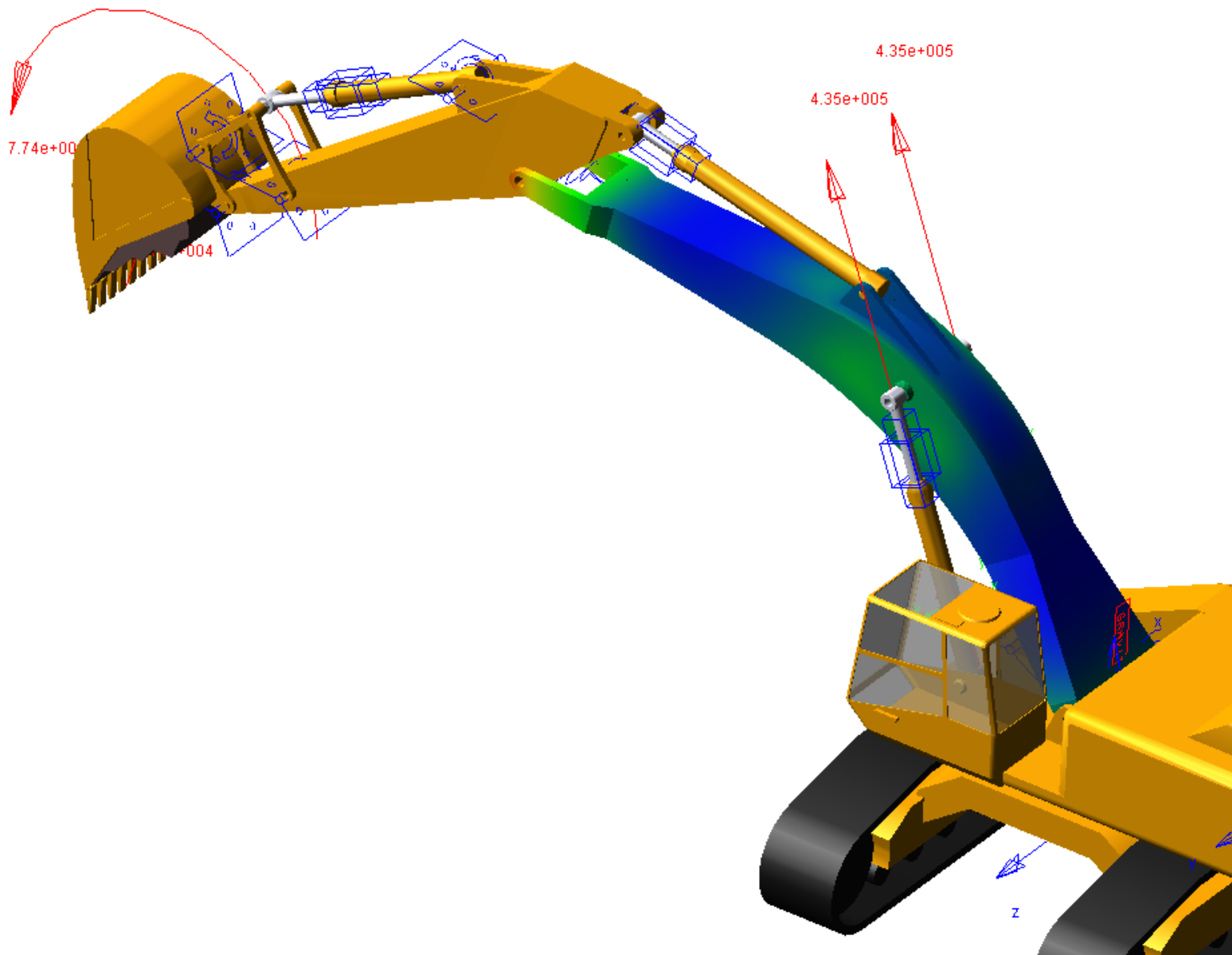


Introduction to

Mechanical System Simulation Using Adams™

James B. McConville



Visit the following websites to learn more about this book:



[amazon.com](https://www.amazon.com)

[Google books](https://books.google.com)

[BARNES & NOBLE](https://www.barnesandnoble.com)

Contents

Dedication.....	6
Introduction.....	7
The Significance of Large Motion.....	7
The Intent and Scope of This Book.....	7
Acknowledgements.....	7
An Example to Come.....	8
Elementary Adams Theory.....	9
Basic Formulations.....	9
The MBD Approach.....	9
The FEA Approach.....	10
Elementary Overview of Solution Approaches.....	10
FEA Transient Response Analysis – Explicit Integration.....	10
MBD Transient Response Analysis – Implicit Integration.....	11
Numerical ‘Stiffness’.....	13
Problem Attributes.....	14
Constitutive Considerations – Deformable vs. Non-Deformable.....	14
Rigid Components.....	14
Hookean Components.....	15
Non-Hookean Components.....	15
Special Case – Non-Linear, Body-to-Body Contact.....	15
DOF Count.....	15
System Motion (Global vs. Convecting Reference Frames).....	16
Large (Nonlinear but Still Hookean) Geometric Effects.....	17
The Pendulum in Theory.....	19
Formulating the System Equations.....	20
Energy Terms and the Lagrangian.....	20
Solving the Equations.....	25
The Gruebler Expression for a 2D Model.....	30
Addition of a Restraint.....	31
Addition of a Constraint (or reduction to ZERO DOFs).....	32
The 3D Pendulum in Adams.....	35
Free Pendulum.....	35

Restraint Added.....	38
Constraint Added	40
Comments Concerning the Adams 3D Pendulum Models.....	43
Concerning the Euler Angles	44
Some Example Problems.....	45
Example 1 – Fourbar Linkage	46
Version 1 – Redundant but Consistent Constraints	47
The Gruebler Expression for a 3D Model	49
Version 2 – Motion into a Non-Solvable State.....	50
A Joint Subtlety.....	52
Version 3 – Motion-Dependent Changes in DOF Count.....	53
Version 4 – Redundant and Inconsistent Constraints.....	55
Further Experimentation.....	60
Example 2 -- Backhoe Excavator	61
Comments on System Locations.....	61
Model Components.....	62
Total Model Aggregate Mass Computation	79
Model Connectivity (Gruebler Count)	79
Bucket Load Modeling.....	82
Bucket Cutting Forces.....	83
Bucket Load Mass Accretion	84
Bucket Load Dump	85
Post-Dump DIRT-to-Ground force	86
Model Variation During Execution Using the Adams (ACF) Command File	86
Boom Reaction Force Reporting.....	87
Conversion to Flexible Boom	87
Boom Structure Flex Content.....	89
Flexible/Rigid Results Comparison	92
Excavator Results – Comments.....	96
Possible Further Excavator Model Enhancements.....	96
Example 3 -- Automotive Differential (Adams/Machinery Model).....	97
Problem Definition	98
Determination of Wheel Loads.....	98

The Differential Model Elements	99
The UDE Gear Set	99
Some UDE Considerations	108
Mechanism Constraints – Intrinsic	111
Mechanism Constraints – Applied Loading	112
Mechanism Restraints – Applied Loading	114
Differential Model Gruebler Count	114
Differential Model Results	115
Differential Model Results – Comments	118
Some Further Notes on Adams Solvers	119
Solver Options	119
GSTIFF	120
WSTIFF	120
CONSTANT_BDF	120
ABAM	120
RKF45	120
HHT	121
Newmark	121
HASTIFF	121
Index Options	121
Index 3 (I3)	121
Stabilized Index 2 (SI2)	121
Stabilized Index 1 (SI1)	121
Corrector Options	121
Error	122
HINIT	122
HMAX	122
HMIN	122
INTERPOLATE	122
KMAX	122
PATTERN	122
CORRECTOR = original	122
CORRECTOR = modified	123

The Adams 3D Pendulum ... Revisited	123
Some Historical Successes.....	124
Concluding Comments	128
Appendix I – Principal Adams Modeling Elements	129
Body Types.....	129
PART.....	129
POINT MASS	130
FLEXBODY	130
General Requirements	130
Restraints (Force-Based Modeling Entities)	131
GFORCE	131
VFORCE	132
VTORQUE.....	132
SFORCE.....	132
ACTION/REACTION SFORCE – TRANSLATION.....	133
ACTION/REACTION SFORCE – ROTATION.....	133
ACTION-ONLY SFORCE – TRANSLATION	134
ACTION-ONLY SFORCE – ROTATION	135
BUSHING.....	137
SPRINGDAMPER	138
BEAM	138
FIELD	140
NFORCE	140
TIRE	140
CONTACT.....	140
Constraint Types.....	141
JOINTs	141
JPRIMs.....	143
GEAR	145
COUPLER.....	145
GCONs.....	145
User-Defined Elements	145
VARIABLE (Algebraic)	146

DIFF	146
Function Expressions	146
Special Elements	148
SENSOR	148
LSE (Linear State Equation)	148
GSE (Generalized State Equation)	148
References	148