

Comments on Highlights from Kuhn's Book
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The 3-D global spatial data model (GSDM) is a “new” paradigm based on the assumption of a single origin (Earth’s center of mass) for 3-D spatial data coupled with application of the rules of solid geometry as outlined by René Descartes in 1637. Standard equations for error propagation comprise the stochastic model part of the GSDM. A definition and description of the GSDM was filed with the U.S. Copyright Office in 1997 – <http://www.globalcogo.com/gsdmdefn.pdf>.

The U.S. National Geodetic Survey (NGS) is preparing an update to the National Spatial Reference System (NSRS) - targeted for completion in 2022. Many dedicated professionals are doing a stellar job meeting that challenge – with one exception. Based upon past practice, NGS plans to define and support 2-dimensional coordinate systems for working on the horizontal 2022 datums. But, as a consequence of the digital revolution, everyone now works with 3-D digital spatial data. NGS is to be commended for doing what is necessary to meet the 2022 deadline but modern measurement systems collect 3-D digital spatial data and future users stand to realize enormous benefits by adopting an integrated 3-D model – the GSDM. See www.globalcogo.com/poster.pdf. In that flyer, it should be noted that the 2nd Edition of the 3-D book by Burkholder was published by CRC Press in July 2017.

In looking at big picture challenges for spatial data models, the book by Thomas S. Kuhn, “The Structure of Scientific Revolutions” presents many parallels that appear to apply. The following comments refer to highlighted portions of Kuhn’s book (included in a separate file).

- Pages 2-3 The incremental nature of scientific progress is explained. That works great! But what if the underlying assumptions also need to be updated? The GSDM does that.
- Pages 4-5 The existing spatial data models (separate horizontal & vertical origins) have worked well in the past, but digital spatial data are handled more efficiently with a 3-D model.
- The scientific community and the vendors (hardware and software) are well aware of the need for an integrated model. But there is a HUGE commercial (and philosophical) investment in use of the existing horizontal/vertical models.
- Pages 6-7 The “geoid” is a link between two traditional origins – sea level and the ellipsoid. Determining precise values for the geoid is a huge task, but NGS is doing it. However, the GSDM is simpler/easier to use and provides adequate support for the third dimension (ellipsoid height) for all but the most demanding mapping/engineering applications. Yes, in a small number of applications, high-precision values of the geoid are essential. In those cases, competent use of the new geoid models remains the domain of the “specialists” See pages 226 and 227 in the 2nd Edition of “The 3-D Global Spatial Data Model.”
- Pages 23-24 Use of a better model needs to be “sold” to the practitioners. Specifically, avoiding distance distortion (inherent in a map projection model) and eliminating the need for geoid modeling are excellent selling points – but objections of current “gatekeepers” are difficult to overcome. Even so, progress is being made - see

<https://ascelibrary.org/doi/full/10.1061/%28ASCE%29SU.1943-5428.0000274>

Pages 66-67 Speaks to the discovery/emergence of a new “generic” model – in this case the GSDM.

Pages 84-85 After some hard-fought battles, the crisis ends with the “victory” of the new model.

Pages 110-111 No model is “perfect” but a new model stands a better chance of being accepted if the new model accommodates the requirements of a previous model in addition to solving problems not addressed by the old model. In this case, the traditional geodesy model is still applicable for “complex” applications but when using the GSDM a greater number of users will be able to handle spatial data efficiently and competently.

Pages 136-137 It seems ironic in a way but the transition to using the GSDM can be accommodated such that most users will be oblivious to the impact and importance of what is truly a scientific revolution.

Further irony is that a reputable textbook describing the GSDM has already been published and many articles related to use of the GSDM are in the public domain – primarily written by the author of the GSDM – www.globalcogo.com/refbyefb.html.

Pages 144-145 Several important points described here include:

- In this case, publication of a textbook is part of the process by which a candidate for a new paradigm becomes part of the revolution – not in the aftermath.
- Having served 2 separate 4-year terms as Editor of the ASCE Journal of Surveying Engineer (JSE), the author of the GSDM is familiar with and reveres principles of technical publishing.
- But, not having a terminal degree and not being part of the inner-circle of “gatekeepers” for geodesy, the definition of a “better” spatial data model by Earl F. Burkholder has been actively opposed – even within the technical literature.
- Testing and proof of the validity of the GSDM are included as a part of the ASCE Discussion/Closure process. Each round of Discussion/Closure as described in the two following links each successfully validates the integrity of the GSDM. Round 1 relies on numerical examples (proof of validity) while round 2 re-iterates the assumptions and logical development of the GSDM. The Closure to round 2 carries little or no justification for speaking ill of the GSDM.

<http://www.globalcogo.com/StdDevLocalNetwork.pdf> (round 1)

<http://www.globalcogo.com/validation.pdf> (round 2)

Pages 150-151 The GSDM and the previous paradigm are not viewed as mutually exclusive. While it is true that the GSDM accommodates portions of the previous paradigm, there are components that will, in fact, be more efficient with a specific transition. Publication of the 2022 datum by NGS should factor heavily in the transition.

Passing of the “old guard” will undoubtedly factor into a successful transition.

Pages 152-153 A discussion of transition continues to acknowledge participation of the older and experienced participants. In this case, it seems that the nationality (and professional stature) of the innovator do play a significant role. But, the section about problems solved by the new paradigm (the GSDM) should be given more weight than the reputation of the innovator. See www.globalcogo.com/poster.pdf.

Pages 158-159 The decision to use a new paradigm is not to be made lightly. Such a decision takes a certain amount of faith even for someone resolutely convinced of the benefits offered by the new paradigm. Hopefully a decision to use the GSDM can be justified by the following benefits:

- Distance distortion can be avoided on survey plats and engineering drawings.
- Geoid modeling can be avoided.
- Meeting the Minimum Standards of the American Land Title Association and the National Society of Professional Surveyors can be accomplished with aplomb. See –

<http://www.globalcogo.com/EFB-SaGES-ALTA-NSPS.pdf>

Even so, convincing traditional “users” will take time. But, Kuhn closes with the statement, “At most he may wish to say that the man who continues to resist after his whole profession has been converted has *ipso facto* ceased to be a scientist.”

Pages 168-169 A very important “unwritten rule of scientific life is the prohibition of appeals to heads of state or to the populace at large in matters scientific.”

“A new paradigm must be recognized as progress” Even so, scientists will be reluctant to embrace a new paradigm unless. . .

- The new candidate seems to resolve recognized problems in a unique way.
- The new paradigm must preserve a relatively large part of the problem-solving that has accrued through its predecessors. Got it covered!

There are many other pertinent points made by Kuhn that should be considered. However, it is hoped that this preliminary summary of issues will prompt serious discussion and consideration of the advantages of adopting the GSDM for both spatial and geospatial data.

Note – I had previously posted extensive copies (23 pages) from Kuhn’s book annotated to show how that material is applicable to viewing implementation of the GSDM as a “scientific revolution.” Posting that much copied information stretches the “fair use” rule.

If you want a copy of the Kuhn material (that was taken down), please send an email to eburk@globalcogo.com asking for “annotated Kuhn” and I’ll be happy to share a copy with you.