A Study of Suspension Design Using Optimization Technique and DOE

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ABSTRACT

A case study of suspension design using typical double wishbone suspension model was studied and discussed. Authors developed optimization system for suspension design based on Genetic Algorithms. Sensitivities of tolerances around optimum are calculated and discussed by DOE.
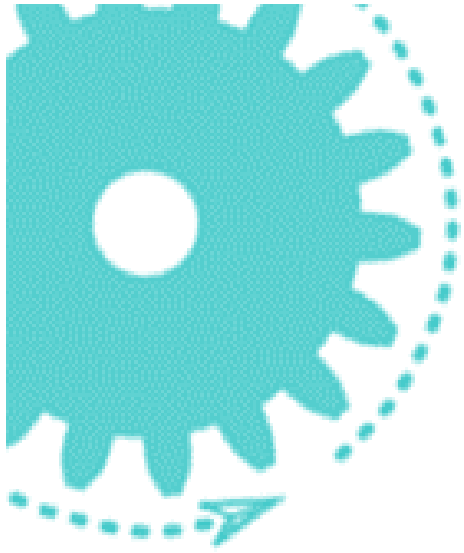
Virtual Prototyping

A Study of Suspension Design Using Optimization Technique and DOE

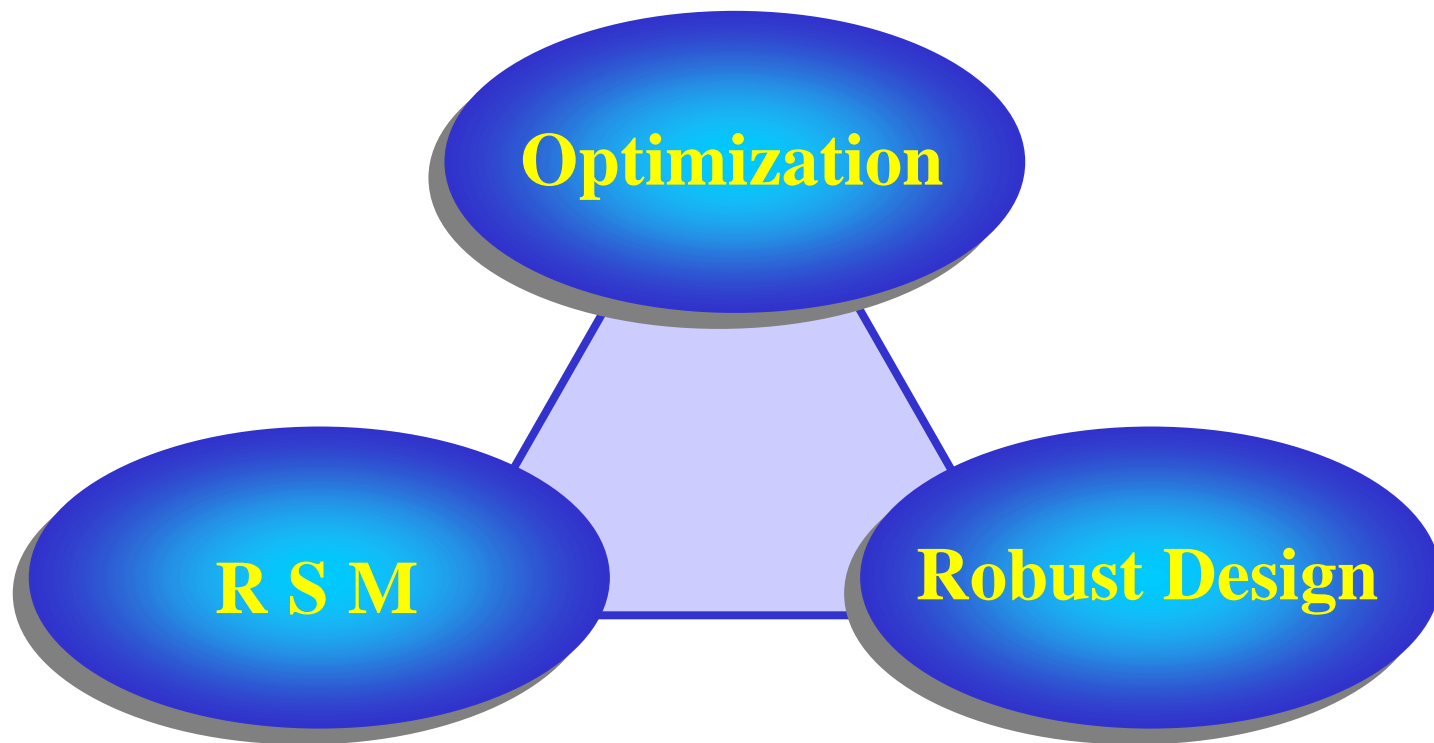*Keiichi Motoyama, MDJ*

Takashi Yamanaka, MDJ

Mechanical Dynamics

- *Started to study suspension design based on optimization since 1999.*

- *Genetic Algorithm Optimization System was proposed (1999 Europe Conference)*

- *Propose Suspension Design Support System*

Mechanical Dynamics

Design Support System

- **Component**

Optimization

R S M

Robust Design

Optimization

Component

<Sub Component>

- Genetic Algorithm
- Simulated Annealing
- Auto Calculation

Nonlinear System

<Contribution>

- Find optimum
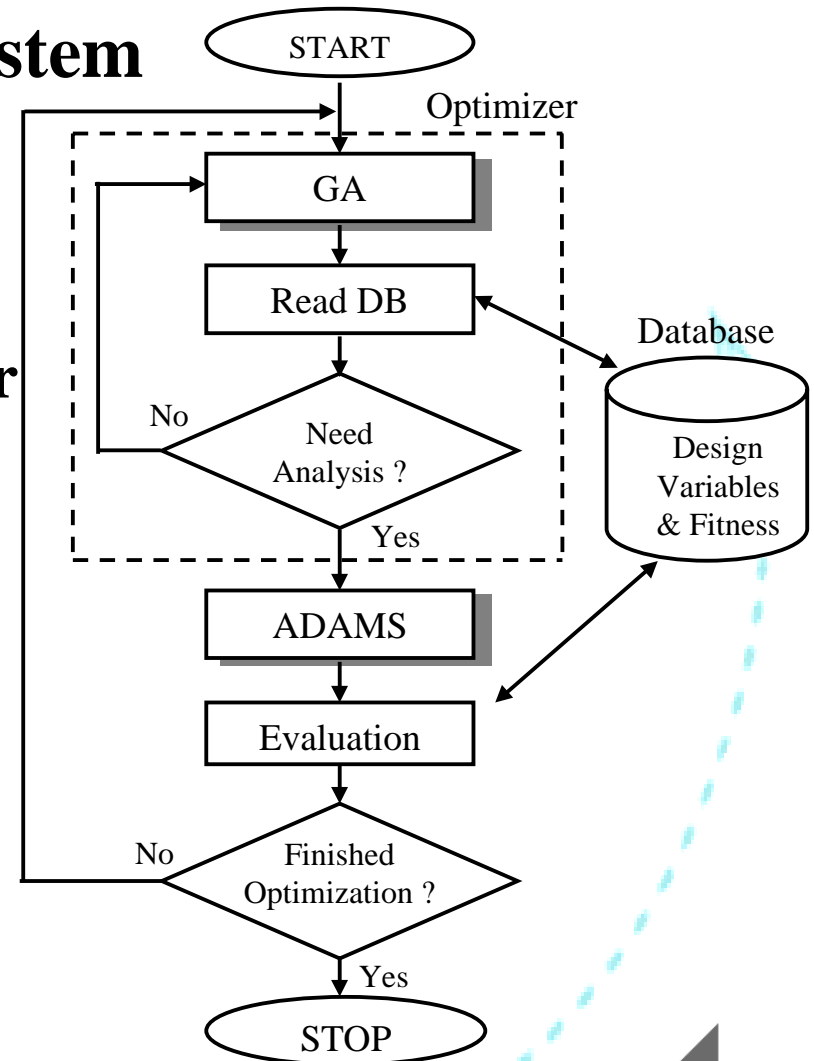- Reduce time to design
- Auto design
- Young engineer can design

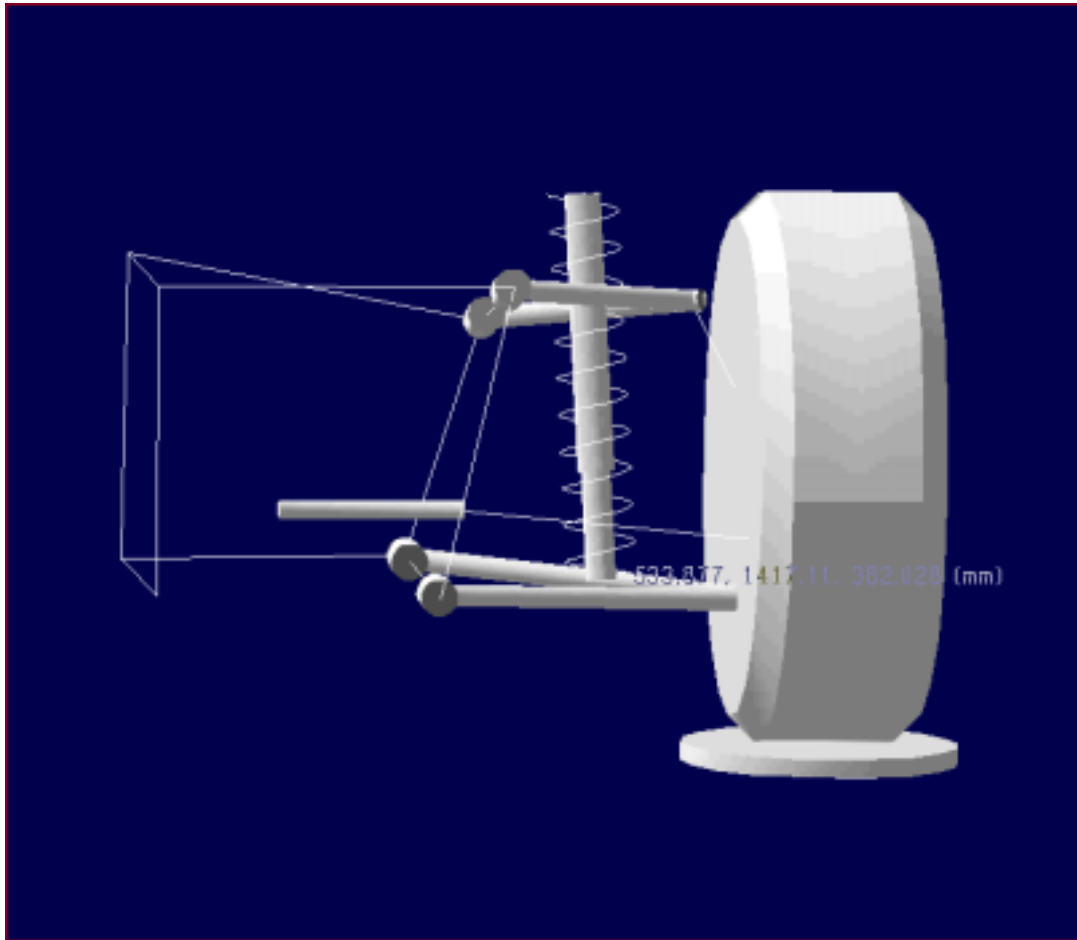**Mechanical Dynamics**

Developed Optimization System

Optimization Algorithm

- **By Genetic Algorithms (GA)**

● **Interface with ADAMS/Solver**

- **Generate ADAMS Solver file**

    using GA information

- **Evaluate the request data file**

    and save data into database

● **Skip the ADAMS simulation**

    if conducted previously

START

Optimizer

GA

Read DB

No — Need Analysis ?

Yes

Database

Design Variables & Fitness

ADAMS

Evaluation

No — Finished Optimization ?

Yes

STOP

Mechanical Dynamics

Model & Design Variables

Variable	Original	Minimum	Maximum
	307	285	330
	1285	1263	1308
	384	360	405
	337	315	360
	1311	1288	1333
	472	450	495
	384	362	407
	1330	1308	1353
	710	688	733

Stroke vs. Toe Angle
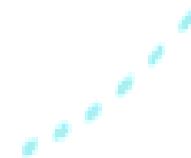
Optimized Result

Variable	ORG	OPT
X1	307	293
Y1	1285	1271
Z1	384	403
X2	337	324
Y2	1311	1331
Z2	472	463
X3	384	394
Y3	1330	1242
Z3	710	702

Optimization Result

Stroke (mm) vs Toe Angle (deg)

Legend: ORG, OPT
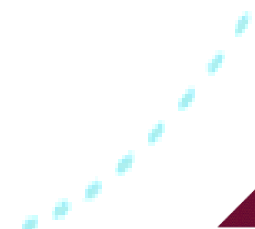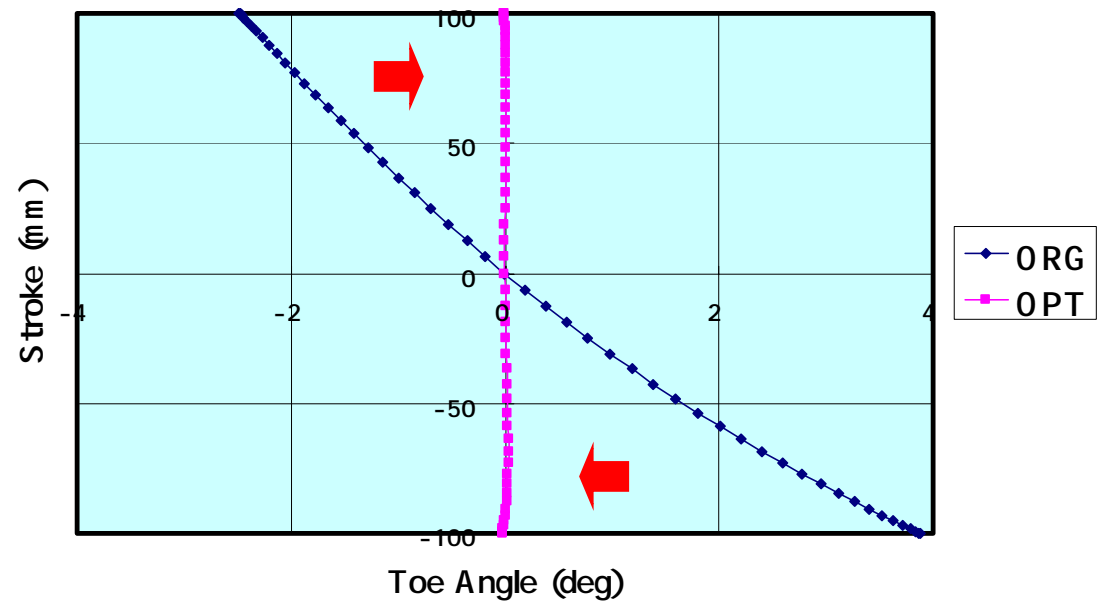
Optimized Result

Variable	ORG	OPT
X1	307	297
Y1	1285	1269
Z1	384	399
X2	337	318
Y2	1311	1315
Z2	472	474
X3	384	401
Y3	1330	1326
Z3	710	703

Optimization Result

Stroke (mm)

Toe Angle (deg)

ORG
OPT

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Component

R S M

<Sub Component>
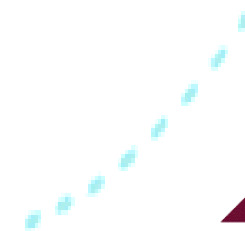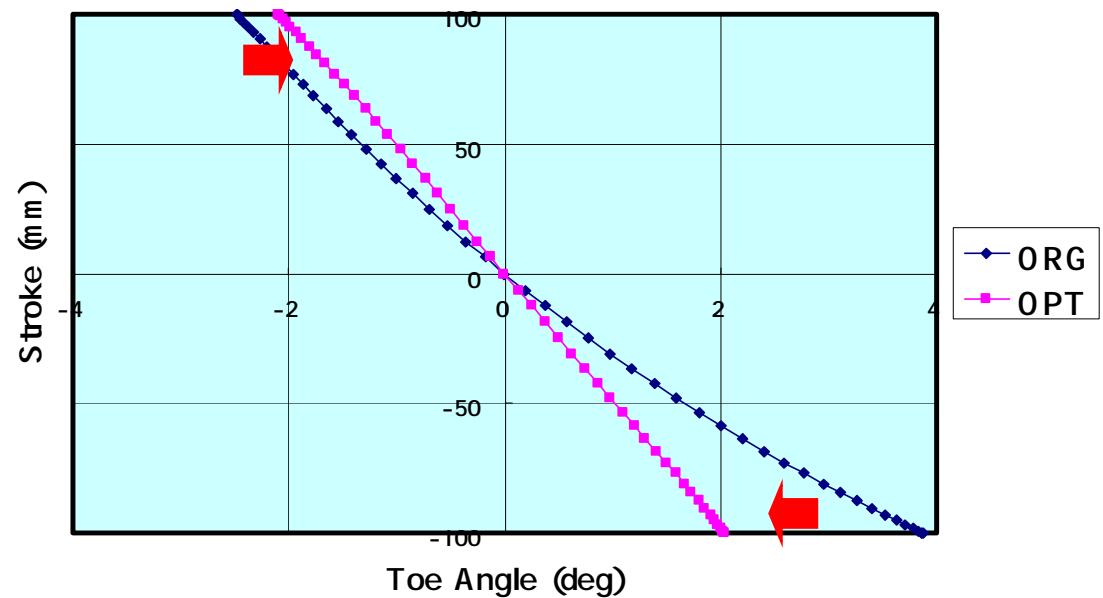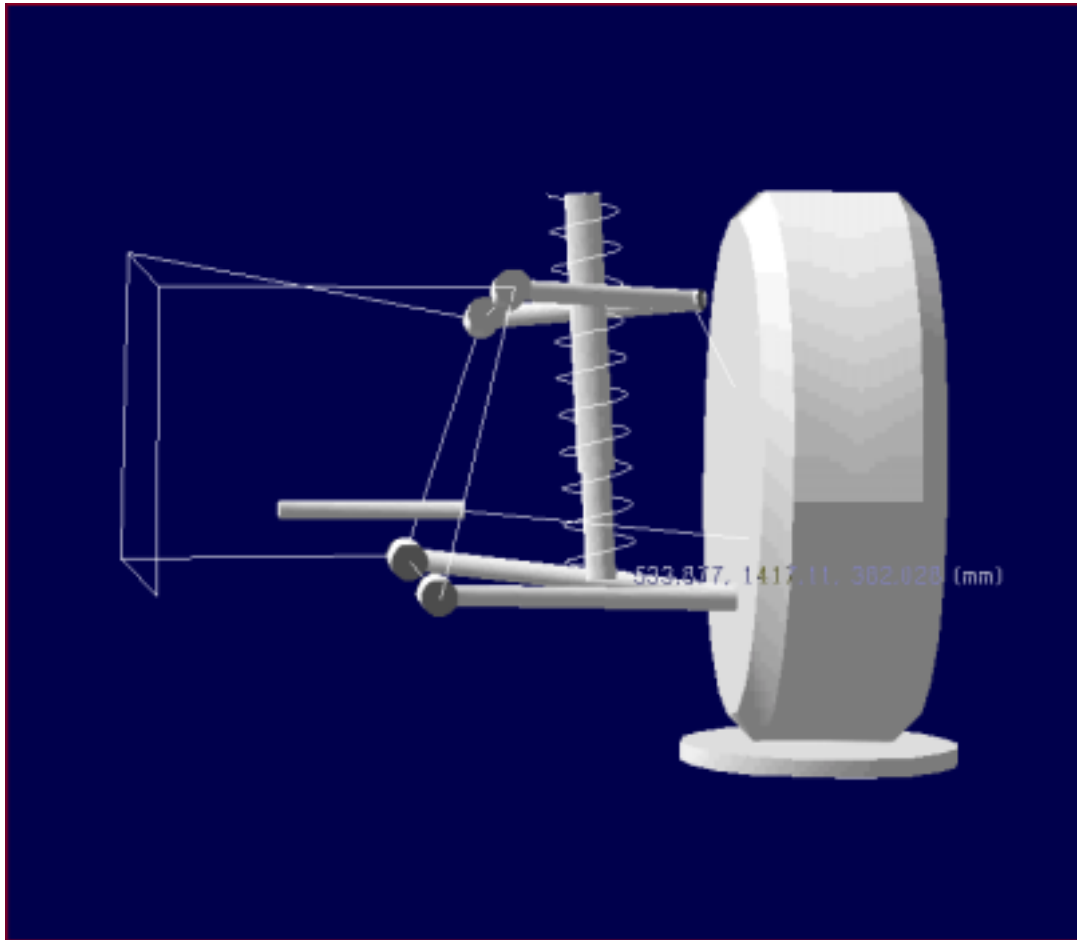
- **Random Generator**
- **QR decomposition**
- **Least Square Method**
- **MS Excel data**
- **Auto Calculation**
  - By random number
  - By orthogonal array
  - By users' data

<Contribution>

- **Reduce time to design**
- **Review design without calling ADAMS**
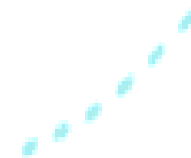- **Network discussion**

Mechanical Dynamics

Model & Design Variables   RSM

Variable	Original	Minimum	Maximum
	307	304	310
	1285	1282	1288
	384	381	387
	337	334	340
	1311	1308	1314
	472	469	475
	384	381	387
	1330	1327	1333
	710	707	713

Stroke vs. Toe

Mechanical Dynamics

Calculation for L64

Robust Design

<Sub Component>

- RSM
- Random Generator
- Optimization
- MS Excel Data
- Monte Carlo Simulation
- Auto Calculation

<Contribution>

- Discuss robustness
- Review tolerance
- Review effect of elastic deformation

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Conclusion

1) *We have developed suspension design support system that has functions of optimization, RSM and consideration of robust design.*

2) *Using this system, we can find good suspension design easily, and we can discuss the design in detail.*

3) *We will clarify the validity of this concept through further case studies and discussion with design team.*