OPTIMIZATION SYSTEMS ASSOCIATES:
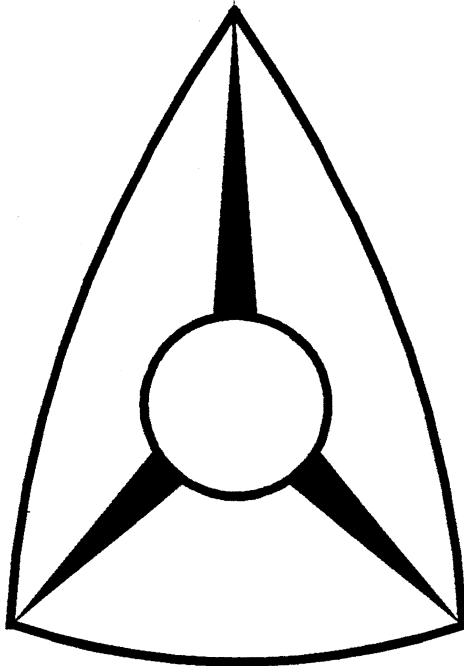**THE FIRST DECADE**

John W. Bandler

OSA-93-OS-6-V

April 27, 1993

OPTIMIZATION SYSTEMS ASSOCIATES:
THE FIRST DECADE

John W. Bandler

Optimization Systems Associates Inc.
P.O. Box 8083, Dundas, Ontario
Canada L9H 5E7

Optimization Systems Associates Inc.

PIONEERS IN

yield and tolerance optimization

circuit performance optimization

parametric design centering

statistical device modeling

robust parameter extraction

harmonic balance simulation

physics based design

EM based design

large-scale optimization

benchmark CAD technology

software architecture for ICs

Optimization Systems Associates Inc.

serving the microwave industry's demand for user-friendly,
state-of-the-art software since 1983

dedication to research insures OSA's customers
rank at the leading edge of microwave circuit design

mathematically optimized microwave CAD algorithms
are unsurpassed in speed and reliability

optimization systems, integrated/interfaced with advanced
circuit simulators

designed to customer specifications

MMIC/CAD Initiatives 1985-89

worked with Raytheon to develop a design methodology for predictable, cost effective microwave CAD with tolerances

enhancements to Super-Compact®/Microwave Harmonica

contributed MIMIC/CAD technology to the Raytheon/ Texas Instruments Joint Venture under the US DoD's MIMIC Program, Phase 1

software architectures for tolerance- and yield- driven design of linear and nonlinear MMIC circuits

CAD methodologies for wafer/chip yield enhancement

Areas of Expertise

RF/microwave circuit simulation, design and optimization

harmonic balance simulation techniques

robust and statistical modeling of active and passive devices

automated processing of DC, RF and spectrum data

device modeling, statistical estimation of production yield

powerful performance and yield optimization algorithms

manufacturing tolerance assignment and cost minimization

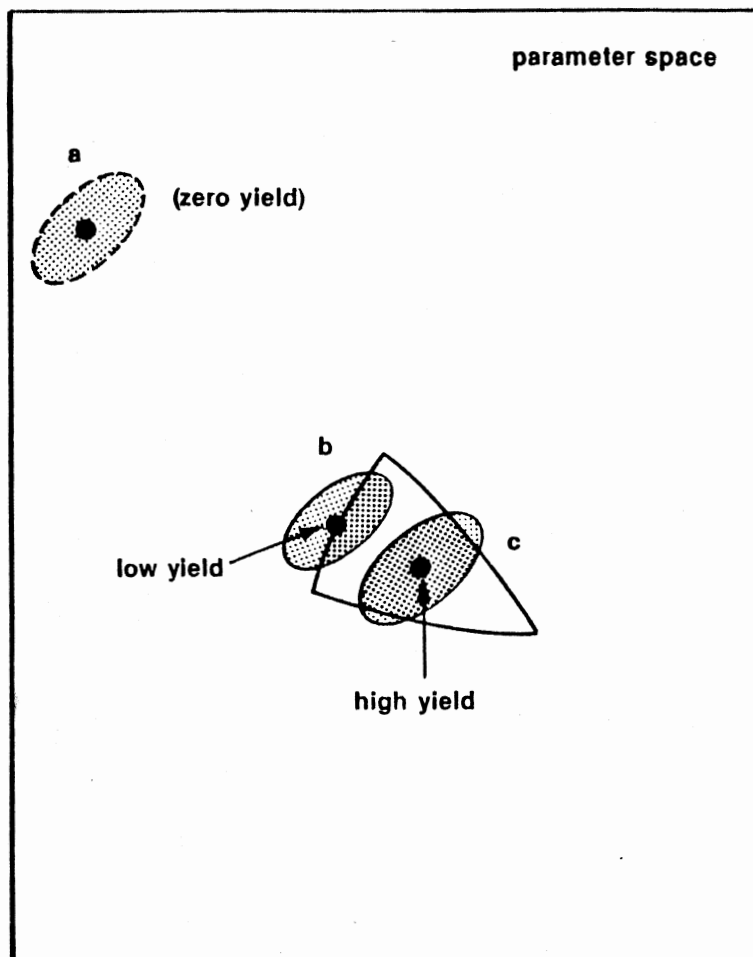customized optimizers for large-scale problems

computer optimization of linear and nonlinear networks

algorithms for automated production alignment and tuning

software architectures for integrated approach to design

Yield interpretation in the parameter space

Milestones I

computerized Smith chart plots (1966)

performance-driven optimization (1968)

adjoint sensitivities (1970)

cost-driven worst-case design with optimized tolerances (1972)

centering, tolerance assignment integrated with tuning at the design stage (1974)

integrated approach to microwave design with tolerances and uncertainties (1975)

yield-driven optimization for general statistical distributions (1976)

new results for cascaded circuits (1978)

Milestones II

optimal tuning and alignment at the production stage (1980)

fault diagnosis and parameter extraction (1980)

world's fastest multiplexer optimizer (1984)

introduction of powerful minimax optimizers into commercial CAD/CAE products (1985)

large-scale microwave optimization (1986)

foundation of multi-circuit ℓ_1 modeling (1986)

world's first yield-driven design for Super-Compact® (1987)

computational enhancements of commercial CAD/CAE products (1988)

parameter extraction using novel large-scale concepts (1988)

Milestones III

nonlinear adjoint (harmonic balance) exact sensitivities (1988)

RoMPE™, world's first commercial product for FET parameter extraction featuring S-parameters and/or DC data (1988)

yield-driven design of nonlinear microwave circuits (1989)

FAST™, novel technique for high-speed nonlinear sensitivities (1989)

efficient large-signal FET parameter extraction using harmonics (1989)

HarPE™, world's first commercial product for harmonic balance driven FET parameter extraction (1989)

combined discrete/normal statistical modeling of active devices (1989)

Milestones IV

efficient quadratic approximation for statistical design (1989)

nonlinear circuit optimization with dynamically integrated physical device models (1990)

analytically unified DC/small-signal/large-signal circuit design (1990)

OSA90™, world's first friendly optimization engine for performance- and yield-driven design (1990)

Datapipe™ Technology, OSA90's interprocess communication system (1990)

OSA90/hope™, the microwave and RF harmonic optimization system (1991)

design optimization with external simulators, circuit-theoretic and field-theoretic (1991)

Milestones V

statistical modeling of GaAs MESFETs (1991)

gradient quadratic approximation for yield optimization
(1991)

physics-based design and yield optimization of MMICs
(1991)

Spicepipe™ connection of OSA90/hope™ with Zuberek's
SPICE-PAC simulator (1992)

Empipe™ connection of OSA90/hope™ with Sonnet's *em*™
field simulator (1992)

predictable yield-driven circuit optimization (1992)

integrated physics-oriented statistical modeling, simulation
and optimization (1992)

Datapipe™ connection of OSA90/hope™ with Hoefer's
TLM electromagnetic field simulators (1993)

Milestones VI

Datapipe™ connection of OSA90/hope™ with
Nakhla/Zhang VLSI interconnect simulators (1993)

microstrip filter design using direct EM field simulation
(1993)

yield-driven direct electromagnetic optimization (1993)

robustizing modeling and design using Huber functions
(1993)

Optimization Systems Associates Inc.

Super-Compact® Enhancements by OSA

new sparse simulator, internal nodal voltages

fast quasi-Newton gradient optimizer

powerful minimax optimizer

yield-driven design optimization

window-driven design

approximations for fast yield evaluations

generalized least pth objective

new Super-Compact statistical analyzer

new input file syntax for statistics

new user-friendly input file features

new features at the command level

improved numerical accuracy

improved handling of parameter constraints

Super-Compact®/Microwave Harmonica™ Enhancements by OSA

software interface linking Super-Compact with Microwave Harmonica

full Microwave Harmonica functionality exploiting Super-Compact simulation

Super-Compact style input file description for nonlinear circuits

Super-Compact library of elements available for harmonic balance analysis

RoMPE™ (Robust Model Parameter Extractor)

first release in 1988

novel, multi-bias modeling theory

simultaneous or separate AC and DC matching

powerful ℓ_1 and ℓ_2 optimizers

exact adjoint sensitivities

nonlinear Materka and Kacprzak model

enhanced model parameter reliability

graphics display of I-V curves

frequency-domain S-parameter plots

versatile, user-friendly input file

on-line screen editor

menu-driven interaction

high resolution graphics

Optimization Systems Associates Inc.

HarPE™ Harmonic Balance Parameter Extractor
and Device Simulator

FEATURES OF THE FIRST RELEASE (1989)

world's first software system exploiting harmonic data for
FET device modeling and parameter extraction

accepts power spectrum, waveform, small-signal S-parameter
and/or DC measurements

extracts large- and small-signal model parameters

optimally matches and compares responses of user-described
models and/or measurements at DC,
fundamental frequency and higher harmonics

accommodates multi-bias, multi-frequency and multi-input-
power level data

features a user-friendly input file syntax and high-quality
graphics

HarPE™ <u>Har</u>monic Balance <u>P</u>arameter <u>E</u>xtractor
and Device Simulator (cont.)

versatile math expression generation for model exploration

creates device models consistent with those in Libra and
Microwave Harmonica

output can be directly pasted into the input files of Libra or
Microwave Harmonica

available on the Apollo workstations

Optimization Systems Associates Inc.

Selected Users of OSA Technology

ComDev

Compact Software

EEsof

Raytheon

TRW

Siemens

CRC

British Telecom

French Telecom

MIT Lincoln Labs

COMSAT