Scientific Method

Simply stated:

* OBSERVE
* MEASURE
* EXPLAIN
* VERIFY

- observation of phenomenon / environment
- formulate questions about observations
- restate in form of hypothesis
- make predictions according to hypothesis
- experiment to verify or falsify predictions
- analyze experiment data
- form conclusions about hypothesis
- steps should be independently repeatable

Question basic assumptions
Wrong assumptions that have not been challenged for a long time cause the weight of tradition to prevail until there are overwhelming reasons for changing the prevailing scientific paradigm.

Proposal: abstract, objectives, methodology, outputs, previous, budget
Paper: abstract, intro, objectives, investigate, analysis, future, conclude

1. Basic assumptions

Basic assumptions include underlying philosophy. For example: is there an outside intelligence operating, or is the system closed depending only on internal known laws? Are the laws of nature constant everywhere? Were conditions in the past the same as they are now? What initial conditions are assumed?

Architecture: Design philosophy; contextual background

Prevailing scientific paradigm
The current theory or model accepted by the scientific community.

2. Hypothesis

The hypothesis is a proposed explanation for an observed phenomenon. The simpler the explanation that fits the facts, the better. This is known as Occam's razor

Architecture: Concept; parti; problem statement; idea

Information input
Recognize and state problem. Information input stage includes an understanding of similar research already completed, existing data and observations, intuitive hunches, or background data from previous theories.

3. Test hypothesis

The testing of a hypothesis can include Theoretical, Interpretive, Experimental, and Survey / correlational re-search on the curiosity-oriented side all the way to Simulation, Qualitative, and Action research on the mission-oriented side.

Architecture: Design investigation; drawing; make models

Data input
Data input includes measurement, observation, and interpretation of phenomena, control groups / test groups, environments, conditions, and alternatives. These are systematized and subjected to statistical scrutiny whenever possible.

4. Analyze results

Reject hypothesis
If hypothesis does not explain the known facts or new data it is important to carefully examine the basic assumptions to see if any of them are incorrect.

Modify hypothesis
Sometimes hypothesis needs to be modified to fully explain the known facts or new data.

The analysis stage attempts to falsify the hypothesis. "Science is the only self-correcting human institution, but it is also a process that progresses only by showing itself to be wrong." -- Alan Sandage. The prevailing scientific world in the Western world today is *Naturalism*. It is assumed that the entire universe can be explained entirely on the basis of physical realities plus time plus chance. It is assumed that the laws of physics have never changed since the beginning and that conditions have been uniform in the past so that recent observations can be compiled and conclusions drawn about the past or future simply by running the clock backwards or forwards in time.

Architecture: Analysis; reflection; presentation; critique

Retain hypothesis
A scientific theory or model remains in vogue until new facts are found that contradict the model, or when a better, simpler theory comes along.

Extend theory or model
When a theory or model has been found that seems to fit known facts, the theory is then extended into the unknown to make predictions. These predictions are next considered to be basic assumptions from which to start the cycle over again.

Partly based on chart "Steps in the Scientific Method" by Lambert Dolphin

Architectural Research Strategies: Ontological, Epistemological and Methodological Orientations

Based on chart by Robert Johnson

	CURIOSITY-ORIENTED <----------						MISSION-ORIENTED
	Theoretical Research	Interpretive Research	Experimental Research	Survey / Correlational	Simulation Research	Qualitative Research	Action Research
Ontological assumptions	Knowledge is created by devising logical, abstract theories of some reality	Knowledge is created by developing alternative interpretations of reality in order to help understand the human condition	Knowledge is created by developing and testing general theories that apply to items of interest	Knowledge is created by developing and testing general theories that apply to all social / psychological issues	Knowledge is created by improving our understanding of the behavior of complex systems through simulation	Knowledge is a socially constructed reality and cannot be generalized	Knowledge is created through the process of change; Generalized knowledge less important
Epistemological assumptions	We know through our own reasoning capabilities	We know through our intuitive understanding combined with reasoning	We know only what we perceive through our senses (Logical Positivist)	We know only what we can measure and test (Logical Positivist)	We learn about the world by simulating artificial worlds	We know only by developing an in-depth, intimate understanding about individuals	Participants learn from trying to improve existing situations
Disciplinary base	Philosophy, mathematics	History and the Arts	Natural sciences	Social sciences	Artificial sciences	Cultural Anthropology; Ethnography	Practice
Research goal(s)	Develop theory	Develop interpretive, theoretical understanding	Indentify causal links; causal explanation; test theory	Causal explanation; test theory	Development of insights about the behavior of complex systems	Describe situation holistically and from the perspective of the participants	Focus is on developing practical results; solving real problems; set change in motion
Methodological orientation	Logical abstraction; use of deductive logic	Both inductive and deductive; critical discourse	Experimental and quasi-experimental; induction; statistical inference	Quasi-experimental; induction; statistical inference	Deduction to build model; induction to evaluate simulation results	Case studies; thematic / content analysis	Diagnosis; development and implementation of action plans; evaluation of plans
Research design approach	Logic	Develop critical perspectives	Test null hypothesis; check for validity, reliability, bias	Test null hypothesis; check for validity, reliability, bias	Formulate model; simulate event; analyze results	Empathy; descriptive orientation	Influence outcome; empowerment (emphasize training)
Variables	Emerge during research	Emerge during research	Predetermined	Predetermined	Predetermined and emerge	Emerge during research	Emerge during research
Control or comparison group	Not relevant	Not relevant	Required	Usually comparison groups established in analysis	Comparisons emerge as result of simulations	Not relevant	Not relevant
Data analysis	Not relevant	Descriptive; possibly augmented with quantitative approaches	Usually parametric (correlation, t-test, ANOVA, regression)	Usually non-parametric (rank correlation, chi-square, MCA)	Varies from descriptive and qualitative to quantitative	Usually thematic or content analysis; descriptive focus	Depends on client and specifics of situation; often used to diagnose problem
Participant's role in research	None	Provides first hand record of event	None	None	Varies depending on definition of artificial system	Usually as an informant	Actively participates
Researcher's role	Seeks theoretical validation	Seeks theoretical interpretation	Seeks to be objective	Seeks to be objective	Extrapolates behavior of simulated system to real world	Interactive; often as participant observer	Collaborative (with client, user, etcetera)
Political pressures	Ignored	Often an integral part of interpretation	Controlled by research design or ignored	Controlled by research design or ignored	May be relevant depending on definition of artificial system	Described	Integral part of the action research context
Research report (implementation and communication)	Presentation of logical conclusions	Presentation of interpretation (usually academic focus)	Presentation of statistical proof (academic focus)	Presentation of statistical test and interpretation (academic focus)	Presentation of model's logic; comparison of simulation results to reality (academic or pragmatic focus)	Present holistic portrayal of participants and settings (academic or pragmatic focus)	Describes the context and outcome of research (pragmatic focus)
Architectural examples	Design optimization approaches; mathematical theories; algorithms; grammars	Theories of architectural history and theory; sketches of working alternatives	Material testing	Post-occupancy evaluations; behavioral mapping	Thought experiment; gaming-simulation; mock-ups; computer simulations; cost / benefit analysis	Participant observation, phenomenology	Demonstration projects; advocacy planning; reflective practice

Reference:
L. Groat; D. Wang (2002). Architectural Research Methods. New York, NY, USA: John Wiley & Sons. ISBN 0-471-33365-4