V&V and QA throughout the M&S Life Cycle

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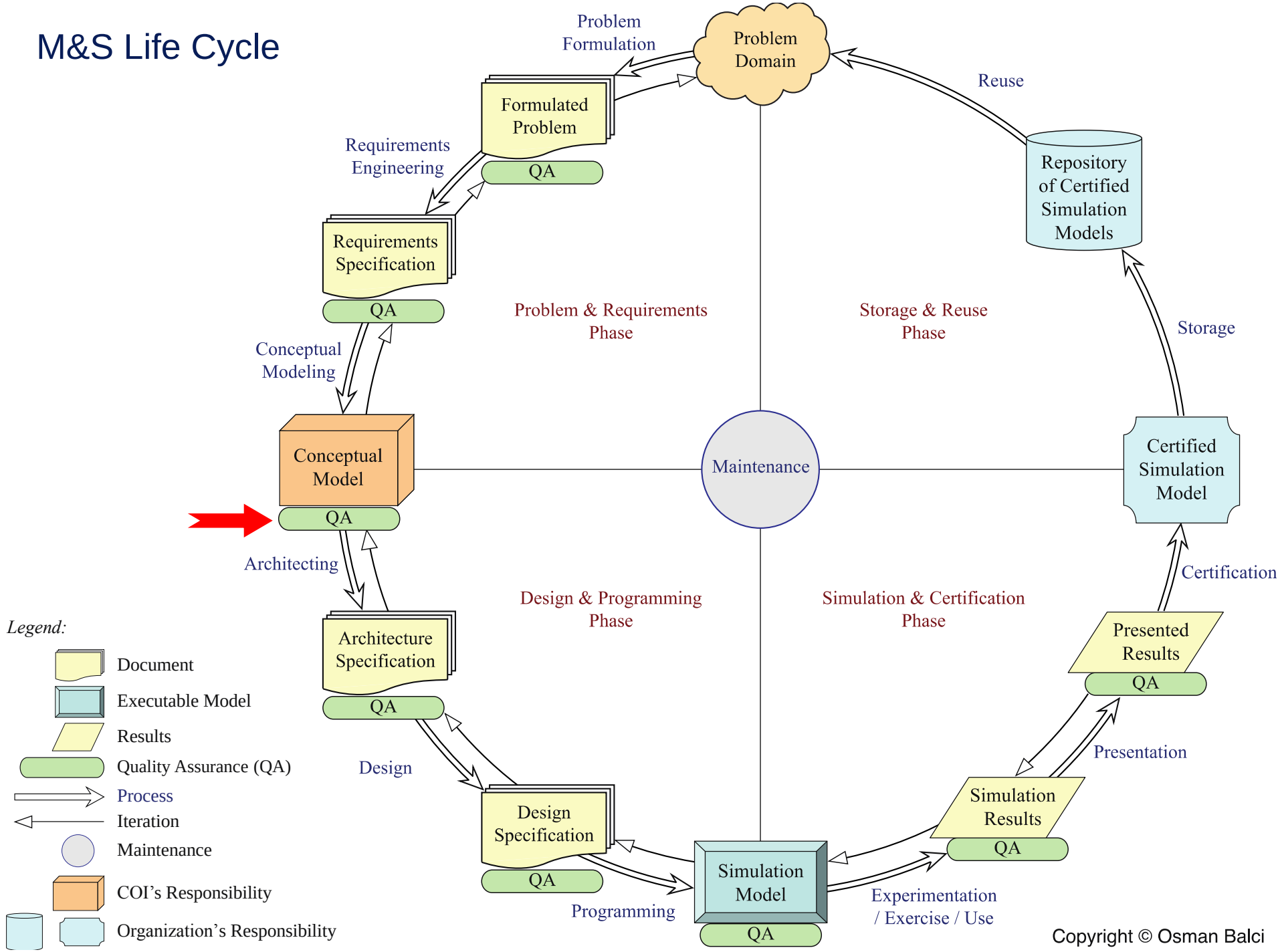
M&S Life Cycle



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Definitions of Terms

- Model and/or Simulation = M/S
- Models and/or Simulations = Ms/Ss
- Modeling and Simulation = M&S
- M/S Quality Assurance (QA) refers to the planned and systematic activities that are established throughout the M&S life cycle to substantiate adequate confidence that a M/S possesses a set of characteristics needed and expected by the user for a set of intended uses.
- Testing is the process of designing a test, specifying test conditions and data, and determining a procedure to follow for the purpose of judging transformational accuracy (verity) and/or representational/behavioral accuracy (validity).

Testing is conducted to perform verification and/or validation.

Definitions of Terms

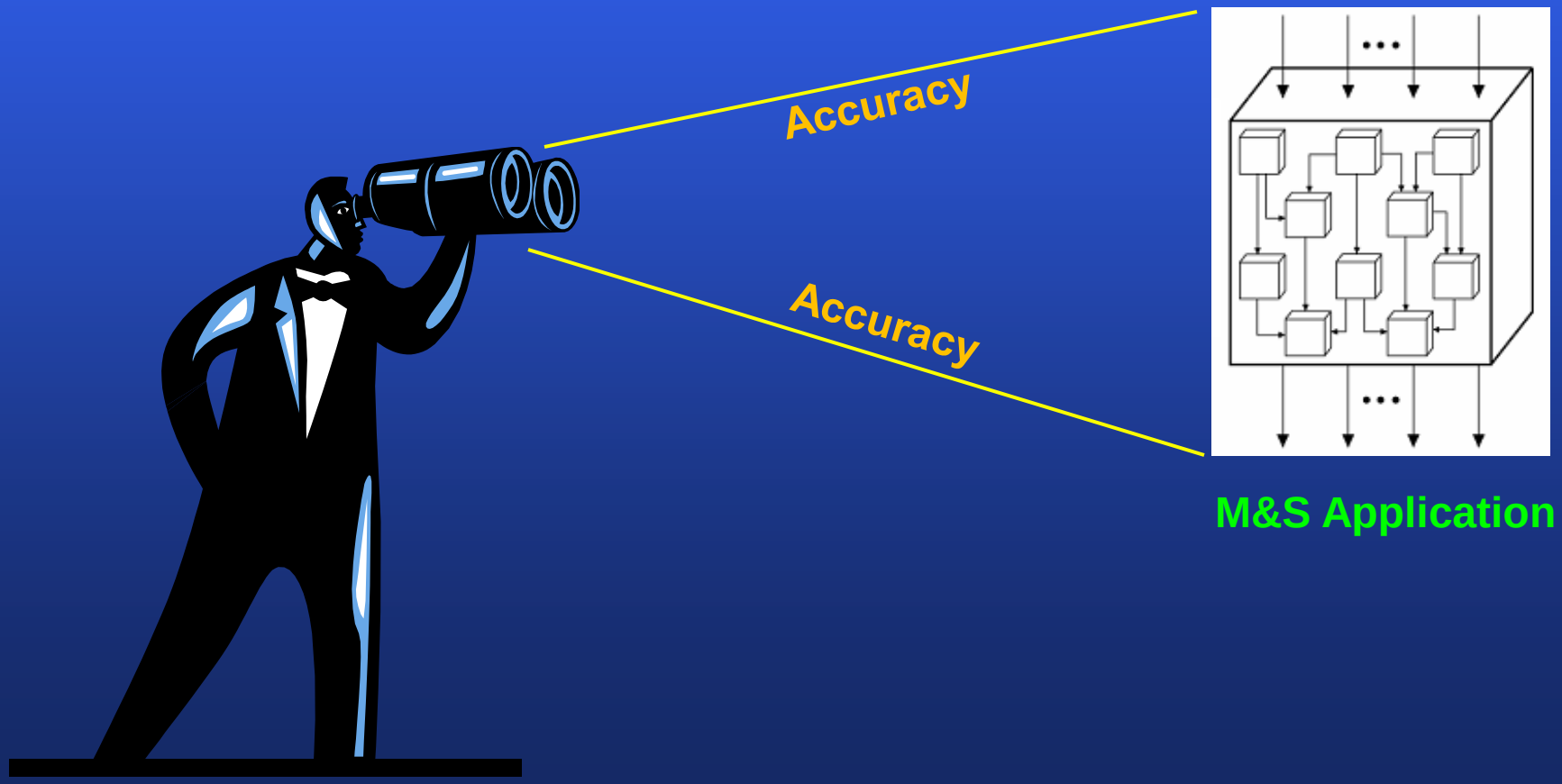
- The terms Verification and Validation (V&V) are consistently defined for whatever entity they are applied to. Let X be that entity such as model, simulation, software, data, or a life cycle artifact (work product) such as requirements specification, conceptual model, design specification, or executable submodel. Then, V&V can be defined generically as follows:
  - X Verification deals with the assessment of transformational accuracy of the X and addresses the question of "Are we creating the X right?"
  - X Validation deals with the assessment of behavioral or representational accuracy of the X and addresses the question of "Are we creating the right X?"
- For whatever entity to be subjected to V&V, substitute the entity name in place of X above, the definitions will hold.

Importance of Quality

- Quality is a critically important issue in almost every discipline.
- Many associations have been established worldwide for quality. Examples:
  - American Society for Quality http://www.asq.org
  - Australian Organization for Quality http://www.aoq.asn.au
  - European Organization for Quality http://www.eoq.org
  - Society for Software Quality http://www.ssq.org
- Manufacturing companies have Quality Control departments, business and government organizations have Total Quality Management programs, and software development companies have Software Quality Assurance departments.

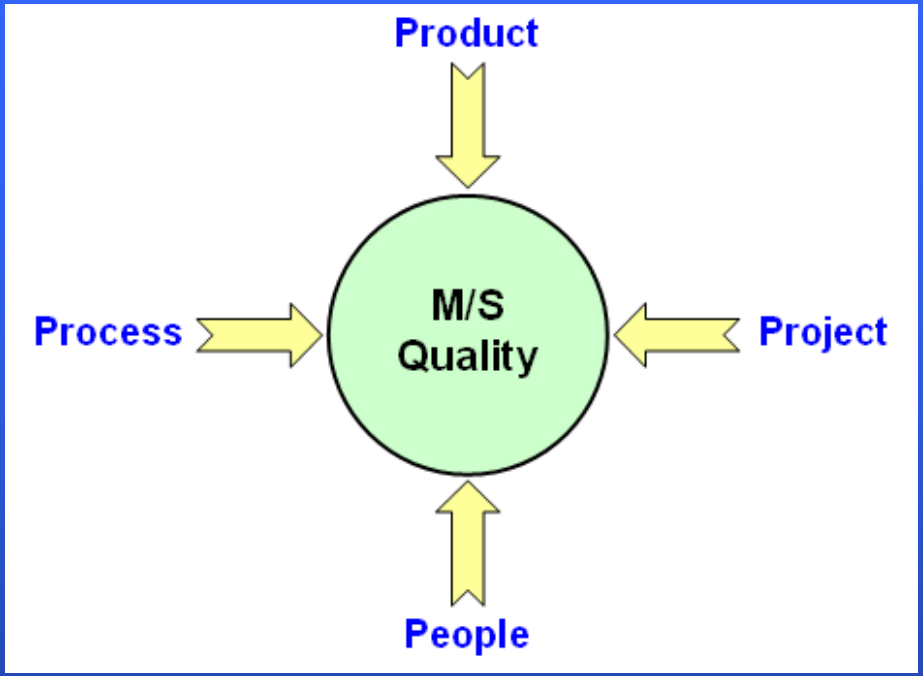
Accuracy versus Quality

- If our objective is to assess the accuracy of an M&S application by conducting V&V, why should we be concerned with M&S quality assessment?



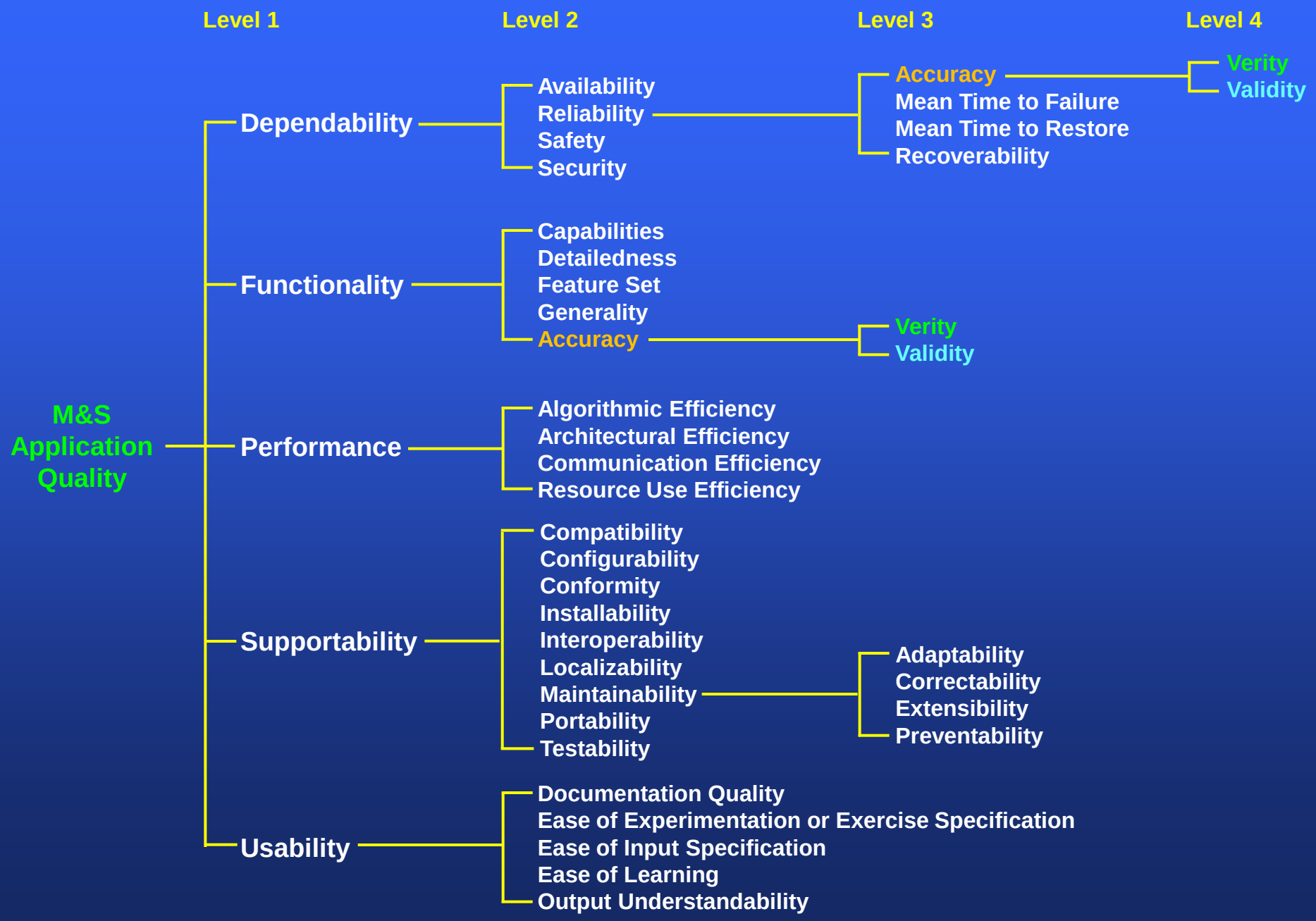
The Four Ps Influencing M/S Quality

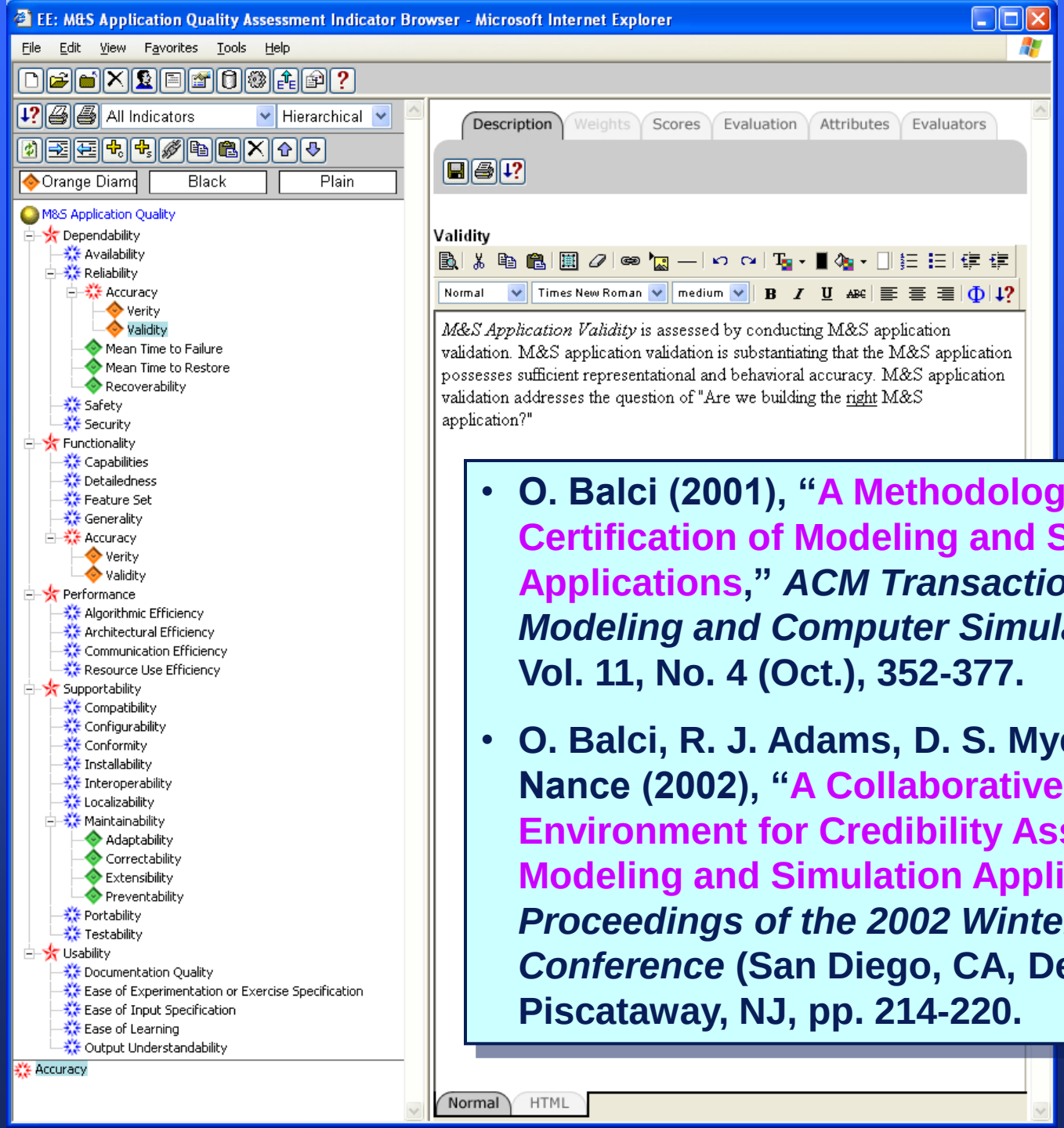
Quality is Job 1 !



- The M/S Quality Assurance (QA) strategy should involve the measurement and assessment of a particular life cycle stage's
  1. output work product (or artifact),
  2. process used in creating the output work product,
  3. quality of the people employed, and
  4. project characteristics (e.g., configuration management, risk management, planning, documentation).

A Quality Model for M&S Applications





- **O. Balci (2001), "A Methodology for Certification of Modeling and Simulation Applications," *ACM Transactions on Modeling and Computer Simulation*, Vol. 11, No. 4 (Oct.), 352-377.**
- **O. Balci, R. J. Adams, D. S. Myers, and R. E. Nance (2002), "A Collaborative Evaluation Environment for Credibility Assessment of Modeling and Simulation Applications," In *Proceedings of the 2002 Winter Simulation Conference* (San Diego, CA, Dec. 8-11). IEEE, Piscataway, NJ, pp. 214-220.**

M&S Application Quality Level 1 Indicators

M&S Application Quality

- **Dependability**
  - **Dependability** is the degree to which the M&S application (a) delivers services when requested, (b) delivers services as specified, (c) operates without catastrophic failure, and (d) protects itself against accidental or deliberate intrusion.
- **Functionality**
  - **Functionality** is the degree to which the M&S application completely captures all of the desired functional modules that need to be present.
- **Performance**
  - **Performance** is the degree to which the M&S application executes its work in a speedy, efficient, and productive manner.
- **Supportability**
  - **Supportability** is the degree to which the M&S application can be supported.
- **Usability**
  - **Usability** is the degree to which the M&S application can easily be employed for its intended use.

Confidence Building

- Undoubtedly, accuracy is the most important quality characteristic of an M&S application, and is assessed by conducting V&V.
- However, under the current state of the art, we are unable to claim a level of accuracy of a reasonably large and complex M&S application with 100% confidence due to many reasons including M&S complexity, reliance on human judgment, qualitative measurements, lack of data, and lack of exhaustive testing. Hence, M&S V&V is viewed as a "confidence building" activity.
- For a reasonably large and complex M&S application, the "confidence building" activity must be performed by assessing not only the M&S accuracy, but also the other M&S quality characteristics such as the ones given in the quality model presented earlier.
- Successful assessment of the overall M&S application quality increases our confidence in M&S accuracy.