Post-graduate scholars can publish Compended-Guides to the literature of their field using Knowledge-Step-Forums

"Publication forms the core structure supporting the development and transmission of scientific knowledge" (Galbraith2015). Yet, with the WorldWideWeb a dominant part of many activities, internet "publication" is still *paper-based in its style and methods*, even when it uses a digital medium. ***Such a paper-based publishing "model" is not adequate for a Web-based world!***

In 2006, an estimated 3,700 peer-reviewed articles were published **per day** (Bjork2009)! As will become apparent, the methods and features described here *are needed now*, and *will be absolutely necessary in the future*, when even more articles are published.

A New Knowledge-Tool is proposed that is *in addition* to those already available. The new Knowledge-Tool is a new Literature-Guide called a "**Knowledge-Step Compendium**" which will be on a **very-narrow topic**, will be organized in a new **MultiLevel-Format**, and will be created in a **Compending-Forum** on the Internet.

This New Knowledge-Tool will, in turn, be the basis for *a change in academic careers* of the timing *of when a scholar "Compends" Knowledge*. A "Knowledge-Compendor" need not be a senior faculty member (as is the case in traditional literature-reviews), but can be a Post-Graduate Student new to a field. Because a Knowledge-Step Compendium is based on a very-narrow topic and created with the aid of an Internet Forum, for a Graduate Student Compendor *this activity will be a means to self-organize groups of like-minded scholars that can be the basis for reviews of new data, discovering new ideas, and finding jobs.*

To learn what these new names describe, read on.

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Post-graduate scholars can publish Compended-Guides to the literature of their field using Knowledge-Step-Forums

Don L. Jewett

Research Director; Abratech Corporation; Mill Valley, CA, USA
Professor Emeritus; University of California, San Francisco; San Francisco, CA, USA

Corresponding Author:
Don L. Jewett, M.D., D.Phil. (Oxon)
69 Ridge Ave., Mill Valley, CA, 94941, USA
dlj@abratech.com
don.jewett@ucsf.edu

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NB: The paragraphs are sequentially numbered for *purposes of discussion*, at the lower right corner, in curly brackets, as shown here--->. {1}

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Introduction:

Intro.1 Where We Are

Quoting the first paragraph of the Abstract: ***A paper-based publishing "model" is not adequate for a Web-based world!*** {2}

Question: Will further adaptations and adjustments to the paper-based publishing-model be sufficient for present and future needs?

The Author's Answer: "**No**"; the Knowledge-Tool described in this article is ***needed now***, and will be ***absolutely necessary*** *in the* ***future***, when even more articles are published. To explain this, one must distinguish between Information and Knowledge. {3}

Intro.2 A Maxim

The Author has composed a maxim for Science and Medicine:

Numbers *alone* are ***not*** Data;
Data *alone* are ***not*** Results;
Results *alone* are ***not*** Information;
Information *alone* is ***not*** Knowledge;
Knowledge *alone* is ***not*** Wisdom. {4}

The phrase "Information is not Knowledge" is from a song by Frank Zappa. (The authorship has been erroneously ascribed to Einstein.) Discovering the phrase stimulated the Author to both write the maxim, and to puzzle about the processes by which Knowledge was actually created. The Author, despite decades dedicated to both Research and Teaching had never considered *in any detail* whether there were systematic means by which Research Information was turned into Medical or Scientific Knowledge. Information and Knowledge, in the author's thoughts, were jumbled together; research articles, textbooks, reviews were all equally "publications". {5}

But, if Zappa's phrase is correct, then by what means does Scientific Information become Scientific Knowledge? For the Author's answer, see Fig. 1. {6}

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Intro.3 Knowledge Paths

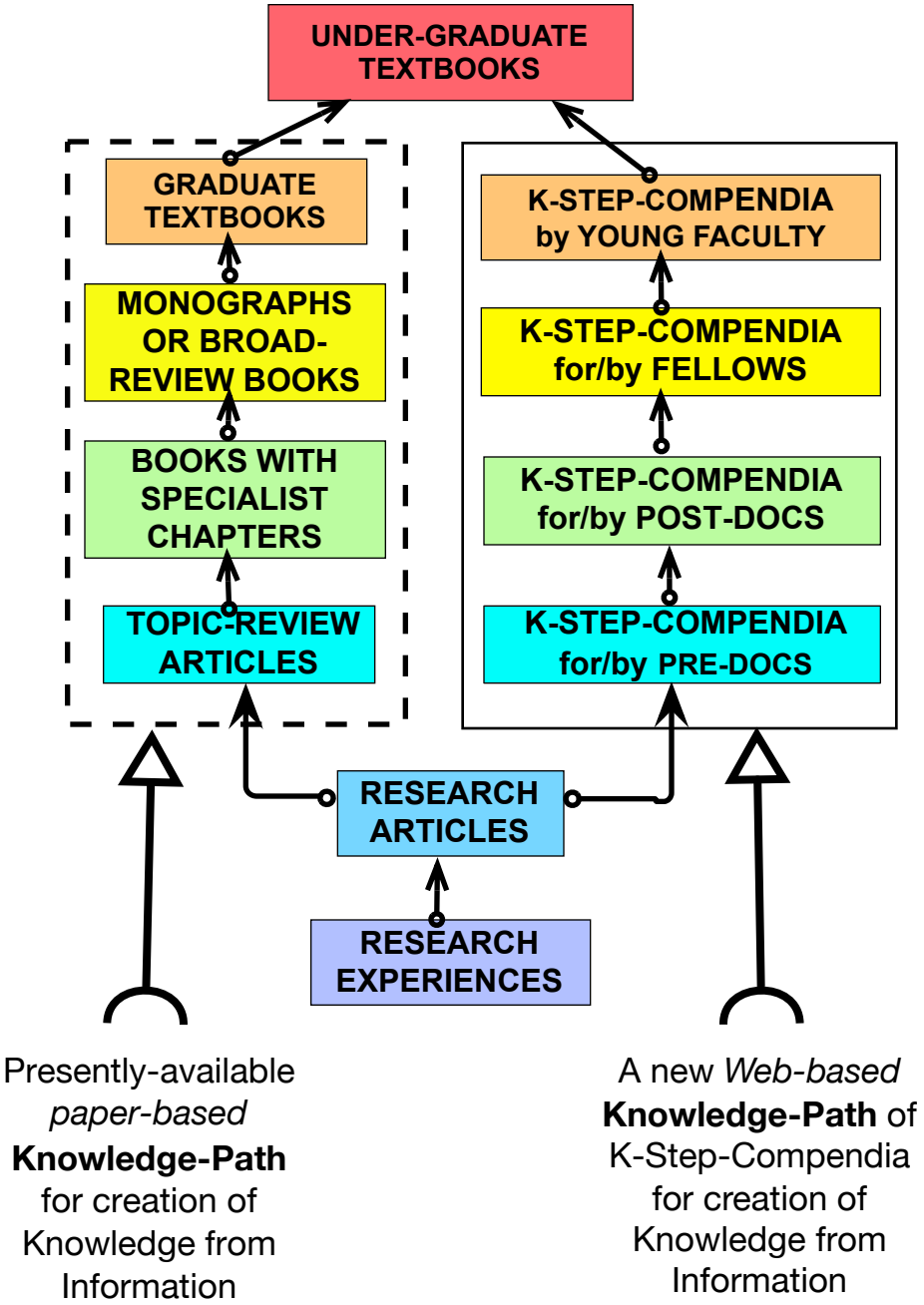

Fig. 1: Knowledge-Paths from Information to Knowledge

Fig. 1 Legend: As Knowledge is created from Experience, Information, and prior Knowledge, multiple steps are needed to make the Knowledge useful. Two Knowledge-Paths are shown (in two columns): **1)** the presently-available paper-based system (*left* column), and **2)** the Web-Based K-Step Compendia method proposed here (*right* column). "K-Step" is short for "Knowledge-Step." {7}
The differences between the two Paths are the main subject of this article.

Fig. 1 illustrates a number of important points:

1. Moving ***upward*** in the Figure, from one publication-type to the next, Information ***decreases*** (there is less particularity), while Knowledge ***increases*** (there is more generality).
2. As Knowledge increases by Knowledge-Creation, the decreased particularity and increased generality make it easier to **learn a given Knowledge level.** As a result students can master the material more rapidly than the creators of the Knowledge-Path were able to do.
3. It is notable that written material is different for different readers. These "levels" are the same in both Paths, as indicated by the ***matching fill-in colors*** in ***both*** the **paper-*based*** and the **Web-*based Knowledge-Paths***.
4. When the steps on the Knowledge-Path have been delineated (by repeated compending), one can see that the *same steps form an* "**Education-Pathway**" when traversed in the **direction opposite to that of the Knowledge-Path (*i.e.,* downward).** At the top of the Figure, Under-Graduate Textbooks form the start of the Education-Pathway by which the next generation of scholars learns a given field. **Moving downwards on the Education-Pathway is the motion towards *higher academic degrees (more particularity).***

   To reiterate: the Education-Pathways are the same as the Knowledge-Paths, except that the Education-Pathways are traversed ***downwards in the Figure,*** whereas the Paths of Knowledge-Creation are followed ***upwards in the Figure.*** A full "cycle" can be described thusly: Knowledge is successively created by moving from particularity to generality. This effort requires the work of many scholars, over time. When the Knowledge-Path is sufficiently consolidated, materials for an Education-Pathway can be created. Neophytes start the Education-Pathway at generalities, and then move to those particularities that are important in a given field. Scholars with advanced degrees learn to create more Knowledge (*see* Compendors.1, below), possibly in new or expanding fields, and the cycle can repeat with new or enhanced content.
5. Whereas the paper-based Path (left side, Fig. 1) is presently well-known, with established (yet inefficient) methods, the K-Step-Compendium Path (right side, Fig. 1) involves ***new Knowledge-Tools in addition to presently-available Tools.***
6. Figure 1 is intended to diagram the **paths** as **Knowledge is created.** It does **not** show what must be combined to create a given "level". To indicate that each level is built upon a level that is larger, there is Fig. 2. {8}

Fig. 2 Title: Comparison of publications in the sequence that creates Knowledge.

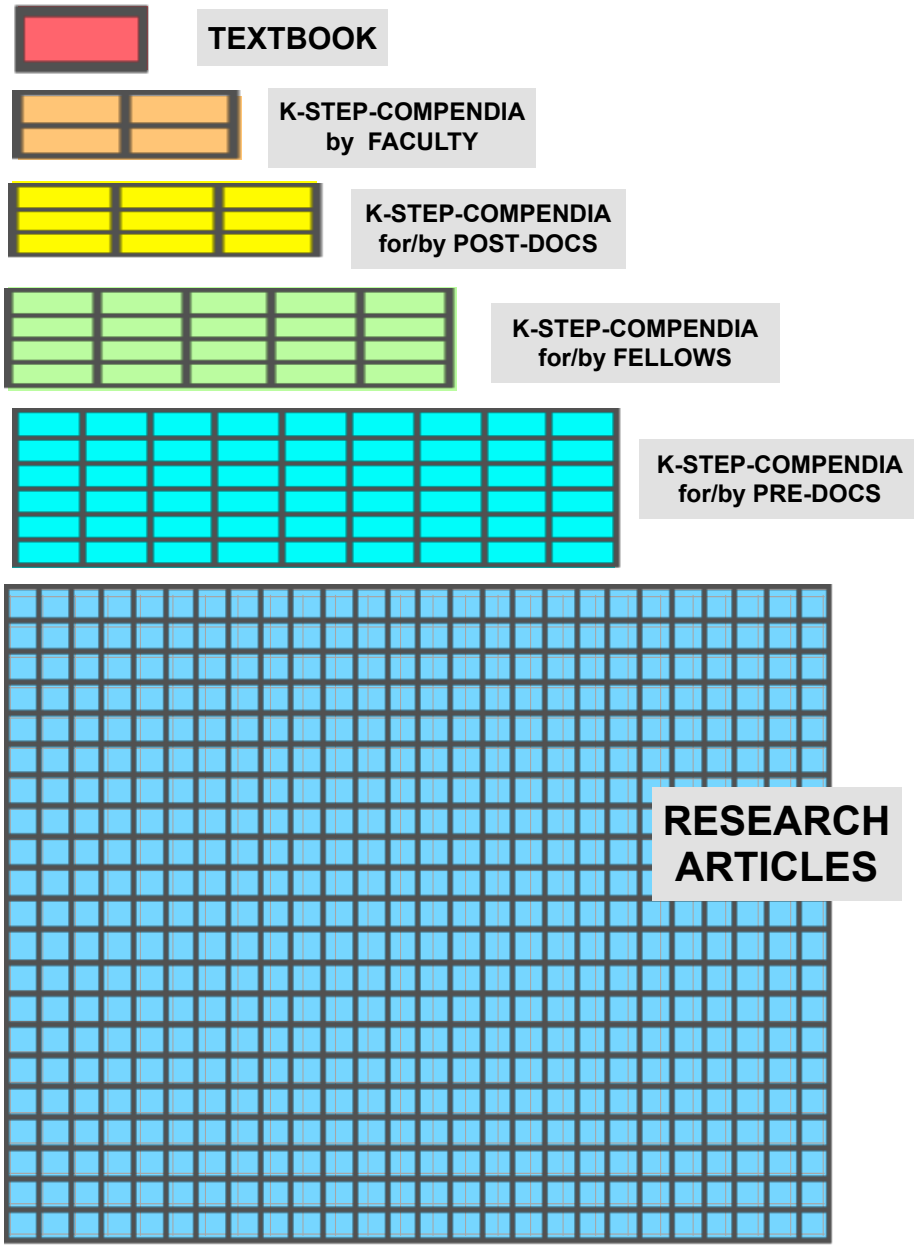

Fig. 2 Legend: The different sizes are not to any scale, and are intended only to indicate that any given Knowledge-Step is based on a large amount of material from one or more steps below. {9}

With the understanding that Fig. 1 only shows pathways, we can return to the issues that arise when creating knowledge.

Intro.4 Definitions: *re* "Knowledge"

Compendium = a scholarly publication that is ***a concise, yet comprehensive, guide to earlier literature***. (plural = Compendia)

The activities needed to create a Compendium are referred to as "Triple-C", where the mnemonic stands for: **C**ompiled, **C**ompared, and **C**ompacted.

It is possible for a written presentation to be both concise and comprehensive, by use of a MultiLevel-Format (*see* Tools.4).

Compend = (neologism) a verb derived from the noun "compendium", to indicate the "Triple-C activities" essential to creation of a compendium.

Compended-Guide = a scholarly guide to available literature, created by compending.

Compendor = (neologism) a noun derived from "to compend" to indicate someone who is active in creating a compendium.

Knowledge-Step Forum = an online WebSite where a Compendor, together with other like-minded scholars, creates a new Knowledge-Step Compendium. A Knowledge-Step Forum utilizes some of the features of present online forums and blogs, but has additional necessary features.

Knowledge-Tool = a mechanism, method, or behaviors that aid scholars during creation of knowledge.

Knowledge-Step = one part of a Knowledge-Path, having an amount of Knowledge roughly estimated as that which can be understood by a single Compendor or a small group of compendors. A Knowledge-Step covers less material than a usual Ph.D. thesis, being limited by a narrow-topic. (**K-Step** = Short form of "Knowledge-Step".)

Knowledge-Path = a sequence of Knowledge-Steps, wherein, moving along the sequence, the Knowledge-generality ***increases*** while the Information-particularity ***decreases*** (*see* Fig. 1). Moving in the opposite direction in the Knowledge-Path sequence is named an Education-Pathway (*q.v.* below; *see* Fig. 1). (**K-Path** = Short form of "Knowledge-Path".)

Education-Pathway = the sequence of Steps of a Knowledge-Path, sufficiently-developed for educational purposes, wherein moving along the Pathway sequence is in the opposite direction from that of the Knowledge-Path (*q.v.* above; see Fig. 1).

K-Step-Compendium = a narrow-focus Compendium planned to integrate with other Steps (*see* Tools.4).

K-Step-WebSite = a WebSite that provides online K-Step "Tools", *e.g., K-Step Compendia, K-Step PrePrint Critiques, K-Step Archives, Knowledge-Step Forums.*

Forum-Compendor = the organizer/moderator of a Knowledge-Step Forum. {10}

Intro.5 Overall Design of Knowledge-Step Compendia and Forums

Knowledge-Step Compendia are specifically designed so that individual K-Steps can be organized into a K-Path. This is accomplished in several ways: **1)** the topics are *narrow* so as to reduce the number of K-Paths a given K-Step will correlate with; **2)** the MultiLevel-Format (described later) puts the most important issues related to a K-Path *first and foremost*; **3)** a regularized presentation makes it easy for Readers, including the next-level Compender, to read and understand the conclusion reached, and the experimental support used. {11}

The Knowledge-Step Forum can become a *very powerful tool for organizing knowledge* when used to create K-Step Compendia. Several features contribute to its strength: **1)** experts from around the world can be involved in the wording of Assertions that are made about a given topic; **2)** the MultiLevel-Format keeps the topics focussed on the issues important in placing the topic within the relevant K-Path(s), especially the experimental evidence; **3)** all participants have motivation to create a high quality Compendium based strongly on *self-interest related to their careers and reputations;* **4)** all submissions to the Forum have protection against plagiarism, by a Chained Hash Algorithm (described later). {12}

Intro.6 Costs

The creation of valid, useful Scientific-Knowledge from Research-Experience (Information) can involve many steps. The number of steps necessary to reach a given level depends on the starting level, and on who is to receive and utilize the Knowledge. ***However***: **every step** requires *human* **effort**, *human* **ingenuity**, and, ***most critically***, *human* **time**. The extra time needed to make a complicated issue concise and clear has been known for centuries. In 1657, Blaise Pascal wrote "I have made this [letter] longer than usual, only because I have not had the time to make it shorter." [Knowles1997]. {13}

The "Standard Path" (based on the presently-dominant Paper-Publishing Model) has notable ***financial barriers*** **at** ***all steps***: Will an Article or Topic-Review keep present reader subscriptions at a profit level? Will a Monograph or Book sell enough copies to cover the "costs" (of the Publisher's other books that are losing money)? Will a Textbook sell to more than the Author's own students? {14}

In marked contrast, the proposed Web-Based Knowledge-Step Compendia Paths have **no out-of-pocket financial-limitations**, because: 1) all posting is Open-Access (no

subscription-limitation on readership); 2) there are no "authorship" charges; and 3) the only (small) funds required by an Author are for WebHosting (if at all). {15}

Intro.7 Increasing numbers of specialities

Addressing now the larger picture: When increasing numbers of scholars, specialists, fellows, and faculty are involved in scientific and medical research, it is not particularly surprising that there is an increase in the *number* of publications. What is less clear is the additional increase in the *number* of specialist-fields.

Recognize that each specialist (being human) has limitations in learning speed and capacity. Also, each specialist has limited time available to reach a given vocational level. It follows, from these limitations, that an increased number of specialist-fields, is an indication that the ***amount and rate*** of Knowledge-Compending with presently-available Knowledge-Tools is ***failing to keep up*** with the Information-Expansion due to expanded scientific and academic activity.

This *failure can be mitigated by what we herein propose:* 1) ***more efficient Knowledge-Tools,*** and 2) ***larger numbers of human Knowledge-Compendors***. {16}

Intro.8 Summary of this Introduction

Returning to the Question at the bottom of p.4: **"By what means does Scientific Information become Scientific Knowledge?",** the summary of the Author's Answer is this:

Knowledge is created by Scholars into Knowledge-Steps, using the Knowledge-Tools that are available to them at the time. In general, each Compending creates only one "step" in the Knowledge-Path. {17}

A notable problem in the "Paper-based" publishing model, is that each step has ***financial constraints*** and this leads to ***Closed-Access Archives***, including those of "Review Articles". In contrast, the use of Knowledge-Step Forums to generate Knowledge-Steps consisting of K-Step Compendia in a MultiLevel-Format can be "Published" by individual Compendors, when posted on the Web with Open-Access. {18}

Can the rate of *Knowledge-Creation* be increased? **Yes.** But increasing the rate of Knowledge-Creation *will involve* ***at least*** *the following changes:* **1) *accepting Knowledge-Step Compendia*** *with a MultiLevel-Format as a new, additional alternative* ***for "online publication" of narrow-topic Reviews;*** *and* **2) *recruiting*** new ***Knowledge-Compendors***. {19}

Neither of these changes need be imposed because ***participation*** will be motivated by the

self-interest of each individual (*see* Tools.8 and Tools.10)**.** {20}

TOOLS:

Tools.1 Knowledge-Tools: past, present, and future

In the past, the primary Knowledge-Tools consisted of paper-based Libraries equipped with:

1. Books;
2. Journals with Articles;
3. Catalogs & Indexes. {21}

Presently, Knowledge-Tools consist of Libraries with mixed media:

1. Books, some paper-based, some on WebSites;
2. Journals with Articles, some paper-based, some on WebSites;
3. Indexing-WebSites. {22}

In the future, Knowledge-Tools ***on the Web*** should consist of the following:

1. Books on WebSites;
2. Journal-WebSites with Articles (*unchanged* from the present);
3. Indexing-WebSites (*unchanged* from the present);
4. **New K-Step Compendia** providing specialized (MultiLevel) Compended-Guides to the literature of a narrow topic. The Compendia will be most easily created in Knowledge-Step Forums. This requires new Software. A subset of the Forum-Software can also be used to post Compendia and receive new comments and citations after posting (an Active Archive).
5. **New Knowledge-Step Forum WebSites** that facilitate Compending of Knowledge by providing the basic tools, and perhaps some luxuries, too.
6. **New Preprint-Critique WebSites,** also using Knowledge-Step Forum Software, which will provide an easy method for Authors to obtain and use critiques of their work, at different stages. The Knowledge-Step Forum Software also provides protection against plagiarism (*see* Tools.12). {23}

Tools.2 The Rules and Features of Knowledge-Step Forums

A Knowledge-Step Forum operates under the follow ***Rules*** (unless modified at setup by the Forum-Compendor)*:*

1. The *entire WebSite* can be **read** by anyone, without restriction (Open-Access).
2. The SiteAdmin can be contacted by any User, without any registration required (in case an unregistered Reader wants to report a problem without spending the time and effort to register).
3. Submissions (contributions) are accepted only from Registered Users (email verification required) who use their own names. In rare instances, an exception to this rule can be made by the Forum-Compendor, with appropriate

justification; the communications regarding these exceptions are not saved by the system, but are listed by date in the History, as "User Exceptions, Reviewed and Accepted".

4. All submissions are posted under a Creative Commons License that is specified on the WebSite and specifically agreed to, by each Contributor, during Registration.
5. The Forum-Compendor is solely responsible for placement in the Knowledge-Step Forum of every submission received. This activity can be assigned to an Editor by the Compendor.
7. Each submission must be placed by the Compendor/Editor into one of the six main Sections within the Knowledge-Step Forum:
   1) Assertions
   2) Conjectures
   3) Observations for Stronger Inference
   4) Rejected Submissions
   5) Scientific Comments (general)
   6) Public Comments.

   This list may be changed at the discretion of the Compendor, as needed to best fit the needs of the Forum's *Narrow-Topic*.
8. Specific Comments about a Submission, from the Forum-Compendor and/or other Readers, are placed in an Extension of the Submission's primary location.
9. **All initial submissions** to the Knowledge-Step Forum WebSite **are saved, unchanged**, in the History of the WebSite (automatically by modified Version Control Software). This protects the Forum-Compendor from accusations that bias has affected either the editing or the placement of the submission within the WebSite. Inappropriate language can be redacted before placement. Communications related to the submission-process are available by links to the stored material. Material that was initially placed in the Compendium***, but later rejected, will still exist in the WebSite History,*** and, in this way, any Links to or from such material will still be valid and functional if they are based upon textual material that can be searched-for.
10. All submissions are processed by the CHA (Chained Hash Algorithm) and the appropriate content and hashes are stored with the MetaData associated with the submission.
11. Readers will be able to find new content in the Knowledge-Step Forum by word and phrase search-engines because Web Search-Engines, specified by the Forum-Compendor, will be automatically notified whenever new submissions (larger than a specified size) are placed within a Section. {24}

The following are some *additional* ***features*** of the Knowledge-Step Forum Software:

1. The Software automatically handles routine communications, using the email

addresses provided by the Compendor.

2. The Software acquires and makes available to the Forum-Compendor, Editor, and SiteAdmin statistics on usage, origin of non-registered Readers, error messages, *etc.*
3. Changes to the code of the Open-Source Content Management System (TikiWiki) can only be made after the SiteAdmin has signed off having read warnings concerning the possible adverse effects of changes on Site performance or behavior.
4. Presentation of content is uniform across K-Step Compendia unless the Forum-Compendor finds a need for additional features. The options available to the Reader, and how to control the options, are also uniform across K-Step Compendia. This uniformity makes it easy for the Reader, once accustomed to the format, to access different paths within Forum Software.
5. Despite the described uniformity, many parts of Knowledge-Step Forums and MetaLinks are highly adaptable to the needs of the Compendia Scholars and Readers. The adaptability includes different needs for different fields, and the changing needs of changing fields.
6. The Software is compatible with existing Browsers and Word Processors.
7. Use of the Software is intuitive, and does not require use of Manuals, or extensive Help. {25}

Tools.3 Definitions: *re* "Format"

MultiLevel Format = a format for presentation, which uses typographical conventions (explicitly defined by the Author), to distinguish different "Levels" of content within the writing [Jewett1981]. A MultiLevel Format provides *different readers* access to *different content*, making the writing less linear and more multi-path. It also provides the *same reader* with content at the level needed by *that reader at that time* (which can be different at a different time).

Stronger Inference = the Author's revision of Platt's "Strong Inference" [Platt1964], such that the process **starts with an *observation*** that cannot be adequately explained by existing knowledge [Jewett2005]. {26}

Tools.4 A MultiLevel Format for K-Step Compendia.

Each Compendium should be devoted to a *Narrow-Topic, since a* Narrow-Topic keeps the Compendium contents focused on the issues of the Topic, and avoids branching to associated topics that may be best covered by *another* Compendium. {27}

The design of the Compendium-Format has two mutually-***reinforcing*** goals:

1. To be ***easy to create*** (by concentrating on the basic "structure", *i.e.*, the core ideas

of the Narrow-Topic; and by organizing the presentation in a MultiLevel Format).

2. To be ***easy to comprehend*** (by the simplification derived from concentrating on the basic "structure", and by the use of the MultiLevel Format).

The way that the MultiLevel Format is able to aid *both of these goals* will be discussed after the MultiLevel Format is described. {28}

One proposed MultiLevel Format for K-Step Compendia contains **Three Main Sections, each with multiple Levels,** as shown in Fig. 3.

Sections ⇓ Levels ⇒	**Level 0 Section Starting Point**	**Level -1 Section Expansion**	**Level -2 Further Section Expansion**
ASSERTIONS **what we -- KNOW --**	A List of **Assertions**	For each **Assertion:** a list of available **Evidence** each with a critical Evaluation	For each **Evidence:** a list of **Methods** for new Evidence for/ against the Assertion
CONJECTURES **what we -- MAY COME to KNOW --**	A List of **Conjectures**	For each **Conjecture:** a list of **Reasons** for/against, each with critical a Evaluation	For each **Reason:** a list of possible **Methods** for/against the Conjecture
STRONGER INFERENCE **what we -- DON'T KNOW --**	A List of **Observations,** each not clearly understood with present knowledge	For each **Observation:** a list of all alternative, **testable Hypotheses**	For each **testable Hypothesis:** a list of **Methods** for obtaining Evidence for/ against Hypothesis

Fig. 3, Title: Sections and MultiLevel expansions for a Compendium-Format.

Fig. 3 Legend: A MultiLevel-Format for K-Step Compendia. On the vertical dimension of different Sections, the range of possible Knowledge about the topic is covered by what we: **1)** Know, **2)** May Come to Know, and **3)** Don't Know. On the horizontal dimension of the expansion of a Section, the evidence, reasons, or alternative hypotheses are presented and evaluated. Further expansion (Level -2) deals with possible means by which to improve knowledge of the topic. {29}

The three Sections (Fig. 3, **vertical** dimension) cover the range of what we know about a given (narrow) Topic. Each Section can be easily expanded (Fig. 3, **horizontal**

dimension) by the Reader to *additional levels*, using clicks. The novice Reader, desirous of an "overview," can avoid the technical levels that are of interest to the expert, such as experimental detail, and debates concerning the adequacy of proffered evidence. A more advanced Reader can "drill down" to find material of interest. This MultiLevel Format is **a powerful tool for any Reader**, who can first see an overall structure in the top levels, and then take a path down into the material to a level that is best for *that particular Reader*, *at that particular time*. {30}

The **Assertions-Section** contains a *List* of Assertions, *i.e.*, statements considered to be "generally believed" and/or "well-established". For a *given* Assertion, the Reader can, by just a click, see the Evidence for (and against) the Assertion, critically evaluated. By another click, descriptions of new research methods that may provide new Evidence can be seen. In this way the Reader can “drill down” into the MultiLevel material, according to the depth of interest *at that time*. *NB*: The MultiLevel Format **does not exist in present review articles**. {31}

By containing only Assertions and their Evidence, the overall "structure" of the field is made apparent. Assertions need to evaluated based on the strength of the evidence that supports them. The most important Assertions are based on the best evidence and they provide the strongest "structure". Weak assertions are better placed in the Conjectures Section, so that the weaknesses can be explicitly stated, and a possible route to better evidence can be delineated. {32}

"One size *may not* fit all." In the case of the Assertions-Section, the Compendor may find that a further classification is needed for the material submitted. For example, topics that are in contention could be subdivided into "Conventional Assertions" and "Unconventional Assertions". Such subdivisions may be suggested by Readers or Contributors. The goal of the Compendor should be the best presentation of the given topic, and some experimentation may be necessary to find the best organization. Indeed, different organizations of Knowledge could be the basis of the use of newer Formats in some topic-areas. {33}

The **Conjectures-Section** will contain a *List* of statements (written in the form of Assertions) within the purview of the Narrow-Topic of the Compendium, but having an inadequate experimental basis to be considered an Assertion. By clicks, the Reader can expand the text to include the reasons that support or refute a given Conjecture, while further clicks can reveal possible experimental methods that might prove or refute that Conjecture. {34}

The Conjectures-Section (which **does not exist in present review articles**) can contain

contributions from those scholars who do not have the time and/or resources to pursue an idea, even a good idea. Such scholars include Emeritus Professors, Investigators whose grant applications were not funded (80% of applications!), "post-docs" working outside of their original fields, researchers who have ideas (but for one reason or another, do not have facilities or support to test them), or those who (though having research training) work in institutions or at jobs where research is not possible. The Chained Hash Algorithm (described later) will ensure that anyone submitting a Conjecture that is posted online in a Knowledge-Step Forum can receive proper credit, even if the words or ideas are later plagiarized.

Because of this automatic protection, submitting ideas to a Conjectures Section is actually *desirable* from the Author's standpoint, in order *to establish priority about the idea.* This is similar to the effect of preprint publications today, but without the requirement for data before being able to qualify as a preprint. {35}

The Conjectures Section is important because informed conjectures may provide a basis from which new advances can occur, as has occurred repeatedly in the history of science. The Section may also contain hints of the benefits and problems of different experimental paths that may be of use to those who may want to work on a Conjecture. {36}

It is expected that the *placement* of a given entry in a Knowledge-Step Forum will be *dynamic*. A given statement may start as a Conjecture and later be moved into the Assertions Section (or *vice versa*), as the evidence builds, over time. {37}

The **Stronger-Inference Section** will have a *List* of Observations that, by present Knowledge, are not understood. (Again, this **does not exist in present** review articles.) {38}

Note: It is important to ***not*** *start with a hypothesis*, even though popular descriptions of science state that a hypothesis is the starting point of a scientific study. The reason to ***not*** *start with a hypothesis* is described in a wonderfully honest, insightful quote from T.C. Chamberlin, a geologist, who, in *1897*, said [Chamberlin1897] [slight editing shown by brackets]: {39}

> "The moment one has offered an original explanation for a phenomenon [and the explanation] seems satisfactory, ... [At] that moment affection for [one's] intellectual child springs into existence, ... and as the explanation grows into a definite theory [one's] parental affections cluster about [the] offspring and [the theory] grows more and more [valuable and indispensable] ... .
>
> "There springs up also unwittingly a pressing of the theory to make it fit the facts and a pressing of the facts to make them fit the theory…."

To avoid this **otherwise inescapable trap**, the Author [Jewett2005] has recommended "Strong***er*** Inference" which *starts* with an ***observation*** *that has not yet been understood.* This must be followed by enumeration of ***all alternative hypotheses*** that might account for the observation, based on present knowledge. Then, using experimentation or observations, *hypotheses are rejected or not.* The skill of the scientist is evident by the number of hypotheses a given experiment can rule-out. The process continues until a single hypothesis remains that has survived an experimental test by which it could have been rejected. This remaining Hypothesis is the "currently-held view" of the "cause" of the Observation (and so could become an Assertion in a Compendium). {40}

To the laity, this remaining hypothesis is "truth," but the Scientist knows that this currently-held view can change if new Knowledge leads to new Hypotheses. If so, then one must return to Experimentation in order to rule-out the new Hypotheses. {41}

It is commonly stated that one can "only disprove a hypothesis", one can never "prove one". Whether this is true depends on the hypothesis. If the hypothesis is a broad generalization ("All swans are white"), then it can only be disproven. On the other hand, if the hypothesis is limited ("Sometimes in this pond, one or more swans are black"), then the hypothesis *can* be proven. This difference is especially important in Medicine, where the hypothesis is often limited ("This patient has tuberculosis"), and the diagnosis can be proven by a single test (*e.g.,* sputum analysis). {42}

An *Important Note*: In Medicine, a "Differential Diagnosis" has a structure very much like Strong***er*** Inference!

1. In documenting a patient's medical condition, first, the physician describes a "chief complaint" (an Observation chosen from the patient's history as important).
2. After a detailed History (containing Observational evidence), the physician lists the clinical and laboratory findings (Evidence).
3. The clinician must next list the *Differential Diagnosis,* a list of *all* diseases (hypotheses) that might explain the chief complaint and the observations.
4. Finally, there should be a list of further tests (Experiments) still needed to rule out (or rule in) some of the diagnoses. The skill of the clinician is shown by proposing tests (independent, experimental observations) that will rule out as many diseases as possible. {43}

*The significance of this parallel between Differential Diagnosis and Strong**er** Inference is that Medical School Faculty can compare a* Clinician's use of Differential Diagnosis with that of the Scientist using Strong***er*** Inference. In this way, **the use of Strong*er* Inference within Knowledge-Step Forums for improving Medical Knowledge** can

become part of Medical and Surgical Post-Graduate Education. {44}

The aphorism "Strong***er*** Inference sharpens the cutting edge of science" will be demonstrated as it is being used in K-Step Compendia. By having Strong**er** Inference as a part of K-Step Compendia, it becomes a natural part of the Compendor's thinking while developing a Knowledge-Step Forum. This is one of the ways that Knowledge-Step Forums (and their associated K-Step Compendia) can make an important contribution to Post-Graduate Education in *both* Science *and* Medicine. {45}

Tools.5 Variations on the MultiLevel-Format

Note that the MultiLevel Format is applicable ***to many different overall teaching patterns***, including many in Medicine, as shown in Fig. 4. Thus, should some Compendor find that MultiLevel Format described above does not suit what is needed for some Narrow-Topic, a change in the meanings of the sections or levels may make the Format useful. What is *most important* is that the presentation be useful to the contributing experts, as well as the ultimate Readers. {46}

Fig. 4: The large variety of different expansions that can be used in a MultiLevel Format.

General ⇒ Specific (Generalization to Examples)
Specific ⇒ General {Instances to Generalizations)
Non-quantitative ⇒ Quantitative
Content ⇒ Critique
Descriptive ⇒ Analytic
Analytic ⇒ Descriptive
Theorem ⇒ Proof
{Medical} Symptom / sign ⇒ Differential Diagnosis
{Medical} Diagnosis ⇒ Alternative Rx
{Medical} Diagnosis ⇒ Complications
{Medical} Presentation of illness ⇒ Disease Progression
{Medical} Disease Progression ⇒ Complications
{Medical} Event ⇒ Consequences
{Medical} Disease Hz & Rx ⇒ Dx Critique
{Medical} Rx ⇒ Appropriate and Inappropriate Usage
{Medical} Novice ⇒ Advanced

Fig. 4 Legend: The MultiLevel Format is applicable to many teaching situations. The list here is not exhaustive, but only intended to show the large range of applicability of the MultiLevel Format. {47}

Tools.6 The MultiLevel-Format as an aid to writing

A previous idea needs further explanation and expansion. In Tools.4 (bottom of p.13) is this statement:

"The design of the Compendium-Format has ***two mutually-reinforcing*** goals:

1. To be ***easy to create*** (by concentrating on the basic "structure", *i.e.*, the core ideas of the Narrow-Topic; and by organizing the presentation in a MultiLevel Format)."
2. To be ***easy to comprehend*** (by the simplification derived from concentrating on the basic "structure", and by using the MultiLevel Format)." {48}

With respect to #1: The process of writing in a MultiLevel-Format is very similar to, and has the strengths of, the method of "writing a paragraph", as is commonly taught in high schools and colleges (here paraphrased): "At first, tell them what you will tell them; then tell them." Paragraphs in this form are *easier for the Reader* for the same reasons that we have presented for the MultiLevel Format. What this does *for the Author* is force an organization onto the presentation in which the "summary (thesis) sentence" is the ***first*** Sentence the Reader sees in the paragraph. In order for the Author to compose such a first-Sentence, the Author must mentally go through the *contentions* that will be presented, and summarize them in his/her mind. ***That summary becomes the first Sentence.*** *This thought-process ensures that the* ***goal*** *of the paragraph is clear to* ***both*** *the* ***Author*** *and the* ***Reader.*** This same procedure is ***an essential part of writing in a MultiLevel Format.*** {49}

What the MultiLevel Format *adds for the Author* is the ability to easily categorize the "contentions" into Levels, and indicate those Levels to the Reader. As described by Jewett [1981] in his article on "Multi-level writing in theory and practice", a **standard presentation** is ***linear***, requiring ***every*** Reader to follow the *same path* through the material. *Any material that is* ***secondary*** to the main theme will *interrupt the linear flow of the ideas*. So, in writing in a linear-presentation-mode, considerable author-time is devoted to finding a way, within the linear-text, to express the importance of ***secondary material***. The Author tries out many phrases, such as "However, . . ", "On the contrary,…", "Another view …", "Despite …", *etc*. {50}

In contrast, the **MultiLevel Format** has a ***parallel*** presentation, where the Reader can immediately understand that the ***secondary material is secondary,*** by means of the typographical method chosen by the author to indicate different levels. So, the author can easily add secondary material just by shifting that material to a different level. ***Such writing is both faster and easier.*** {51}

The ease of writing in an MultiLevel Format was confirmed when Jewett & Rayner wrote an

entire textbook in this style [Jewett1984]. Both authors, each very experienced in technical writing, found it *much easier* to write in this format. {52}

Tools.7 The MultiLevel-Format mimics the Knowledge-Path

Returning, now to the 2nd part of the statement near the start of Tools.4 (top of p.14):

"The design of the Compendium-Format has ***two*** *mutually-reinforcing* goals: ...

2. To be *easy to comprehend* (by the simplification derived from concentrating on the basic "structure", and by using the MultiLevel Format)." {53}

The reason that the MultiLevel-Format *aids comprehension* is shown in Fig. 5, where the multiplicative nature of the MultiLevel Format is diagrammed. {54}

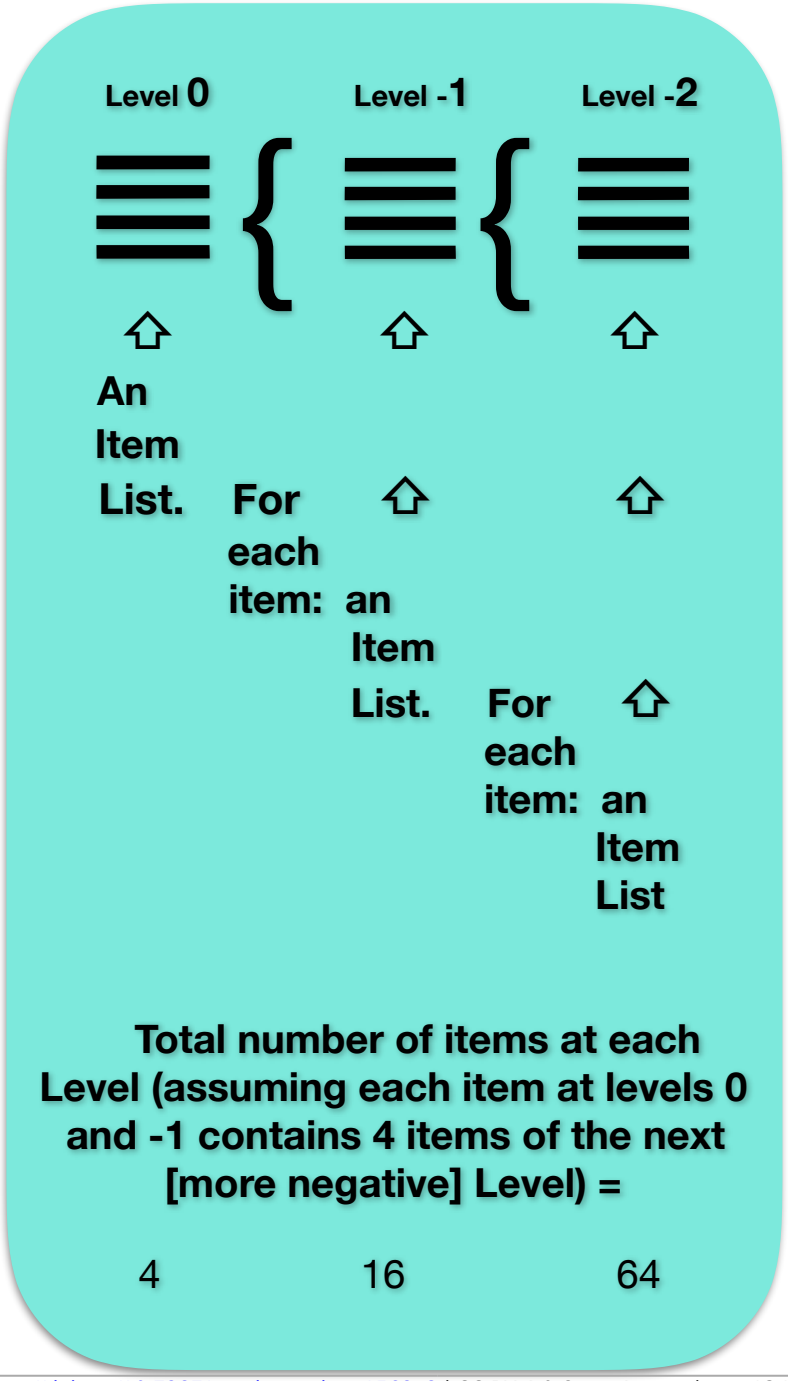

Fig. 5: The multiplicative nature of MultiLevels in K-Step Compendia.

Fig. 5 Legend: This diagram demonstrates what is *not* shown in Fig. 3: that the increasing Levels of the **MultiLevel Format** are multiplicative in number. That is, more and more *detail* is described when moving to the next lower level (the more negative level number). {55}

In Fig. 5, the horizontal lines show *items* at three ***levels***, *within a single Section,* such as "Assertions". For didactic purposes, let's assume that there are four Assertions (shown just as horizontal lines at Level 0). Further, assume that the third Assertion contains four items (as indicated by the large '{' symbol). In turn, the third item at Level -1, itself contains four items at Level -2. When this sort of expansion occurs for *many* of the items of the Assertions Section, then the ***total number of items at*** *each Level increases as a multiple of the preceding Level* (as shown by the numbers at the bottom of the Figure). Notice also that the amount of *detail increases* when going to more negative Level numbers. Expressed differently, the evidence needed for an Assertion at Level 0 is made up of greater and greater ***detail*** at Levels -1 and -2, *etc*. {56}

Thus, when going from ***RIGHT-to-left*** in Fig. 5, one is moving from *lower levels to higher levels.* This is in the *same direction as "up" on the Knowledge-Path in Fig. 1 with respect to increasing generality and decreasing particularity.* {57}

Summarizing: when the MultiLevel Format is used in a Knowledge-Step, *the relationships* ***within each*** *Knowledge-Step* is analogous to the relationships ***between*** the Steps to the Knowledge-Path. Stated yet again in a different form: the *local* organization *within* each Knowledge-Step mimics the structure *within* the Knowledge-Path of Fig. 1. {58}

The Knowledge-Path goes from particularity to generality, just as occurs *within* a Step from ***RIGHT-to-left*** in both Figs. 3 & 5 (where the Level 0 generality is based on the particularities in lower Levels). W*ithin a step, each Assertion is* essentially an accurate *summary* of the material at lower-levels within that Step, just as a "higher-level" K-Step-Compendium (in Fig. 1) should accurately summarize the Knowledge of "lower-level" K-Step Compendia. {59}

The reason that this organization makes it "*easy to comprehend*" should now be clearer. A Reader of a K-Step-Compendium will find the "summary statements" first (just as in the "paragraph structure" advocated by our teachers. {60}

For the same reason, it is easier for the Knowledge-Compendor of a Knowledge-Step to evaluate how the Knowledge in previous steps will be incorporated (or modified) to go into the Step the Compendor is creating. {61}

In summary, the overall goal of K-Step Compendia is to organize information and knowledge so that it is easily accessible and understandable. The Knowledge-Path contains an organization such that moving on the path, the ***generality of knowledge-structure becomes apparent, while the particularity of detail diminishes. The same organization occurs also within each Knowledge-Step via the MultiLevel Format*** {62}

Tools.8 Protecting posted submissions from plagiarism

Authors wish to be quoted, but *not* plagiarized. The difference between quotation and plagiarism is in the **attribution:** is it correct or faked? A Chained Hash Algorithm can be used to establish which of two sources was first to publish on the Web. If a plagiarizer uses the algorithm, but fakes to make it appear to have been published earlier, faking demonstrated by a Chain of Hash-numbers cannot be refuted by a plagiarizer. {63}

Providing proof of authorship will be especially important in the "Conjectures" category of MultiLevel K-Step Compendia. Conjectures do not have sufficient evidence in their favor, and may well be rejected for publication in a paper-based publication-paradigm for that reason. Those who have such Conjectures are Senior Scientists or Clinicians, and Students just entering Post-Graduate Training, **and** everyone **in between!** These ideas are often hidden because **if they are made public, the attribution will be lost** (*i.e.,* it is highly-likely that plagiarism may occur on the good ideas). By offering a place where attribution will ***not*** *be lost*, Knowledge-Step Forums provide a means for **broader dissemination of "odd-ball" ideas, and hunches**. Realize that **some of these ideas and hunches will actually become the basis for progress in the field**, as has been shown repeatedly in the history of science! {64}

There should be several classes of recognition when new evidence brings about a change of knowledge in a field:

1. Who thought of the idea, and when?
2. Who invented the method used to test and prove the idea, and when?
3. Who created the definitive evidence, and when? {65}

All of these scholars deserve credit for the ultimate result, though presently only #3 presently "counts". The use of a Chained Hash Algorithm in K-Step Compendia could certainly provide appropriate credit within the research enterprise, while contributing to dissemination of potentially useful, but as yet unproven ideas. {66}

Here is how the CHA (Chained Hash Algorithm) will work. A new contribution to a Knowledge-Step Forum (such as a comment, an annotated citation, a quotation, a section, *etc*.) is only permitted for those who have previously registered and provided name, contact information, and other MetaData, and have been verified by email. Automatic processing of a new contribution from a registered Author includes creating MetaData that identifies the Contributor as the Author of the contribution. Then, both the contribution and specified parts of the MetaData are concatenated together with a previously-chained hash-number, and the whole concatenation is then hashed yielding the CHA Hash for that contribution. The CHA Hash is then transmitted within the MetaLink MetaData, so it exists on multiple WebSites. This is a variant of "cipher block chaining" [Schneier1996, p.193]. {67}

A characteristic of such Hashes is that change of even a single bit in the concatenation will markedly change the Hash-number. While collisions (identical hash-numbers) can theoretically occur, they are *exceptionally unlikely, especially when the change* in the contents of the concatenation *is limited by actual names, and appropriate words of a language.* Any claim of a plagiarist to have published the contribution before the true Author can be rebutted by review of the published hash-numbers of both the Author and the plagiarist. {68}

Since any errors in these hash-numbers might have a serious effect on an Author's career, mistakes (such as data-drop out) could be costly. Therefore, extra ECC (Error-Correcting-Code) is applied to the hash-numbers for storage and transmission. {69}

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Tools.9 A Summary of the differences between a present-day Review Article and a MultiLevel K-Step-Compendium Compended-Guide

Fig. 6: Comparison of a *Review Article and the new "Compended-Guide" (on **two pages**).*

Comparisons of ⇒ ⇒ with respect to ⇓ ⇓	**Paper-based Journal Review Article**	**Online Journal Review Article**	**Online Compended-Guide: a K-Step-Compendium, with narrow-topic, in MultiLevel Format**
Paradigm shift	No	No	**Yes**
Author's Academic Level	Senior Scholar (Faculty, Scientists, & Clinicians)	Senior Scholar (Faculty, Scientists, & Clinicians)	*All Scholars*, both Senior Scholars (Faculty, Scientists, and Clinicians), and those in training (PreDoc, PostDoc, Clinical Fellow, Medical/Surgical Resident)
Readership Limitations	Must be Subscriber or Library user	None: Open Access	None: Open Access
Reader's Cost	High	Low	Low
Author's Cost	Low	Moderate to high	Low
Typography by	Publisher	Author	Author
Facilities needed to make Review article public	Publisher, Subscribers & Libraries	Online Publisher; Fee support	Individual Scholar with access to WebSite server (Institutional [free] or Commercial [low fee]), using Knowledge-Step Forum Software
Peer review	Once	Once	**Continuous**; *After* Posting
Time before content is available	Often Many Weeks from review, delays waiting for space	Possible less review delay; some waiting for space	**Immediate Posting**; 1. Peer review occurs ***after*** posting; 2. No waiting for space
Can content expand with new info?	No (separate errata only)	Yes, by Revision	**Yes.**

Comparisons of ⇒ ⇒ with respect to ⇓ ⇓	Paper-based Journal Review Article	Online Journal Review Article	Online Compended-Guide: a K-Step-Compendium, with narrow-topic, in MultiLevel Format
MultiLevel Format?	No; *Linear* presentation	No; *Linear* presentation	Yes; **Parallel** format for a range of different Interests and/or Backgrounds
Efficiency for Developing a Bibliography	*Low* efficiency; Reader must access multiple WebSites; must choose Link-jump based only on standard citation to whole article	*Moderate* efficiency; Reader may need access to several WebSites; must choose Link-jump based only on standard citation to whole article	**High efficiency**; All information available online with these reader-aids: 1. **Assertions with Evidence** 2. **Observations with alternative hypotheses** 3. **MultiLevel-Format helps to identify weak Assertions and additional research pathways** 4. **Contributions with correct attributions**
Ancillary benefits	Author's reputation enhanced if Journal is highly ranked	Rapid Publication at times	1. ***Self-organizes* a community of like-minded scholars** 2. **Speeds knowledge creation** 3. **Actively teaches scholarly approach to problems** 4. **Each participant motivated by *self-interest*** 5. **Format helps placement in Knowledge-Path** 6. **Is "self-correcting" *via* continuous peer-review** 7. **Can be used to "make a mark" in one's field.** 8. **Creative Commons copyright with correct attribution** 9. **Automatic Hashes against plagiarism.**

(no Fig. 6 legend) {70}

Tools.10 The use of Knowledge-Step Forums for Preprint-Critiques

The Software for Knowledge-Step Forums is designed for collection and display of *peer-reviews* of scholarly work by Compendors. Another means of obtaining *peer-reviews* and critiques from experts is by means of a Preprint Publication on the Web. Such preprinting has a substantial history in Physics through the WebSite "ArXive". Pre-printing is just beginning in Biology and Computer Science *via* "PeerJ Preprints".

If a Preprint is the content of a Knowledge-Step Forum, then the Forum-Software can post the Article, and receive comments from registered viewers. The Author/ Compendor can then reply, or modify the content, as appropriate. Thus, if the "peer-review needs" of scholars are not being met, then the Knowledge-Step Forum Software will provide an easy means for scholars to obtain peer-review on the Web. {71}

An advantage of the Software for Knowledge-Step Forums for use in Preprinting is that it provides protection against plagiarism (*see* Tools.8). By this means the Chained Hash Algorithm will provide definite evidence of the date of posting. {72}

Tools.11 Speeding Publication via posting of Articles

Just as the Knowledge-Step Forum Software can be used to post Preprints (*see* Tools.10), the Software can also be use to *post Articles* on the Web. As with Preprints, the advantages include protection against plagiarism (*see* Tools.8). {73}

Thus, an Author could post using the Knowledge-Step Forum Software initially for a Preprint-Critique, and then, after either replying to the Critiques or modifying the Article, the continued posting would essentially be a Web-based "publication" on an Active Archive, which can remain available until the Preprint becomes a Journal-Article, or until it is Archived elsewhere. {74}

This completes the "Tools" Section. Next the Knowledge-Compendors are described.

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KNOWLEDGE-COMPENDORS:

Compendors.1 Who will be Compendors for Knowledge-Step Forums?

As evident above, the duties of the Compendor are several. Whom in Academe can we count on? Who will self-nominate for this activity when there are *always* grant deadlines and teaching responsibilities? {75}

This Article supports the Author's view of Post-Graduate Education, which is based on the following aphorism:

> A goal of "Training" is for the student to
> "Learn specific ***responses*** for specific ***situations***".
> A goal of "Education" is for the student to
> "Learn to devise ***new*** responses for ***new*** situations".
> A goal of "Post-Graduate Education" is for the student to
> "Learn how to ***Create Knowledge***, *by doing it*". {76}

In the Author's view the best candidates to be Compendors are **Post-Graduate Students *at all levels.*** There are several reasons for this statement:

1. These students are organizing information and knowledge *for themselves,* as part of the process of qualifying for a higher degree, or for a higher academic position.
2. These students have Thesis Advisors who can help them in their efforts to maintain a K-Step-Forum on a narrow topic.
3. These students will want to coordinate the *self-organizing community of like-minded scholars interested in the same* narrow *topic that will automatically occur as the Knowledge-Step Forum becomes known*. Such scholars have similar interests, may become friends and collaborators, and *may become sources of jobs* in the future. The community will be world-wide and not limited by the requirement to meet other scholars at expensive international meetings -- a huge benefit of the Internet/Web.
4. These students have grown up with computers, and with social networks based on computers, so Knowledge-Step Forums are just another part of their "computerized" life.
5. The bibliography resulting from a good Compendium could be an important part of the bibliography that is needed for a thesis.
6. It is a unique opportunity to have one's research plans *peer-reviewed* both before and during the research.
7. It may provide a chance to "make a mark" in a field. The discussion (over which the Compendor has some control) can allow the Compendor to demonstrate

competence by (offline) analysis of issues and publications.

8. K-Step Compendia may be listable on a *C.V.* in the future, if the Compendia are of good quality. {77}

Specifically, what students are we talking about?

1. Pre-doctoral students studying for a Ph.D. in science, engineering, medical sciences, *etc*. These are Post-Graduate Students from a university's viewpoint.
2. Post-doctoral students *either* working on a topic related to their Ph.D., but with new techniques and/or mentors, *or* entering a field that differs from that in which they received their doctorate.
3. Post-MD students in Medical or Surgical Residencies.
4. Post-Residency Fellows in Medical or Surgical Specialties {78}

The numbers of students in these categories are *large*. Here are some estimates:

1. Ph.D. students: The NSF (National Science Foundation) in April, 2015 listed total graduate students in Science & Engineering (excluding health) in the U.S. at over 500,000, with about 140,000 in their first year [NSF2015]. If we use the NSF first-year estimate and assume that 15,000 drop out, there would be about 125,000 new students per year. Since 50% of all students are above average, for this discussion assume a number of 62,500 above-averaged Ph.D. students each year will become Forum-Compendors.
2. Post-Doctoral students: NSF listed over 40,000 postdocs in [NSF2015]. There is no estimate of the duration of the PostDocs. If we assume a 4 year duration, there would be 10,000 new PostDocs per year. Since all are above average (continuing for a Post-Doc is *not* average), let's assume they all become Forum-Compendors.
3. Post-MD's in Residencies: The AAMC (American Association of Medical Colleges) estimated in 2013 the total physicians in Residency positions was over 116,000, with 28,500 in 1st year (average duration of 4.1 years) [AAMC2015]. It is common at many Medical Schools for Senior Residents to provide a Seminar on an advanced topic at least once in the Residency; regrettably this work is rarely published, even though many are considered by the faculty to be of high quality. Assuming that (the above-average) 50% of the Senior Residents were Compendors, then there would be 14,500 Knowledge-Step Forums in this group.
4. The total number of above-average possible Knowledge-Step Forum Compendors in the above three groups is **87,000** *per year* (62,500 + 10,000 + 14,500).

What has *not* been estimated in the number above are the following:

1. The number of students in any of the categories who study *outside of the U.S.*

Science is international in scope and geography. Good students in other countries will become Forum-Compendors for the same reasons as U.S. students do.

2. Scholars with research experience but are not presently active in research, such as Emeritus Professors, Investigators whose grant applications were not funded (80% of applications!), and those, though having research training, are working where research is not possible.

No numbers have been included for these possible Compendors. {79}

If we allow a number of 13,000 per year to cover the last two categories, an order-of-magnitude estimate for the total number of possible Forum-Compendors *per* ***year*** when each Compendor creates only one Compendium, could be **100,000**, which is about 274 per *day*. While this is a large number, it is dwarfed by the estimate of **3,700** peer-reviewed **articles** that were published ***each day*** in 2006 (1,350,000 per year) [Bjork2009]. {80}

There is plenty of material for Compending, for all!

Compendors.2 How will Post-Graduate Students communicate with Experts?

The neophyte Compendor need not be anxious that her/his expertise is insufficient for the job. Consider these reasons:

1. In reality, the Editor of a Journal does not know everything about which the Journal accepts articles. The Editor depends on the Reviewers for expert opinion, while the Editor *need only be able to read and understand* ***the reviewers comments, but not the exact details.***

   Similarly, the Compendor of a Knowledge-Step Forum, in order to be effective, need only have a general understanding of the materials submitted, since this will be sufficient to deal with comments from a Contributing Expert. If mistakes are made, the Experts and Readers will bring them to the attention of the Compendor; this is the method by which "peer review" improves publications.
2. The Compendor who is still in training will have a Mentor available for advice, either a PhD Thesis-Advisor, a Project supervisor, or a Senior Clinician. These Mentors will want each Compendium be of high quality, since it comes from her/his lab or institution. Consequently, Mentors are likely to look carefully at what the Compendor does.
3. The non-expert Compendor can start a Compendium by doing a literature search and then quoting from the literature. The Compendor need not express an opinion, but rather, can let others (in the literature) speak. In this way, it is the quoted author who "makes a claim", not the Compendor. For example, imagine

that the Compendor finds this quote in the literature: "Experiment Q by Dr. R has not resolved this issue." This can be put into the Knowledge-Step Forum, and if others disagree, then the arguments will also make the Knowledge-Step Forum an interesting WebSite. Indeed, the Compendor can write to Dr. R and say "I'm creating a Compendium related to your work, and I've found this quotation. Would you care to comment?" The probability of receiving a reply is *very* high. In this way, the Compendium can be built up, even by a neophyte Compendor. {81}

Compendors.3 Will experts review and contribute to Knowledge-Step Forums?

It is reasonable to be concerned about how much time academic faculty will be willing to spend on "yet-another job", busy as they are both writing grants and teaching. However, *self-interest is a powerful motivator:*

1. The Expert wants to be sure that her/his work is *quoted correctly*.
2. The Expert wants to ensure that the *limitations in the work of others is described accurately and completely.*
3. The Expert wants to *increase readership* of his/her work. Citations in Knowledge-Step Forums and K-Step Compendia to the Expert's publications will collect new Readers.
4. The Expert wants to *increase the quantity* of what the Expert has "given away". Academia is a "Gift-Culture" where prestige is determined by the quantity and quality of what is given away (such as time, energy, and creativity) [Raymond2000]. Note that the recognition of the Compendium-Submission is by the *group of like-minded* scholars who have been automatically assembled during the Knowledge-Step Forum-Process. Lack of participation may be noted as easily as participation.
5. The review of a Knowledge-Step Forum by like-minded scholars is a form of *post-hoc peer-review.* Experts will be encouraged to provide skilled, helpful reviews because the Expert's "peer-review" comments or additions *are read and judged by their own Peers!* Such "Meta-PeerReview" does not occur in the paper-publishing paradigm (a major failing because of the [growing?] misuse of confidentiality).
6. The Expert *wants to be* ***quoted,*** but *not* to be ***plagiarized***. The Creative Commons basis of K-Step Compendia encourages quoting, but does not guard against plagiarism. However, the Knowledge-Step Forum's regular use of the Chained Hash Algorithm means that the correct authorship of the Expert's statements can be proven at a later date. By the nature of the Chained Hash Algorithm, the plagiarist cannot deny the plagiarism. The algorithm was described in Tools.8 (above). {82}

Compendors.4 What will ensure the quality of K-Step Compendia?

There are a number of factors that should *sustain the quality* of K-Step Compendia, even though there is no *central control*:

1. The Compendor's reputation will be affected by the quality of his/her Knowledge-Step Forums. This means that there should be strong motivation for the Compendor to do a good job.
2. Since all Submissions are automatically saved, any critical comments will need to be dealt with in some way, thus increasing the quality if the criticisms are useful.
3. If K-Step Compendia of poor quality do appear, a WebSite running the Software "SlashDot" can be used to provide Readers with evaluations of K-Step Compendia so that lower-quality K-Step Compendia can be avoided. SlashDot is a well-developed method by which evaluations by many "reviewers" can be organized and presented, and where *the reviewers themselves are rated for quality and consistency*. Automatic Meta-PeerReview *via* the Web!
4. Recognize that even a low-quality K-Step Compendia may be better than *nothing*. So, time spent in finding that a Compendium is not useful, may not be fully wasted; some new References may be found.
5. Since K-Step Compendia can be copied (with correct attribution), it is feasible, under an extreme situation, to copy an existing Compendium, make changes that are felt necessary (with new attribution of the changes added to the prior attributions), and to place the modified Compendium on the Web in a new Knowledge-Step Forum. This offers a path for those who have **major** disagreements with a given Compendium (*e.g.,* when the Compendor hinders or prevents contrary views in discussion). Note that copying and re-publishing a Compendium will be plagiarism if the original Compendium is not given correct attribution, as can be proven by the Chained Hash Algorithm (Tools.8, above). Such "forking" is common in software projects involving many volunteers, and does not stop collaborations.
6. A feedback mechanism will improve Knowledge-Step Forums and K-Step Compendia, as Users communicate to Compendors about problems. New Users and Programmers may make the system better by adding to the Software when it is made Open-Source and supported by volunteers. {83}

Compendors.5 The multiple roles of Knowledge-Step Forums a scholar's career

As described in this Article, Knowledge-Step Forums can play multiple roles at different stages in the careers of scholars.

1. Initially a Post-Graduate Student could use a Knowledge-Step Forum to help delineate an area of research that is promising for an Article or Thesis.

2. During the research, a Knowledge-Step Forum could help a Post-Graduate Student to obtain comments and advice from experts other than the student's thesis advisor.
3. As research results became available, the Post-Graduate Student could use a Knowledge-Step Forum to obtain Preprint-Critiques.
4. While waiting for acceptance from a Journal, a Knowledge-Step Forum can become a form of Open-Access "Publication" on the Web, with commenting available.
5. As an Academic Career develops, there will be repeated need for Knowledge-Step Forums to study new areas, or new aspects of an area, for publications and grant applications.
6. Each of these Knowledge-Step Forums provides the Compendor with the opportunity to have two-way written communications about technical topics with Experts in the field. This is a personal advantage that is needed *throughout an academic career.* {84}

Discussion:

Much of the Discussion has been included in the parts above.

A List of the Principles that have governed the Software design, includes:

1. All software must be Intuitive-to-use for present Web-Users (*i.e.*, no manuals needed, though online Help should be available for new users).
2. The Software must utilize existing Browsers and Word-Processors.
3. Centralized administration or support must not be required (after software development and distribution).
4. Forums and Compendia will be Open-Access.
5. All code that is supported by volunteers will be Open-Source.
6. Knowledge-Step Forums will be able to adapt, over time, to changes in scholarly needs. {85}

While the long-term plan is that neither Central Support nor Central Control will be needed, initial support is absolutely needed to provide the necessary Software. After release of the Software, there may be need for additional financial support for the following:

1. A WebSite to host a SlashDot program to evaluate posted Compendia, and to "GreyList" poor Sites.
2. A WebSite to provide CHA seed numbers until minimum requirements for adequate security are met in other ways.
3. A WebSite where volunteers can provide additions/changes to Open-Source Software as continuing improvements. {86}

Conclusion:

What scientist would not wish to reach into the present fount of information/knowledge to obtain a portion of the cool, clear water, presently shooting with cannon force out of a **firehose at 3,700 articles *a day*** [Bjork2009]? That was in 2006! How many firehoses are there **today?** {87}

Extending the metaphor, the firehoses are spraying the top of a giant iceberg where only the top 10% is above the sea level. Active scholars search around the top using keyword searches and looking at "the best" journals, while the vast majority of the stored information/knowledge is soon frozen, inaccessible under the cold water. {88}

Is our Knowledge increasing? Yes, but not in proportion to the "flow" of the firehoses, but only in proportion to a numerical increase in Specialists utilizing just a small part of the information that has been produced. *Knowledge-creation* requires ***more than research papers***, and nowadays we are ***not keeping up*** with the ***just the research paper output of the firehoses!*** {89}

Contemplation of this situation should lead us to conclude that *the* present *internet paper-publishing model is* ***failing us***. No solutions, public or private, are on the horizon. {90}

In this context the idea of Knowledge-Step Forums is offered as the basis for creating *a* ***new form of peer-reviewed*** "***Compended-Guide***" *in a MultiLevel Format* (Knowledge-Step Compendia). A multitude of Forum-Compendors (pre-docs, post-docs [Nature2016], and medical/surgical residents) can be aided by their mentors and online experts to create K-Step Compendia. *All will be motivated by their own self-interest.* The Knowledge-Step Forum Software can also be used to speed publication on the Web because it will easily support Publication Preprints with online peer-review. {91}

The new method to aid Knowledge-Creation, Knowledge-Step Forums, will be:

1. adaptable to the needs of users;
2. widely-available;
3. used easily by all participants;
4. without need for continuing financial support, after the start;
5. used to improve student-roles in Post-Graduate Education;
6. useful even on *big* icebergs. {92}

Software Availability:

At present no Software is ready to be released. We have programmed various "proofs of principle" to show that the goals can be achieved with Software additions to one Content Management System: the TikiWiki Content Management System Groupware. We have determined that a consistent, easy to use format can be accessed, modified, and controlled by available word processors. We now know that the TikiWiki "Forum" mode can be modified to allow all of the other procedures described here, including restrictions. Other PHP-based Content Management Systems should also be able to incorporate the Software. {93}

Readers can check www.webcompendia.org to find the current standing of the project, and when versions may be available for beta-testing or use. {94}

Competing Interests:

The Author is the Research Director, and majority stock holder of a small business, Abratech Corporation. He is also the Principal Investigator on the small-business NIH grant that has supported this effort so far (*see* next section).

There are no other Competing Interests. {95}

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