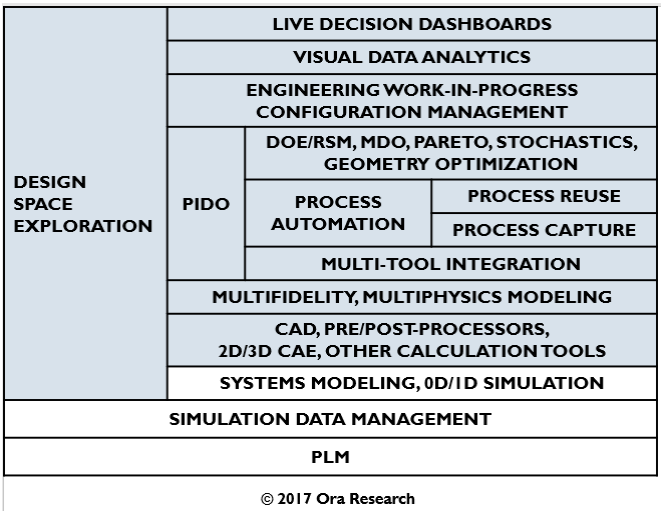
DESIGN SPACE EXPLORATION MARKETS & OPPORTUNITIES

TECHNOLOGY DRIVERS • BUSINESS DRIVERS • JUSTIFYING THE INVESTMENT • IMPLEMENTATION BEST PRACTICES • PRACTITIONER SUCCESS CASE STUDIES • MARKET STATISTICS AND FORECASTS • VENDOR AND PRODUCT PROFILES

A report for engineering and discrete manufacturing organizations, engineering modeling and simulation software developers, engineering service providers, methods development experts, systems integrators, resellers, investors and anyone else who needs to understand technology drivers, business drivers, investment justification strategies and implementation best practices for Design Space Exploration technologies and methods; software market size and composition, vendor market share and industry growth forecasts; and in-depth business assessments plus product profiles for 38 leading technology providers.

BACKGROUND AND PURPOSE—The most successful engineering projects begin with discovery—conceiving a rich array of ideas to solve a problem or address a need—then move on to methodically explore which candidates are most promising for development and refinement. But the power of such discovery and exploration is too often sacrificed to schedule pressures and resource constraints, compounded by digital toolset gaps and limitations. The result is familiar: engineers conceive two or three design alternatives, then rely on intuition, best guesses and handbook formulas to choose one that looks reasonably promising and not too risky to implement—without really knowing whether it's the best, most cost-effective or most robust solution attainable.

An emerging answer to this quandary is Design Space Exploration—both a family of methods and a rapidly evolving category of software tools that are beginning to radically advance the capabilities of engineers and multidisciplinary engineering teams to discover an array of feasible design concepts early; quickly and fluently evaluate sensitivities, variants and tradeoffs; then select the best design candidate and implement it.



WHAT'S NEW? WHY NOW? TECHNOLOGY AND BUSINESS DRIVERS—Design Space Exploration lets engineers systematically and automatically investigate very large numbers of design alternatives to identify those with the most promising performance values. Many of the quantitative methods that underpin Design Space Exploration have been long known—and sometimes applied, in cases where the attendant costs in expertise, time and labor could be justified. What's changing now is the way fresh software technologies are at last transforming these powerful but formerly difficult-to-apply methods into practical everyday engineering aids.

Design Space Exploration is defined by Ora Research and intrinSIM to consist of software application products providing one or more of the functional capabilities listed below either as standalone software products, or software modules that can be used as part of a larger suite of software from the software developer and/or its partners.

- Design of experiments
- Response surface modeling and interrogation
- Parameter optimization
- Multidisciplinary optimization
- Multi-objective (Pareto) optimization
- Robustness and reliability (stochastic) optimization
- Geometry optimization (including parametric, non-parametric topology-based, and non-parametric mesh-morphing-based methods)
    - Shape
    - Size
    - Topology
    - Topography
    - Topometry
    - All other types
- Software work-process automation specifically in support of the above functionality: Definition/mapping/setup and editing of automated workflow with engineering modeling/simulation software such as geometry modelers, analysis solvers, materials databases, spreadsheets and other engineering calculation tools.

Design Space Exploration specifically does not include:

- Engineering modeling/simulation software tools (geometry modelers, analysis solvers, materials databases, spreadsheets, other engineering calculation software) that do not contain, onboard, the design space exploration functionalities listed above
- General-purpose simulation process management software
- General-purpose simulation data management software
- Software customization and custom software development

The foundational business value of Design Space Exploration is the ability it confers on engineering teams and organizations to gain more complete, higher-fidelity visibility into product performance earlier in project schedules than was possible or practical with older technologies and approaches. In essence, it does this by enabling more efficient, effective and revealing application of simulation, analysis and digital prototyping assets—tools, expertise, methods, work processes—to the perennial business drivers for any organization's investments in those assets:

- To become more competitive by gaining increased capability to explore, create and **innovate.**
- To apply that capability to create better **performing** products.
- To improve product **quality** and **reliability**—yielding expanded opportunity and customer appeal at the same time as lowered warranty expenses, liability exposure and lifecycle costs.
- To control or, better yet, reduce product development **schedules** and **budgets** by supplanting costly, time-intensive physical testing with digital prototyping.

Ultimately, the transformational advantage of Design Space Exploration is to **replace intuition-based, guess-and-correct engineering practices with systematic, rational, rapid design discovery and evaluation.**

Design Space Exploration and its companion, simulation process automation, are rooted in the technological domain known as PIDO—Process Integration and Design Optimization. One of this report's authors (Bruce Jenkins) originated the identification of PIDO as a distinct and significant segment of engineering software at the beginning of its development, and coined the terminology. Now this new publication, tracing the path from the first rudimentary PIDO tools of two decades ago to the stunningly powerful, intelligent, self-directed multidisciplinary design exploration technologies of today, offers the first comprehensive survey, review and analysis of this dynamic industry and the revolutionary benefits it offers engineering organizations. Spotlighting and exploring the latest advances, this groundbreaking report documents how these powerful tools and methods are helping engineering organizations master the unprecedentedly demanding, complex product development and innovation challenges of today and tomorrow.

CONTENTS—What you'll learn from this report:

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WHO WE ARE

Ora Research investigates new technologies that foster innovation, quality and performance and reduce schedule, cost and risk in the engineering of manufactured products and constructed assets. We seek to identify technologies yielding high return for initial adopters and on the cusp of first-wave mainstream acceptance. We offer research and advisory services to help engineering organizations evaluate, select and justify new technology investments; to help technology providers qualify and quantify emerging market opportunities, validate demand drivers and craft competitive positioning; and to give institutional investors insight into industry competitive dynamics, revenue and growth potential, and emerging market opportunities for technology providers. Our goal is to foster insight and action that strengthen the industries we serve.

Ora Research LLC was founded in 2008 by Bruce Jenkins. Before founding Ora Research LLC, Jenkins was president of research and co-founder of 3D imaging industry research firm Spar Point Research LLC (now Spar Point Group, Diversified Communications). Previously he directed research and publishing operations at CAD/CAM/CAE, AECO and GIS consultancy Daratech, Inc., where he originated the identification and definition of PIDO as a distinct and significant category of engineering software technology in 2001, and coined the terminology.

intrinSIM—After over 30 years of experience in various roles from applications to executive management in the engineering software market, Joe Walsh realized that the biggest obstacle to growth of this market and its participants was overcoming the gaps and incompatibilities between business, route to market and technology. intrinSIM was launched in January 2010 to accelerate the growth of the engineering software market by leveraging a unique technology broker model and a world class set of technology partners.

intrinSIM in its short history has already worked with over 100 companies spread across the world in the engineering software market in a variety of roles and activities related to Connecting Worldwide Business & Technology. intrinSIM leverages a unique technology broker model, engineering software market domain knowledge and an extensive network of technology partners, services partners and resources to bring the right people, services, and technologies to bear at the right time to meet the individual needs of its clients to overcome the gaps and incompatibilities between business, route to market and technology.