimization
- Micro-GA
- EA

Advanced Global Optimization
- CMA-ES
- HMA

Discrete Optimization
- PADO

Multi-Objective Optimization
- MOGA

Quick Search Optimization
- ePPAO
- Fsolver

DOE (Design Of Experiments)

Traditional Sampling Methodologies and DACE Methodologies to perform Experiments efficiently.

- Autonomous recommendation of appropriate sampling techniques tailored to user requirements
- Automatic sequential sampling considering space-filling properties
- Automatic detection of duplicate points

AI based Automatic Selection
- Rule based method selection

Conventional Sampling
- FFD
- OA(1,775 types)
- Near OA
- PBD
- BBD
- CCD/ICCD/FCCD

CADE Sampling
- LHD/OLHD
- OA(1,775 types)
- Near OA
- CVT
- SOBOL

Augmenting Design Sampling

PS (Parametric Study)

1-D Parametric Study
Vector Parametric Study

DSA (Design Sensitivity Analysis)

Finite difference method

RBDO (Reliability-based Design Optimization)

ASLSV

DOUU (Design Optimization Under Uncertainty)

GDM

RA (Reliability Analysis)

Statistical Model Identification
- Akaike Information Criterion

Sampling
- MCS
- LHS

First Order Reliability Method
- HLRF

Approximation Integration Method
- eDR

Robust Design Optimization
- eDR-Based Design Optimization

Composer

Post-processing Tools

Post-processing tools to provide valuable information by analyzing design results.

Post-processing Tools

- Autonomous analysis of key factors with BruceMentor for Screening
- Automatic generation of Excel report

Main effect analysis
· ANOM
· ANOVA

Data-driven optimization
· Formulation
· Find Best values

Optimization results
· Initial vs. Optimal table
· Pareto front plot
· Convergence history plot

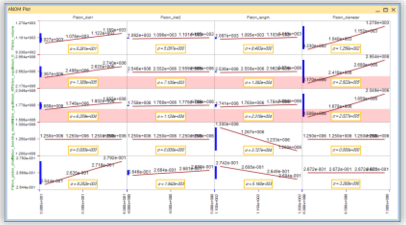
AI based automatic screening
· BruceMentor for screening
· Statistical analysis methods (6 Items)

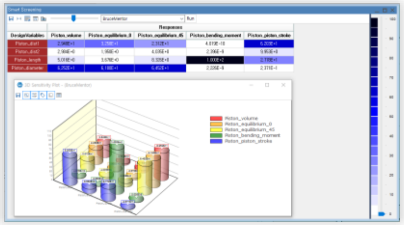
Automated report export in Excel format
· Design optimization results
· Parametric Study results

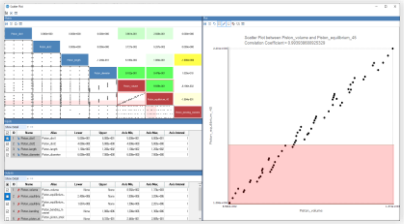
Design space exploration
· 2D exploration
· 3D exploration

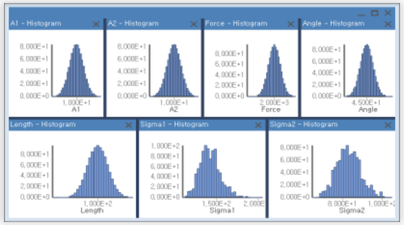
Special plot
· Parallel
· Scatter
· Radar

Uncertainty analysis
· Histogram
· PDF & CDF
· Probabilistic sensitivity
· Confidence interval
· Correlation
· General statistics
· Reliability


ANOM Plot


Smart Screening


Scatter Plot


Histogram

· · ·

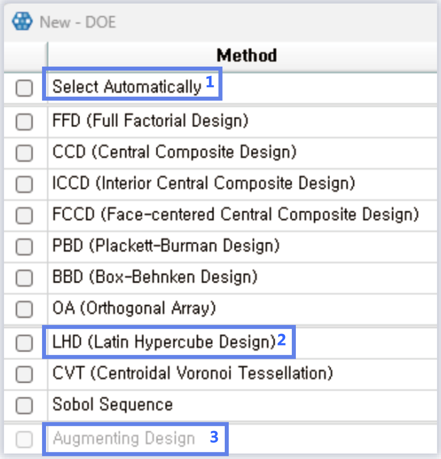
Sampler

Provides various Sampling techniques to establish Design of Experiments (DOE)

Immediate generation of sample points can be processed only with a definition of design variables, as well as addition of sample points considering space-filling properties.

1

Select Sampling techniques

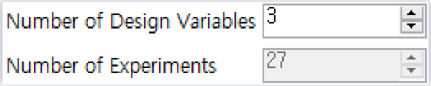


New - DOE

	Method
☐	Select Automatically [1]
☐	FFD (Full Factorial Design)
☐	CCD (Central Composite Design)
☐	ICCD (Interior Central Composite Design)
☐	FCCD (Face-centered Central Composite Design)
☐	PBD (Plackett-Burman Design)
☐	BBD (Box-Behnken Design)
☐	OA (Orthogonal Array)
☐	LHD (Latin Hypercube Design) [2]
☐	CVT (Centroidal Voronoi Tessellation)
☐	Sobol Sequence
☐	Augmenting Design [3]

2

Select the Number of Design Variables/Levels and Number of Experiments

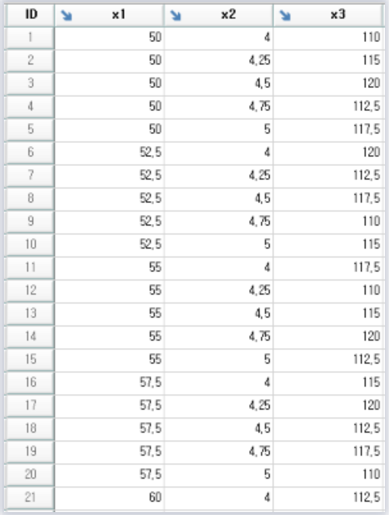


Number of Design Variables: 3

Number of Experiments: 27

3

Generate Sample points



ID	x1	x2	x3
1	50	4	110
2	50	4,25	115
3	50	4,5	120
4	50	4,75	112,5
5	50	5	117,5
6	52,5	4	120
7	52,5	4,25	112,5
8	52,5	4,5	117,5
9	52,5	4,75	110
10	52,5	5	115
11	55	4	117,5
12	55	4,25	110
13	55	4,5	115
14	55	4,75	120
15	55	5	112,5
16	57,5	4	115
17	57,5	4,25	120
18	57,5	4,5	112,5
19	57,5	4,75	117,5
20	57,5	5	110
21	60	4	112,5

[1] **Select Automatically** : Automatically selects the most appropriate sampling techniques by considering the user requirements

[2] **Bruce LHD:** Automatically selects the appropriate technique from LHD techniques provided by PIDOTECH, based on the number of design variables and sample points set by the user.

[3] **Augmenting Design** : Effectively adds sample points upon previous sample points by considering space-filling properties

NEW!

A new technique added in ver. 2025

- Added Bruce LHD, a user-friendly LHD technique: automatically selects and generates a suitable LHD technique based on user requirements.
- Included a novel Near-Optimal LHD technique developed by PIDOTECH: Cyclic LHD (CLHD)

Metamodeler

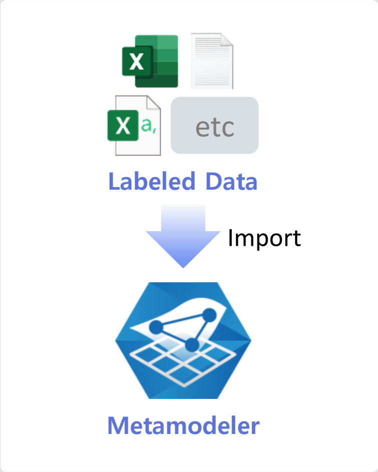
Responsible for generating metamodels with imported labeled data.

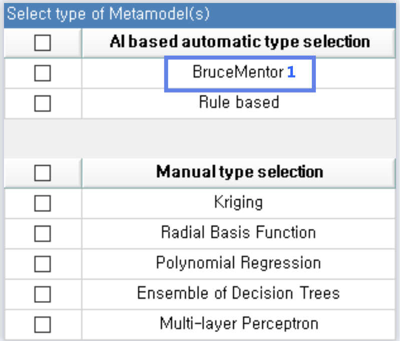
BruceMentor for Metamodeling can autonomously determine the metamodel type that is the most appropriate for the imported labeled data.

Additionally, the generated metamodel can be exported as PIAnO Composer, Executable file (MetaPredictor), and Excel formats.

Users without PIAnO License can utilize the metamodel exported as executable file and Excel formats.

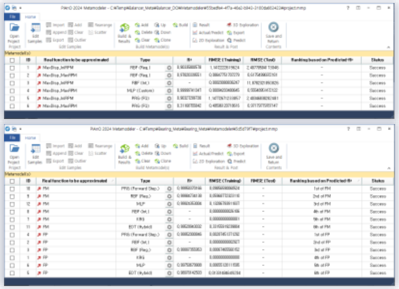
1. **Import Labeled Data**
2. **Select Metamodel Type**
3. **Generate Metamodel and predict the output variable values**
4. **Export and utilize the generated Metamodel**

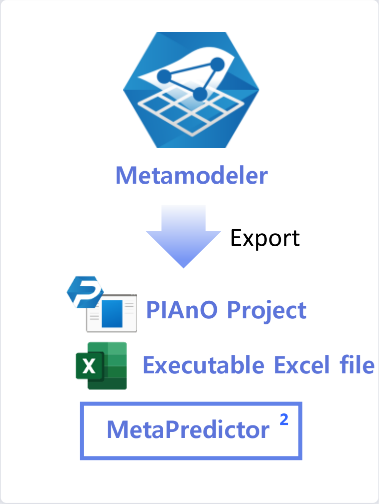




Select type of Metamodel(s)

☐	**AI based automatic type selection**
☐	BruceMentor [1]
☐	Rule based
☐	**Manual type selection**
☐	Kriging
☐	Radial Basis Function
☐	Polynomial Regression
☐	Ensemble of Decision Trees
☐	Multi-layer Perceptron





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[1] **BruceMentor (for Metamodeling)** : Autonomously select the most appropriate metamodel type

[2] **MetaPredictor** : an executable file with a separate UI that can be utilized without PIAnO License

NEW!

Enhanced performance of BruceMentor in PIAnO 2025

Applied data preprocessing techniques and data expansion compared to PIAnO 2024. →

- Reduced the duration of AI-based Metamodel recommendation by 1/5.
- 3 additional recommended metamodels (a total of 18)
- 30% Increase in the amount of training data

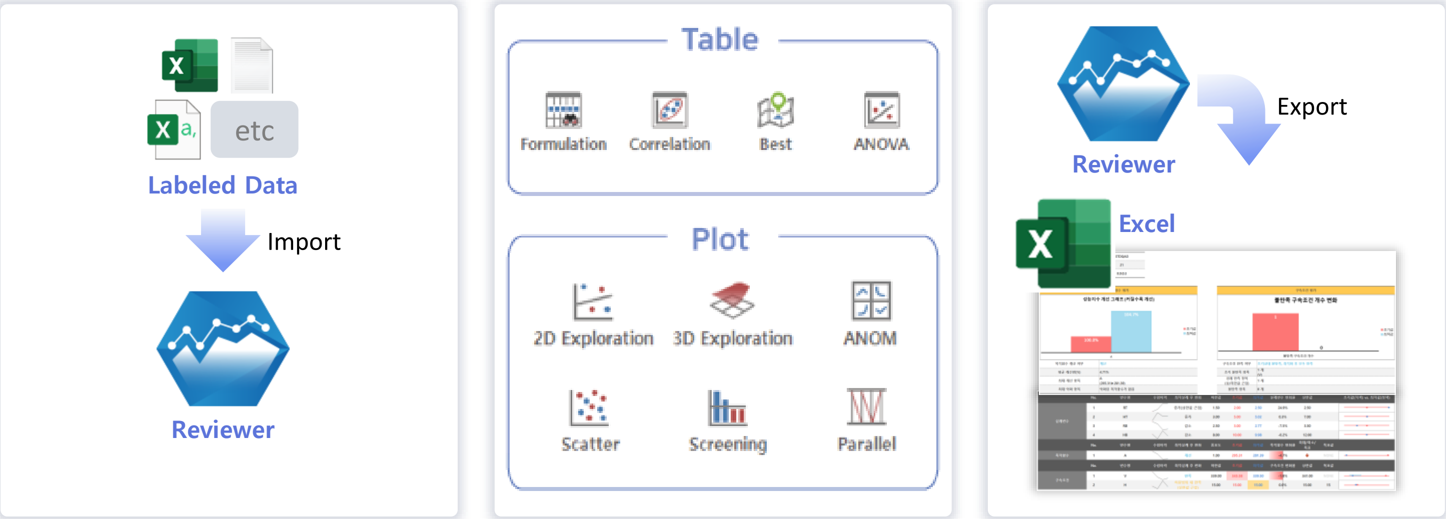
Reviewer

A Post-processer that can visualize the analysis result of the imported labeled data, responsible for exporting the report as Excel format. BruceMentor for screening can autonomously determine the analysis technique that can accurately analyze the key factors of the imported labeled data.

1 **Import Labeled Data**

2 **Data Analysis**

3 **Export Excel Report**



etc
Labeled Data
Import
Reviewer
Table
Formulation
Correlation
Best
ANOVA
Plot
2D Exploration
3D Exploration
ANOM
Scatter
Screening
Parallel
Reviewer
Export
Excel

AIDesigner sim

An AI-based autonomous optimization and data analysis software for PIAnO users.

As no prior knowledge of design optimization or data analysis is required for AIDesigner sim, anyone can easily and quickly perform optimization and generate result reports.

Composer

Analysis Process Integration and Automation

AIDesigner sim

- Design Problem Formulation
- Enter the desired accuracy of Metamodel

① Screening

Select key design variables

② Autonomous Metamodeling

Autonomous generation of metamodels based on Sequential Sampling

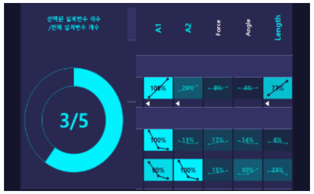
③ Optimization

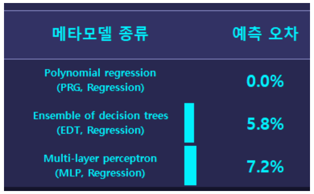
Autonomous optimization based on the generated Metamodel

④ Validation

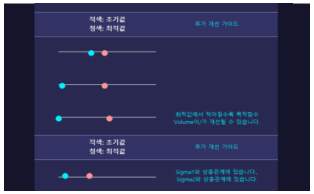
Validate the optimal design

Step-by-step execution or one-click execution (Run All) available!


선택된 설계변수 개수
/전체 설계변수 개수
3/5
A1
A2
Force
Angle
Length
100%
29%
9%
4%
77%
100%
13%
17%
14%
6%
80%
100%
15%
30%
23%



메타모델 종류	예측 오차
Polynomial regression (PRG, Regression)	0.0%
Ensemble of decision trees (EDT, Regression)	5.8%
Multi-layer perceptron (MLP, Regression)	7.2%


적색: 초기값
청색: 최적값
추가 개선 가이드
적색: 초기값
청색: 최적값
추가 개선 가이드

최적값에서 작아질수록 목적함수 Volume이/가 개선될 수 있습니다.

Sigma1와 상충관계에 있습니다.
Sigma2와 상충관계에 있습니다.

Multi-objective Optimization Result
4
3
1
500
3/3

NEW!

Improved the reporting functionality

- **Provides the report of optimal design result and design guideline using DAVIS* technology in a data-storytelling format**
  (*DAVIS: Data Analysis, Visualization and Interactive Storytelling)
- **Offers an Excel report of the analysis result in three color modes: Dark, Light, and Black & White.**

Expected Benefits of PIAnO Signature

Enhanced Usability

Enhances usability as no engineering background is required for performing Design Optimization and Data Analysis

Reduction of M/H

All procedures of the Analysis of Key design variables, Metamodeling, Optimization, Data Analysis, and Report Generation can be executed with one-click, significantly reducing M/H.

Accumulation of Know-hows

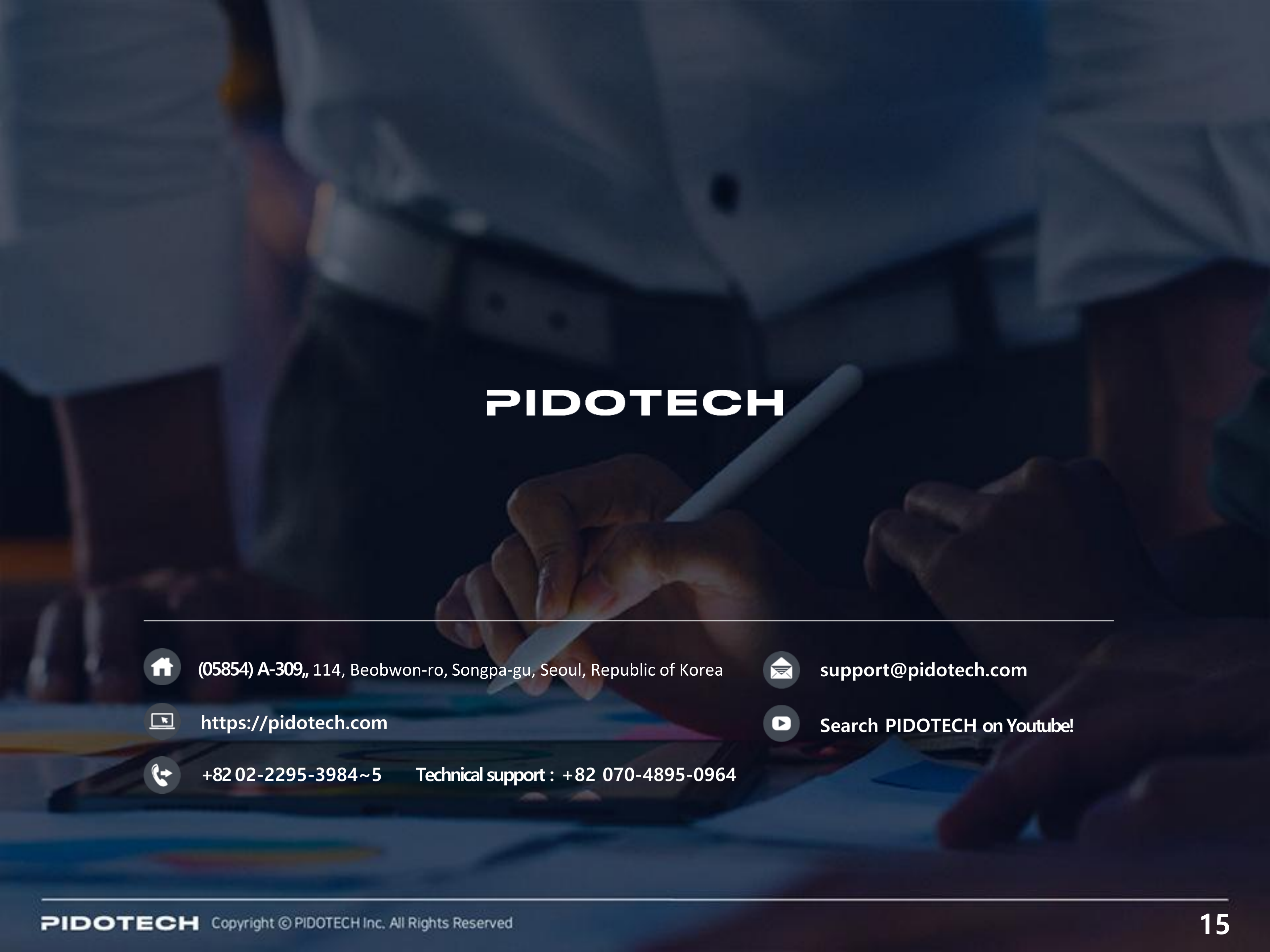
Provides design guides for data analysis and optimization result analysis, enabling the accumulation of product design knowledge.

Utilization of Engineering Data

Utilizes data accumulated from simulations or experiments to establish performance prediction and design optimization processes.

Customers

Automobile	HYUNDAI HYUNDAI TRANSYS HYUNDAI MOBIS KIA Movement that inspires SJG SEJONG KUMHO TIRE Better, All-ways
Electrical/Electronic	산업통상자원부 SAMSUNG 삼성전자 SAMSUNG 삼성전기 LG전자 hp LS ELECTRIC 녹색에너지연구원 Green Energy Institute ILJIN 일진전기
Steel	posco DaehanSteel
Construction	KICT 한국건설기술연구원
Shipbuilding/Plant	해양수산부 한화오션 KRISO HD한국조선해양 RIMS 중소조선연구원
Material	LOTTE CHEMICAL KIET boss
National defense / Aviation	국방과학연구소 Agency for Defense Development KAI 한국항공우주산업주식회사 KOREA AEROSPACE INDUSTRIES, LTD. Hanwha Aerospace
Machinery/Production	산업통상자원부 과학기술정보통신부 재단법인 경북테크노파크 GYEONGBUKTECHNOPARK KITECH KIST 한국과학기술연구원 Hanwha Power Systems
IT/SW	FunctionBay TTA ANY ANYCASTING
University	광주대학교 GWANGJU UNIVERSITY knu KU KONKUK UNIVERSITY KOOKMIN UNIVERSITY PUSAN NATIONAL UNIVERSITY 상명대학교 SANGMYUNG UNIVERSITY 서울시립대학교 UNIVERSITY OF SEOUL DCU DAEGU CATHOLIC UNIVERSITY 세종대학교 SEJONG UNIVERSITY USW 수원대학교 THE UNIVERSITY OF SUWON SUNCHON NATIONAL UNIVERSITY 연세대학교 YONSEI UNIVERSITY Yeungnam University JEONBUK NATIONAL UNIVERSITY KAIST 호남대학교 HONAM UNIVERSITY HANYANG UNIVERSITY 전남대학교 CHONNAM NATIONAL UNIVERSITY 창원대학교 CHANGWON NATIONAL UNIVERSITY 한국교통대학교 원광대학교 WONKWANG UNIVERSITY 아주대학교 GNU 경상국립대학교 Gyeongsang National University 조선대학교



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https://pidotech.com

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