Numetrics R&D Analytics

Introduction
There are many questions that can be answered by leveraging analytics in R&D and project planning.

<table>
<thead>
<tr>
<th>Examples of questions analytics can help with</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Predictability &amp; planning</strong></td>
</tr>
<tr>
<td>▪ <strong>Project planning</strong> – How can we have better predictability on duration, resources and cost for new projects?</td>
</tr>
<tr>
<td>▪ <strong>Portfolio planning</strong> – How can we best manage the portfolio and optimize our R&amp;D spend?</td>
</tr>
<tr>
<td>▪ <strong>Resource allocation</strong> – How can we ensure optimal staffing and avoid resource bottlenecks?</td>
</tr>
<tr>
<td>▪ <strong>Risk management</strong> – How can we identify execution risk and early on and minimize costly schedule slips?</td>
</tr>
<tr>
<td>▪ <strong>What-if analysis</strong> – What are the cost/resources/schedule trade-offs for different project plans and scenarios?</td>
</tr>
<tr>
<td><strong>Performance improvement</strong></td>
</tr>
<tr>
<td>▪ <strong>Performance benchmark and root cause analysis</strong> – How does our performance vary internally? How does it compare to peers and what best practices should we adopt?</td>
</tr>
<tr>
<td>▪ <strong>Improvement tracking</strong> – How well are our improvement initiatives (e.g. Agile transformation, complexity reduction, etc.) working?</td>
</tr>
<tr>
<td>▪ <strong>Informed operational decisions</strong> – Is our outsourcing strategy working? Is our footprint harming productivity? How can we identify best practices across BUs?</td>
</tr>
</tbody>
</table>
Numetrics offer analytic solutions, applicable to embedded SW, semiconductor IC and application SW development

**What is Numetrics?**

**SaaS-based** R&D predictive analytics platform based on a patented complexity algorithm to provide:

- **Performance benchmarking**
- **Root cause analysis**
- **Project planning**

**Where can Numetrics be applied?**

- **Software (Embedded and application):**
  - **Verticals:** Automotive, Telecom, Financial, Medical devices, Industrial controls, Aerospace & Defense, etc.
  - **OS:** Android, IOS, Linux, Microsoft, Wind River, TI, etc.
  - **Platforms:** ARM, MIPS, Broadcom, Freescale, IBM, Microchip, Renesas, Samsung

- **Semiconductors (ICs):** Across segments, including Analog, Mixed signal, Memory, SOC, FPGA, IP, RF
Numetrics leverages advanced and predictive analytics to enable step-function improvements in R&D performance and project predictability.

**Performance benchmarking**
Measure performance and benchmark against industry peers.

**Root cause analysis**
Use analytics to find causes and drivers of low performance.

**Project planning & risk assessment**
Provide an accurate estimation of time and resources required.

1 R&D Capacity is measured as “complexity units per person-week”
2 Schedule Slip is the amount of schedule overrun, expressed as a % of the original schedule. (e.g. if a 100-week project slips 12 weeks, then schedule slip = 12%)
Performance benchmarking – Creates a productivity baseline to enable internal and industry benchmarking

Create a project-level productivity baseline based on recent projects, and benchmark across multiple dimensions against a database of ~2,000 IC and 1,700+ SW projects

Sample outputs

Project duration Vs. Design complexity

Productivity Vs. Team size
Performance benchmarking – Wide range of metrics can be benchmarked

- **How fast can we deliver SW?**
  - Duration vs. Complexity

- **How many people do we need?**
  - Team Size vs. Complexity

- **How efficient are we?**
  - Productivity vs. Team Size

- **Is our verification strategy effective?**
  - Residual vs Design Defects

- **How granular are our requirements?**
  - Tests/Requirement vs. LOC/Requirement

- **How cost competitive are we?**
  - Cost efficiency vs. Productivity

**SOURCE:** Numetrics SW project database

---

NOT EXHAUSTIVE

- Client Software Projects
- Band containing 50% of industry peers
Root cause analysis – Analyzes industry database and best practices to identify likely causes of low productivity

Root cause analysis

Use analytic tools to find root causes and drivers of low performance, and compare to industry best practices to determine recommended course of action

Sample outputs

Poor spec stability caused significant schedule slip

<table>
<thead>
<tr>
<th>Specification stability</th>
<th>Low</th>
<th>Average</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schedule slip</td>
<td>N=10</td>
<td>N=6</td>
<td>N=7</td>
</tr>
<tr>
<td>Percent over plan</td>
<td>53%</td>
<td>32%</td>
<td>20%</td>
</tr>
</tbody>
</table>

Insufficient effort during design phase caused higher test effort

- Client projects
- Industry Best-in-Class

<table>
<thead>
<tr>
<th>Role</th>
<th>Mngmt</th>
<th>Req</th>
<th>Design</th>
<th>Coding</th>
<th>Test</th>
<th>Docum-ent</th>
</tr>
</thead>
<tbody>
<tr>
<td>% of total effort</td>
<td>8</td>
<td>4</td>
<td>4</td>
<td>10</td>
<td>15</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>29</td>
<td>29</td>
<td>30</td>
<td>42</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>10</td>
<td>15</td>
<td>15</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

-67% +75%
Project planning – Predictive analytics used to generate robust project plans and identify time-to-market risks

Project planning and risk assessment

Use predictive analytics to provide better transparency to schedule and required resources at the project’s outset and assess schedule risk due to unrealistic productivity assumptions

Sample outputs

**Predicted staffing requirements by role and project phase**

**Schedule risk due to unrealistic productivity assumption**

Unrealistic productivity assumed for new project
Project planning – predictive analytics is used to optimize schedule and staffing at the project and portfolio levels

“What-if” scenarios to determine tradeoffs and optimize the plan

- Planned staffing plan is plotted against the predicted resource requirements to identify gaps
- “What-if” scenarios can be run to better understand tradeoffs between specifications, resources, budget and timeline, and to determine the optimal plan for the project

Analytics on required staffing and available resources across multiple projects

- Estimated staffing requirements by role and project phase across multiple projects is compared to available resources
- Resource gaps and bottlenecks are identified early on with plenty of time to adjust staffing levels, modify scope or reprioritize projects
Benchmarking and root cause analysis require project data and timelines of several completed projects

<table>
<thead>
<tr>
<th>Activities</th>
<th>Data collection</th>
<th>Complexity and Performance calculation</th>
<th>Benchmarking</th>
<th>Root cause analysis and recommendations</th>
</tr>
</thead>
</table>
|            | Identify projects and data providers (often a project/program leader who solicits input from internal project records, architects or developers) | Numetrics calculates complexity and performance metrics, such as:  
- Design complexity  
- Total duration and phase durations  
- Total effort and phase effort  
- Schedule slip  
- Development productivity  
- Development throughput  
- Cost per complexity unit and total cost  
- Reuse and reuse leverage | Numetrics identifies a peer group of projects, as similar as possible to client projects  
- Client performance is compared to the peer group, differences are highlighted using a variety of analytic tools and techniques including:  
  - XY scatter plots  
  - Radar charts  
  - Tabular data  
  - Phase charts  
  - Histograms | Analytic tools search for root causes for areas of high and low performance (identify drivers of performance)  
- Use best in class practices to determine recommended course of action  
- Share results and discuss implications and opportunities for improvement |
|            | Training on the input requirements (2 hours Webex or on-site) | | | |
|            | Start-up workshop: on-site, individual or group (3-4 hours) | | | |
|            | Collect data, including:  
  - Project milestones and staffing history  
  - Features / use cases  
  - Team description, tools and methodology, specification changes, and defects data | | | |

Initial effort from client is approx. 5-6 hours per project
Numetrics’ predictive analytics can help optimize project planning and timely execution

### Schedule & Resource Estimation

- **Baseline performance**
  - Past performance across a range of projects is assessed to build a performance baseline for the organization

- **Input project data**
  - New project characteristics (e.g., # features, re-use, platform) and constraints (e.g. resources) are captured

- **Calculate complexity**
  - Numetrics’ complexity engine, calibrated by a set of industry wide projects, estimates the complexity of the project

- **Estimate project plan**
  - Prediction engine estimates resource and schedule plan based on past performance, project data and complexity

- **Identify risks in current plan**
  - Identify resource and schedule risks based on a comparison of predicted plan and project expectations or existing plan

### Schedule Risk Analysis

1 Measured in Complexity Units - A metric reflecting the amount of effort the average development team will spend on the project
There are several ways to engage Numetrics

<table>
<thead>
<tr>
<th>Scope</th>
<th>Engagement model</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ 4-6 week (depending on data availability), <strong>Numetrics led diagnostic</strong></td>
<td>▪ Numetrics team handles data entry, validation, analyses, and reports</td>
</tr>
<tr>
<td>▪ <strong>Standalone analytic assessment</strong> of 5-7 completed projects</td>
<td>▪ Client collects required project data under Numetrics’ guidance and support</td>
</tr>
<tr>
<td>▪ Provides a productivity baseline, industry benchmarks and analytic root cause analysis</td>
<td></td>
</tr>
<tr>
<td>▪ <strong>Deep R&amp;D diagnostic</strong></td>
<td>▪ Numetrics team handles data entries, validation, analyses, tailored benchmarking and reports</td>
</tr>
<tr>
<td>▪ 8-10 weeks <strong>deep diagnostic, combining analytic and qualitative analyses</strong></td>
<td>▪ Client collects required project data with Numetrics’ guidance</td>
</tr>
<tr>
<td>▪ Includes <strong>analytics focused diagnostic, complemented by qualitative tools</strong> such as surveys, project deconstruction, process mapping, interviews and workshops to provide a complete view of productivity and performance drivers</td>
<td></td>
</tr>
<tr>
<td>▪ May include <strong>planning of a new project</strong> to determine required resources and schedule risk</td>
<td></td>
</tr>
<tr>
<td>▪ <strong>Subscription</strong></td>
<td>▪ Client trained to input project data and run reports directly using the web interface</td>
</tr>
<tr>
<td>▪ Embed Numetrics planning tool in the standard PD process to <strong>continuously track performance</strong></td>
<td>▪ Numetrics team runs the analyses and provides insights</td>
</tr>
<tr>
<td>▪ Use predictive analytics to <strong>increase TTM transparency and optimize resource allocation</strong></td>
<td></td>
</tr>
<tr>
<td>▪ Includes initial benchmark and baseline creation and access to the planning tool</td>
<td></td>
</tr>
</tbody>
</table>
Numetrics provides a field proven, analytics based productivity and planning suite of solutions

**Experience and expertise**
- **Core competence** in developing complexity and productivity models
- Mature complexity models (10th generation of the IC and 7th generation for SW model) with over 10 years of continuous development
- Models calibrated based on a database with 2000+ IC and 1700+ SW industry projects
- Supported by a team of experts with hands-on R&D and productivity enhancement experience

**Distinctive, readily available tools**
- Full productivity and planning solution readily available for productivity measurements and benchmarks, root cause analysis and project and portfolio planning and risk assessment
- Immediate productivity improvement with minimal distraction from maintaining and reconciling internal complexity tools

**Analytics-based accuracy and proven impact**
- Demonstrated ~90% accuracy across all predictive models
- Provides unbiased, independent view of complexity, that is not subject to manipulations
- Output is facts and analytics based rather than subjective assessments and opinions
- Typical impact in the range of 20 - 40% increase in R&D productivity and 60 - 90% reduction in schedule slips

**Field proven across clients and technologies**
- Successfully deployed by large, diversified clients with distributed teams
- Scope includes: IC (SoC, Analog, RF, IP, Mixed Signal, FPGA), Embedded Software and Application/Enterprise Software
Who to contact to get started?

Prasad Kunal
Director, Client Development
prasad_kunal@mckinsey.com

Mike Fogerty
Head of Client Development
Mike_fogerty@mckinsey.com

Ori Ben-Moshe
General Manager
ori_ben-moshe@mckinsey.com

Aaron Aboagye
Principal
aaron_aboagye@mckinsey.com
Appendix
Numetrics is a SaaS-based analytics solution that enables rapid improvements in embedded SW and IC development.

**Proprietary** complexity algorithm successfully applied in >400 companies.

- **2,000+** IC projects
- **1,700+** software projects
- **40+** industry segments
- **50+** operating systems
- **20+** programming languages

**Large industry database of peer projects**

- **Industry Benchmarking**
- **Project Planning & Estimation**
- **Root Cause Analysis / Productivity Diagnosis**
- **Portfolio & Resource Planning**
Numetrics’ analytics engine is based on a proprietary “design complexity” model that normalizes productivity across projects.

**Design/development complexity:**
- A metric representing the total amount of project effort the average design/development team in the industry would expend on the project – quantifies the true, normalized output of the design team.
- The complexity model fully takes into account the stochastic nature of product development, which enables the predictive analytics engines to reliably estimate schedule & resource requirements and perform meaningful comparisons of performance metrics across different projects/designs.

**Software Complexity Measures**
- Customer requirements
- Functional requirements
- Test cases
- Use cases
- Test types
- Lines of Code
- Architectural layers
- Number/type of components
- Reuse
- Programming language(s)
- Number of variants
- Real-time content
- Available storage space
- Number of platforms
- Platform maturity
Project selection guidelines

- Project scope (phases) must include requirements definition, implementation, verification and validation, and a production release.

- Projects must be finished, having been released into production and/or the project has transferred to sustaining engineering.

- Choose projects for which you can access with reasonable effort, the milestones, staffing and technical characteristics.

- Include a variety of projects, from small to large, to facilitate drawing trends. First-timers typically choose projects with teams from 5 to 50 FTE for which there was a dedicated project manager.

- Include representative projects, neither the best nor the worst.

- Include projects from the same business unit. This will 1) facilitate selection of peers from industry and 2) increase consistency of methodology, tools, etc.

- Quantity: the smaller the project, the larger the number of projects needed to establish a baseline. Reason: smaller projects exhibit more variation in most dimensions. A typical performance baseline should contain a minimum of 5-10 projects.

SOURCE: Numetrics
Example of project data collected for benchmarking

**Categorization**
- Type of End Equipment
- Project Scope & Description

**Features (only one required)**
- # Customer requirements, or
- # User stories, or
- # Use cases

**Other software measures**
- # Functional & non-functional requirements
- # Test cases (Unit, System, Other)
- # Lines of code (reused & new)
- # Variants
- # Platforms
- Object code footprint (size)

**Software architecture**
- # Components
- # Components containing real time code
- % code in each architectural layer
- Programming language(s)

**Hardware platform**
- # Platforms
- Platform type & maturity
- Available object code storage space
- # and type of processors

**Diagnostic factors**
- # Defects
- # Spec changes
- Tools and methodologies employed
- Team environment (#sites, experience, …)

**Project duration, effort & cost**
- Milestone dates
- Weekly or Monthly staffing
- Total project cost

SOURCE: McKinsey
Numetrics is a well-established company with a field proven sets of solutions.

- **1998** Launch of semiconductor benchmarking solution
- **2001** Launch of semiconductor predictive planning solutions
- **2004** First embedded SW complexity model
- **2006** Launch of embedded SW predictive planning solution
- **2010** First 1,000 SW projects released in industry database
- **2013** Numetrics acquired by McKinsey

- Extensive database of ~2000 IC and ~1700 SW projects
- Field proven complexity estimation and predictive analytics algorithms
- Wide industry coverage including automotive, aerospace & defense, high tech, financial services, medical, etc.