Improving knowledge-creation and post-graduate education in science and medicine by means of webpendeons and meta-links

A Compendium is a scholarly publication that is a *concise, yet comprehensive, evaluation* of earlier work. This Article describes ways to efficiently create knowledge to be stored in Web-based Compendia. *The amount and rate* of Knowledge-Creation with presently-available Knowledge-Tools *does not keep up* with the Information-Expansion that occurs with expanded scientific and academic activity. Two issues *contributing to this failure* are *inefficient Knowledge-Tools and insufficient numbers of human Knowledge-Compenders*. WebPendeon Software will create and manage a WebSite to be used by a group of experts, in a highly-moderated special forum, *to create new Knowledge by* **WebPending** *published literature* about a *Narrow-Topic*, into an open-access online Compendium, *in a MultiLevel Format*. "WebPending" means **Compiling, Compending, Combining, and Compacting** prior literature. Repeated WebPending creates Knowledge in forms needed for easier training. The Open-Source Software described here will have *considerable and immediate impact* on Science and Medicine, with regard to: *efficiency of Knowledge-Creation, and quality of Post-Graduate Education*. The project has been designed so that *it does not need continuous funding, and will make the future Web, by itself,* **a complete self-sustaining Knowledge-Repository that can be used more efficiently than the present Web**. Open-Access WebPendeon-WebSites will be initiated and controlled by self-nominated Moderators (primarily those in *Post-Graduate Education* [Science and Medicine]). Over time, a WebPendeon will dynamically change and be repeatedly peer-reviewed (post-publication). The WebPendeon/Compendium MetaData will automatically *attribute Authorship* of contributions and then create, save, and transmit a *Chained Hash Number* in the MetaData to authenticate authorship which will make plagiarism, should it occur, provable. When no longer active, the Compendium will ultimately be placed in a

ActiveArchive in which the content is aging, but the MetaData is up-to-date about newer publications that have cited the ActiveArchive's content. Today's "passive" Archives can be transformed into more valuable ActiveArchives by means of the Open-Source MetaLink Software. Software for new MetaLinks will improve WebLinkages from/to each Compendium and WebPendeon. A MetaLink is a WebLink with considerable MetaData collected for Readers, conforming to the new MetaLink-Protocol, and will provide enhanced WebLinks that are available directly on a given WebSite. Unlike present "backlinks", all MetaLinks will be from Sentence-to-Sentence, even when forwards-in-time. The MetaData will contain data known to be of interest to Readers because means are provided within the Protocol for adapting the MetaData-Categories to the different needs of different fields, or to the changing needs in a changing field.

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Abstract

(For location of full Definitions of New Terms, see Contents.)   {2}

A Compendium is a scholarly publication that is a ***concise, yet comprehensive, evaluation*** of earlier work. This Article describes ways to efficiently create knowledge to be stored in Web-based Compendia. *The amount and rate* of **Knowledge-Creation** with presently-available **Knowledge-Tools** *does not keep up* with the Information-Expansion that occurs with expanded scientific and academic activity. Two issues *contributing to this failure* are **inefficient Knowledge-Tools and insufficient numbers of human Knowledge-Compenders**.   {3}

WebPendeon Software will create and manage a WebSite to be used by a group of experts, in a highly-moderated special forum, *to create new Knowledge by WebPending published literature* about a *Narrow-Topic*, into an open-access online Compendium, *in a MultiLevel Format*. "WebPending" means ***Compiling, Compending, Combining, and Compacting*** prior literature. Repeated WebPending creates Knowledge in forms needed for easier training.   {4}

The Open-Source Software described here will have *considerable and immediate impact* on Science and Medicine, with regard to: **efficiency of Knowledge-Creation, and quality of Post-Graduate Education**. The project has been designed so that *it does not need continuous funding, and will make the future Web, by itself, **a complete self-sustaining Knowledge-Repository that can be used more efficiently than the present Web***.   {5}

Open-Access WebPendeon-WebSites will be initiated and controlled by self-nominated Moderators (primarily those in *Post-Graduate Education* [Science and Medicine]). Over time, a WebPendeon will dynamically change and be repeatedly peer-reviewed (post-publication). The WebPendeon/Compendium MetaData will automatically *attribute Authorship* of contributions and then create, save, and transmit a **Chained Hash Number** in the MetaData to authenticate authorship which **will make plagiarism**, should it occur, **provable**.   {6}

When no longer active, the Compendium will ultimately be placed in a ActiveArchive in which the content is aging, but the MetaData is up-to-date about newer publications that have cited the ActiveArchive's content. Today's "passive" Archives can be transformed into more valuable ActiveArchives by means of the Open-Source MetaLink Software.   {7}

Software for new MetaLinks will improve WebLinkages from/to each Compendium and WebPendeon. A MetaLink is a WebLink with considerable MetaData collected for Readers, conforming to the new MetaLink-Protocol, and will provide enhanced WebLinks that **are available directly on a given WebSite**. Unlike present "backlinks", all MetaLinks will be from Sentence-to-Sentence, even when forwards-in-time. The MetaData will contain data known to be of interest to Readers because means are provided within the Protocol for adapting the MetaData-Categories to the different needs of different fields, or to the changing needs in a changing field.   {8}

Introduction:

This Project started small, but it gradually became larger as the solution to one problem solved another problem outside of the original goals. This occurred repeatedly. To see how all the pieces fit together, jig-saw style, this article is much longer and detailed than a usual submission. The Author hopes you will find your time reading this well spent. If some parts are too detailed for reading at this time, it may be advantageous to jump ahead to other parts using the Contents page (above) as a guide.   {9}

As Galbraith has said "Publication forms the core structure supporting the development and transmission of scientific knowledge." [Galbraith2015]. The Internet and the Web (World Wide Web) have revolutionized publication and information access. Libraries have discontinued "paper" journals and acquired online subscriptions for students and faculty. Open-Access publication of publically-funded research is now common, though not universal (perhaps 20%). "Publication" is still *Paper-based* in its **style and methods**, even in the **digital medium**.   {10}

Question: Will further adaptations to the paper-based publishing-model be sufficient for present and future needs? This article argues "No"; the methods and features described here are *needed **now***, and will be *absolutely necessary in the **future***, when even more articles are published. To explicate this assertion, let's first describe and discuss Knowledge-Creation.   {11}

The Author has composed an "extended aphorism" about Knowledge-Creation in Science:

Numbers *by themselves* are *not* Data;
Data *by themselves* are *not* Results;
Results *by themselves* are *not* Information;
Information *by itself* is *not* Knowledge;
Knowledge *by itself* is *not* Wisdom. {12}

The statement "Information is not Knowledge" is a phrase from a song by Frank Zappa (sometimes erroneously ascribed to Einstein). Finding the phrase stimulated the Author to both write the aphorism, and to puzzle about how Knowledge was actually created. A good question to ask is: **By what means does Scientific Information become Scientific Knowledge?** For the Author's answer, see Fig1. {13}

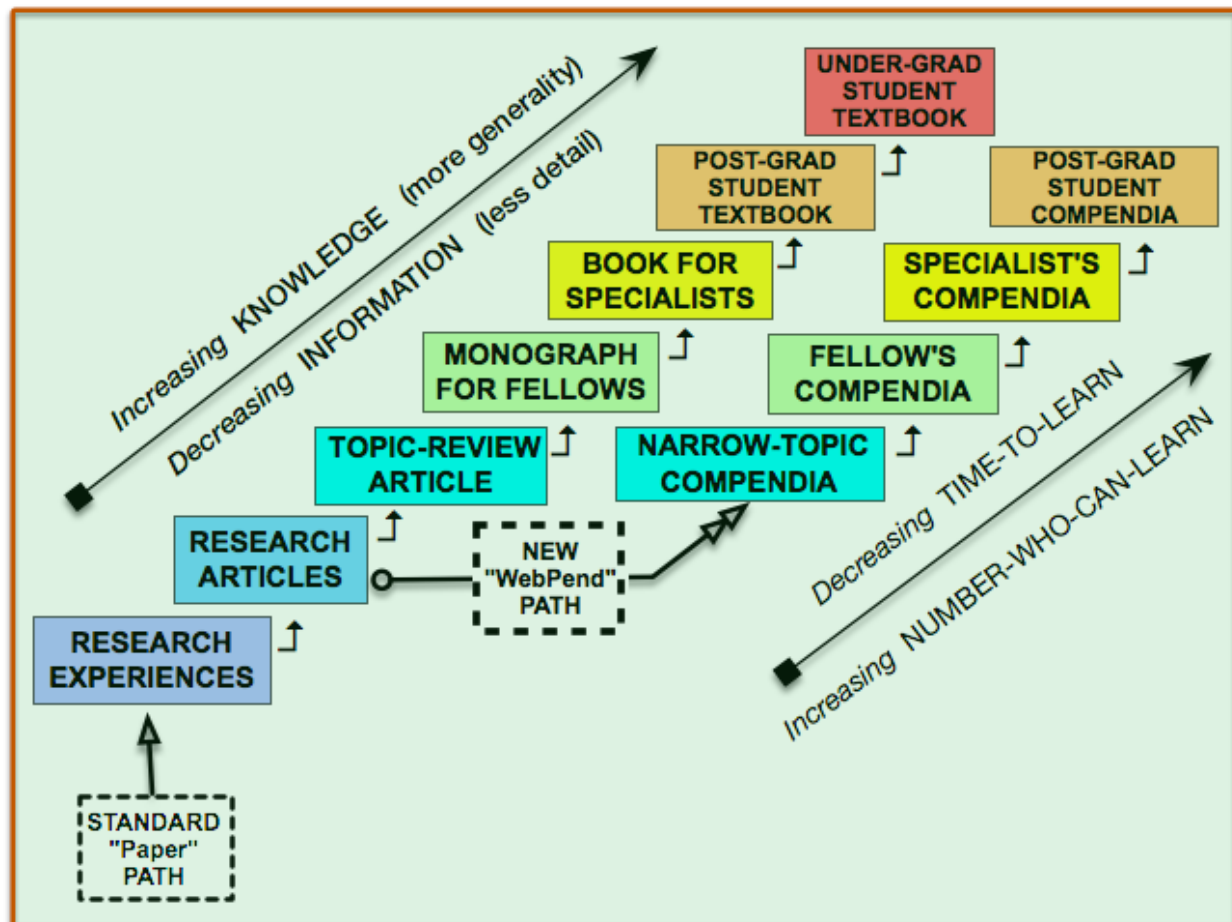Fig. 1:   A Knowledge-Staircase showing the Standard Path and a New Path.

Fig. 1 Legend: As Knowledge is created from Experience, Information, and/or prior
      Knowledge, human action is required, so that, at each step, the material is
      compiled, compended, combined, and compacted.   {14}

This complicated (yet informative) Figure shows TWO Knowledge-Staircases, each
      showing a different "Path": a) the Standard "Paper" Path; b) the New "WebPend" Path.
      In the Standard Path (the one with *more steps*), as one ascends, it is clear that the
      written material is geared towards *different Readers:* Research Articles and Review
      Articles for Researchers; Monographs for Fellows; Books for Specialists; Textbooks for
      Post-Grad Students; Textbooks for Under-Grad Students.   {15}

As one follows either path *up the Staircase*, the Level of Knowledge required of the Reader
      to understand the material becomes less. Also, going up either Staircase, the colors
      go from cooler to warmer. A similar color in *both paths* implies that the intended
      Readership is about the same at those points in the paths.   {16}

Going *down* either Staircase, one encounters the texts *in the order that students use the*
      texts to become more knowledgeable and specialized. For example, Medical Scholars
      have these levels (Standard Path *starting at the upper-right red "Under-Grad Student*
      Textbook"): Pre-Med (Under-Grad); Med School (Post-Grad); Residency Training
      (Specialists); Post-Residency (Fellows); Faculty (Review Article, Research Article).
      Another example, Science Scholars have these levels (New Path starting at the upper-
      right orange "Post-Grad Student Compendia"): Doctoral Student (Post-Grad); 1st Post-
      Doc (Specialist); 2nd Post-Doc (Fellow); Faculty (Narrow-Topic).   {17}

Compend Definitions:
    Compend = to weigh, compare, or evaluate together.
    Compendium = a scholarly publication that is *a concise, yet comprehensive,*
      evaluation of earlier work. (plural = Compendia)
    WebPend = To use the Web to create knowledge from information and/or previous
      knowledge, by means of four inter-related processes: 1) *Compiling*, 2)
      Compending, 3) *Combining*, and 4) *Compacting*. WebPending can be used to
      create the Steps of the Knowledge-Staircase ("New WebPend Path", Fig. 1). With
      sufficient compaction of knowledge students can master the material more rapidly
      than the Knowledge-Compacters of the preceding level were able to.
    WebPendeon = an online WebSite where one or more scholars can WebPend prior
      information and/or knowledge. (Plural = WebPendeons; the medical suffix "-eon"

means "that which acts".) A WebPendeon utilizes some of the features of present online forums and blogs, but has additional features that neither has. Thus, WebPendeons require special Software.

Knowledge-Staircase = a sequence of steps from repeated compending and compacting of knowledge.

Knowledge-Tool = a mechanism that aids scholars during creation of knowledge.

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Fig. 1 illustrates a number of important points:

1. *Increasing* Knowledge (greater generality) is accompanied by *decreasing* Information (less detail).

2. With decreasing detail, there is *decreasing* **time needed to reach a given level of attainment.**

3. With less time needed to learn, there are *increasing* numbers of those who *can* learn.

4. In the Figure, there are two "Paths": a) the "Standard Path", and b) the "New Path". Levels in the two Pats that have about the same degree of complexity have the same background color.   The blue "Topic Review Article" (in the "Standard Path") matches "Narrow-Topic Compendia" (in the "New Path"); note the plural "Compendia" for the singular "Article". This implies that the Topics are narrower in Compendia, and that multiple Compendia are needed to cover the larger topics in a Topic-Review, Monograph, or book.

5. Compendia in the "New Path" can serve as the "educational tools", *i.e.,* Compendia may be able to substitute for the documents described at the same Level in "Standard Path", thus moving much Knowledge online. So, a Compendium at a given level serves two goals: a) an available summary of Knowledge at that level for learning, and b) a useful Tool for creating the next Step in the Knowledge-Staircase. {19}

The creation of Scientific-Knowledge from Research-Experience (Information) can involve many steps. The number of steps to a given level depends on who is to receive and utilize the Knowledge. **Each step** requires *human* **effort**, *human* **i**ngenuity**,** and, *most critically, human* **time***.* The extra time that is 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." [Oxford1997]. {20}

The resources needed to create a full Staircase clearly involves considerable human "cost" in "time and effort". It is not cheap to makes things simple. *Au contraire.* In which case, the question of "who pays" inevitably arises. The "Standard Path" (based on the Paper-Publishing Model) has notable **limitations based on financial issues, repeatedly.** Will an Article or Topic-Review keep present reader subscriptions at a profit level? Will a Monograph or Book sell enough copies to cover costs (of the Publisher's money-losing books)? Will a Textbook sell to more than the Author's own students? **Such limitations can be hidden** with phrases such as **"the article failed peer review"**, or **"the topic is not appropriate for our venue"**, or **"our Library can't afford the subscriptions to so many Journals"**.   {21}

The "New Path" has **no financial-limitations**, where: a) all posting is Open-Access (no subscription-limitation on readership); b) there are no "authorship" charges; and c) the only (small) funds required by an Author are for WebHosting time (if at all).   {22}

Addressing now the larger picture: With increasing numbers of scholars, specialists, fellows, and faculty involved in scientific and medical research, it is not surprising that the *number* of both publications and specialized "fields" is increasing. What may be surprising is that with *increasing numbers* of specialized fields, *the number* of specialists **required to** *learn, remember, and utilize* the increased Information and knowledge *of each field* **is also increasing**!   {23}

This occurs because each specialist (being human) has limitations in learning capacity and also has a limited time available to reach the level of expertise needed for a given vocational level. From the increased number of specialist-fields, and number of specialists within a field, it follows that the *amount and rate* of Knowledge-Compending with presently-available Knowledge-Tools *does not keep up* with the Information-Expansion that occurs with expanded scientific and academic activity. Two issues that can *mitigate this failure* are a) *more efficient Knowledge-Tools* and b) *Larger numbers of human Knowledge-Compenders*. **Both** of these issues **are** directly addressed in this Article.   {24}

In the past, the primary Knowledge-Tools consisted of (paper-based) Libraries equipped
   with:
   a) Books,
   b) Journals with Articles, and
   c) Catalogs & Indexes.   {25}
Presently, Knowledge-Tools consist of:
   a) Books, some paper-based, some on WebSites,
   b) Journals with Articles, some paper-based, some on WebSites, and
   c) Indexing-WebSites with WebLinks that provide some MetaData (such as Authors,
      Titles, Fields, Keywords, Backlinks), *but which lack further MetaData that could be
      of help to Readers.*   {26}
In the future, Knowledge-Tools *on the Web* should consist of the following:
   a) Books on WebSites,
   b) Journal-WebSites with Articles,
   c) Indexing-WebSites providing specialized summaries,
   d) plus **new Nodes** (WebPendeons) and **new Links** (MetaLinks). Both are described in
      the Methods Section, below.   {27}

Summarizing the Answer to "By what means does Scientific Information become
   Scientific Knowledge?": Knowledge is Compended by Scholars into Knowledge-
   Steps, using the Knowledge-Tools that are available to them. In general, each
   Compending creates only one "step" in the Knowledge-Staircase. A notable problem
   is that each step has financial limitations in the historic "Paper-based" publishing
   model. One focus of this article is the use of WebPendeons to generate Knowledge-
   Steps in Compendia that are "published" by posting on the Web. The other focus,
   MetaLinks, is a new Knowledge-Tool that will make it easier for a scholar to traverse the
   Web to find related publications, archived Compendia, or WebPendeons.   {28}

Can the costs of the steps of *Knowledge-Creation* be lowered? **Yes. But** *it will involve
   changes* in the *format* of *online **Review-Articles.* It will also require *recruiting* new
   Knowledge-Compenders. These changes will be **voluntarily accepted** (rather than
   need to be imposed) because participation will be driven by the ***self-interest of each
   individual participant.***   {29}

Methods:

Both *Nodes and Links* on the Web are required to supply efficient Knowledge-Tools for scholars.   The new **Nodes** are described in **Section #1**. Descriptions of the new **Links** then follow in **Section #2**.

1. Nodes:

The *new Nodes are WebSites* that host WebPendeons by which Compendia are created, reviewed, modified, and displayed. The design of WebPendeons and Compendia has been influenced by the needs of the Knowledge-Staircase (Fig. 1).   {30}

Format Definitions:

MultiLevel Format = a format for presentation, which uses typographical conventions (explicitly defined by the Author), to distinguish different "Levels" of content within the writing. 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.*

Strong*er* 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].
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1a. A MultiLevel Format for 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*.* In the ascent of the Knowledge-Staircase, a MultiLevel Format for each Compendium-step will improve efficiency (*i.e.,* reduce time and effort, **both** in writing **and** in reading!).   {32}

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).   {33}

The way that the MultiLevel Format aids *both of these goals* will be shown after a description of the MultiLevel Format.

The proposed MultiLevel Format for Compendia will contain **Three Main Sections, each with multiple Levels,** as shown in Fig. 2.

Fig. 2: Sections and MultiLevel expansions for a Compendium-Format.

Section Level ⇒ ⇓	Level 0 Starting Point	Level 1 Expansion	Level 2 Further Expansion
ASSERTIONS what we -- KNOW --	A List of Assertions	For *each* Assertion, available Evidence: Description & critical Evaluation	For *each* Evidence: Methods for new Evidence for/ against Assertion
CONJECTURES what we -- HOPE to KNOW --	A List of Conjectures	For *each* Conjecture, Reasons for/ against with Summary & critical Evaluation	For *each* Conjecture: possible Methods for/against Conjecture
STRONGER INFERENCE what we -- DON'T KNOW --	A List of Observations, *not yet understood*	For *each* Observation: alternative, *testable* Hypotheses	For *each testable* Hypothesis: Methods for critical Evidence for/ against

Fig. 2 Legend: A MultiLevel Compendium-Format. On the vertical dimension of different Sections, the range of possible Knowledge about the topic is covered by what we: 1) Know, 2) Hope to Know, and 3) Don't Know. On the horizontal dimension of the expansion of a Section, the evidence is presented and evaluated, so that possible pathways are described by which to improve the knowledge of the topic.   {34}

The three Sections (Fig. 2, vertical dimension) cover the range of what we know about a given (narrow) Topic. Each Section can be easily expanded (Fig. 2, horizontal

dimension) to *additional levels* by the Reader, using clicks. The novice Reader, desirous of an "overview", can avoid the technical levels that are of interest to the expert, such as detail of experiments, and debates concerning the adequacy of proffered evidence. This MultiLevel Format is **a powerful tool for any Reader**, who can first see an overall structure, and then take a path into the material that is best for *that particular Reader*, *at that particular time*. {35}

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 viewed. 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**. {36}

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 described. {37}

"One size *may not* fit all." In the case of the Assertions-Section, the Moderator 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 Moderator 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. {38}

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.   {39}

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 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
    published online in a WebPendeon can receive proper credit, even if the idea is
    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 to qualify as a preprint.   {40}

The Conjectures Section is important because informed conjectures may provide a basis
    from which new advances can occur. It may also contain hints of the benefits and
    problems of different experimental paths.   {41}

It is expected that the *placement* of a given entry in a WebPendeon 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.   {42}

The **Observations Section** will have a *List* of Observations that are not presently
    understood. (Again, this **does not exist in the present** review articles.) **Note:** here one
    does *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]:
        "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…." {43}

To avoid this (otherwise inescapable) trap, the Author [Jewett2005] has recommended "Stronger Inference" which *starts* with an **observation** *that has not yet been understood.* This must be followed by enumeration of **all alternative hypotheses** that can account for the observation, based on present knowledge. Then, using experimental observations, *hypotheses are rejected by experimentation* 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 would then become an Assertion in a Compendium). {44}

To the laity, this remaining hypothesis is "truth," but the Scientist knows that this currently-held view can change if new Knowledge creates new Hypotheses. If so, then one must return to experimentation. {45}

The aphorism "Stronger Inference sharpens the cutting edge of science" will be demonstrated as it is being used in Compendia. By having Stronger Inference as a part of Compendia, it becomes a natural part of the Moderator's thinking. This is one of the ways that Compendia can make an important contribution to Post-Graduate Education in Science and Medicine. {46}

It is commonly stated that one can "only disprove a hypothesis", one can never "prove one". This 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 restricted ("the group of swans in this pond sometimes includes a black swan"), then the hypothesis *can* be proven. This difference is especially important in Medicine, where the hypothesis is often restricted ("this patient has tuberculosis"), and the diagnosis can be proven by a single test (*e.g.,* sputum analysis). However, the sputum-test may *not* reveal the final cause of the patient's high body temperature, which might be due to some other disease. {47}

An *Important Note*: In Medicine, the "Differential Diagnosis" is formulated just like Stronger Inference! First, the physician describes a "chief complaint" (an Observation chosen from the patient's history as important). After a detailed History (containing Observational evidence), the physician lists the clinical and laboratory findings (Evidence). Finally, the clinician must list the *Differential Diagnosis,* a list of *all* diseases

(hypotheses) that might explain the chief complaint and observations. 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.   {48}

The significance of this parallel between Differential Diagnosis and Stronger Inference is that Medical School Faculty can compare a Clinician's use of Differential Diagnosis with that of the Scientist using Stronger Inference. In this way, **the use of Stronger Inference within WebPendeons for improving Medical Knowledge** can become part of Medical and Surgical Post-Graduate Education.   {49}

Note that the MultiLevel Format is applicable *to many different overall teaching patterns*, including many in Medicine, as shown in Fig. 3. Thus, should some Moderator 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.   {50}

Fig. 3: 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. 3 Legend: The MultiLevel Format is applicable to many teaching situations, if the Author wishes to move from one level to another. The list here is not exhaustive, but intended to show the large range of applicability of the MultiLevel Format. NB: Examples are given for teaching in Medicine, where the MultiLevel Format was shown to be useful [Jewett1984], and where a version of Stronger Inference is

commonly practiced ("Differential Diagnosis").   {51}

Returning now to the statement made at the start of *this section (1a)*: "... a MultiLevel Format for each Compendium-step will improve efficiency (*i.e.,* reduce time and effort, **both** in writing **and** in reading!)." This statement needs further explanation and expansion. *First, with respect to writing*: think of the "structure" of a given Section, where "structure" means "the core ideas". This process 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; and at the end, tell them what you told 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.*   {52}

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 tend to *interrupt the linear flow of the ideas*. In a linear-presentation-mode, considerable author-time is devoted to finding a way, within the linear-text, to express the importance of this *secondary material*. The Author tries out many phrases, such as "However, . . ", "On the contrary,…", "Another view …", "Despite …", *etc*. **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-- and writing is thus faster and easier.   {53}

The ease of writing in an MultiLevel Format was confirmed when Jewett & Rayner wrote an entire textbook in this style: "Basic Concepts of Neuronal Function" [Jewett1984]. Both authors, each very experienced in technical writing, found it *much easier* to write

in this format. {54}

Returning, again, to the start of this Section, there was the following 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). {55}
These goals work together to produce a strong basis for *the next compending "step".*"
The reason for this statement (just quoted) can now be made explicit (see Fig. 4). In Fig. 4
the multiplicative nature of the MultiLevel Format is diagrammed as described in the
Fig. 4 Legend.

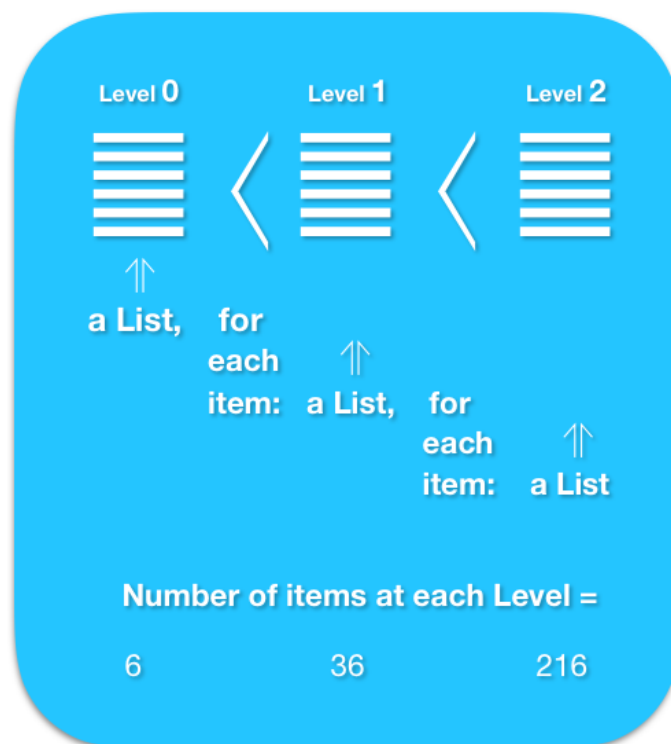Fig. 4: The multiplicative nature of MultiLevels in Compendia.

Fig. 4 Legend: This diagram demonstrates what is not shown in Fig. 2: that the increasing Levels of the MultiLevel Format are multiplicative when more and more *detail* is described.

Here, the horizontal lines show *items* at three levels, *within a single Section,* such as "Assertions". For didactic purposes, let's assume that there are six Assertions (shown as Level 0). Further, assume that the third Assertion from the bottom contains six items (as indicated by the large < symbol). In turn, the item third from the bottom at Level 1, itself contains six items at Level 2. When this sort of expansion occurs for *many* of the items of the Assertions Section, then the *size of 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 expanding

to increasing Level numbers. {56}

Now let us focus on the Assertion Section in the MultiLevel Format. As a single Assertion is expanded into lower Levels (larger Level Number), the amount of *detail is increasing!* Thus, when going from **right-to-left** in Fig. 4, one is moving in the *same direction as "up" on the Knowledge-Staircase in Fig. 1.* Expressed differently, the evidence needed for an Assertion at Level 0 is made up of greater and greater detail at Levels 2 and 3, and on. In the MultiLevel Format, *the process localized within each stair-step* is analogous to the global view of the Knowledge-Staircase itself. This provides an explanation of how the *local* organization in each Step helps the construction of the (global) Knowledge-Staircase. {57}

In the Knowledge-Staircase, a Step with a MultiLevel Format helps with the WebPending of the *next Step because, within a step, each Assertion is* essentially a *summary* of the material **within the Step**, *at the lower levels* about that Assertion (see Fig. 4). Thus, each Assertion shows a part of the *main structure (i.e., the core ideas)* of the accumulated Knowledge within that Step. In this way the MultiLevel Format helps in organizing information and knowledge, by emphasizing the **structure that persists while detail diminishes-- first within a step, and then when going up the Knowledge-Staircase.** And, because of the MultiLevel Format, it is easier for the Knowledge-Compender of the next step to evaluate how the lower-levels will be incorporated (or modified) to go into the next Step. {58}

1b. How Compendia will be created.

Forums, Blogs, and Wikis are well-developed on the Web, and WebPendeons share *some* of their characteristics. However, WebPend*eons must differ in significant ways* from each (as will become evident with further description); the consequence is that *new software is needed for WebPendeons*. {59}

To start a WebPendeon, a self-nominated Moderator establishes a WebSite with the special software described here. The Moderator chooses a narrow Topic for the WebPendeon. The Topic should meet the following criteria:

1. The Moderator is interested in the Topic and will personally gain from creation of a Compendium on the Topic.
2. The Topic is **very narrow** in scope. A narrow Scope keeps the focus of the comments and content of the WebPendeon within a range that one person's

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learning can encompass. The Scope can be enlarged later, but It is very difficult to narrow a Scope, once a WebPendeon has become established within a community of scholars.

3. The Topic has currency within Scholars of the subject-area, or will develop new interest by means of the WebPendeon.   {60}

The WebPendeon-Software for an independent WebSite will be Open-Source and will be freely available on the Web. The Moderator can place the WebSite on the Web either by means of an Institutional Server, or by a Hosting Service subscription (as described later in the Competing Interests Section of this Article). To start, the only Information the Moderator must input into the start-up text boxes of the Software, are these items:

1. Title of Compendium
2. Subtitle (if any)
3. Moderator's name
4. Moderator's affiliations
5. Keywords
6. The Narrow-Topic of the Compendium
7. Moderator's email
8. SiteAdmin's email
9. Editor's email (if appointed)
10. URL of this WebPendeon
11. Language, primary
12. MetaData required from Contributors (checklist)
13. Search-engines to be notified about changes (checklist)
14. Will content be Open-Access? Y/N   {61}

When the SetUp is complete, the WebPendeon Software sends the Title, Subtitle, and Keywords to all online search-engines that were chosen by the Moderator. The Moderator also abstracts from the available literature (or an unfunded grant application) some entries for the different sections of the WebPendeon, and emails Authors who have published material relevant to the WebPendeon's Topic, informing them that their work is being quoted. It is highly likely that the quoted Authors will reply with corrections and/or additions (see *Self-Interest*, later).   {62}

The WebPendeon operates under the follow *Rules:*
1. The *entire WebSite* can be **read** by anyone, without restriction (Open-Access).

2. All submissions are posted under a Creative Commons License that is specified on the WebSite and specifically agreed to by each Author during Registration.

3. Copying of the WebPendeon's content is only possible for Registered Users. All MetaData associated with the parts copied *must also be received and stored* by the (copying) Registered User. Thus, any material can be quoted with correct attribution from the MetaData. The MetaData will contain the content and hashes of the associated Chained-Hash-Algorithm. If a User who is *not* registered tries to highlight and copy the content of the WebSite *without the MetaData*, the WebSite's Software will make this very difficult.

4. The SiteAdmin can be contacted by any User, without any registration required (in case an unregistered Reader finds a problem).

5. Submissions are accepted only from Registered Users (email verification required) who use their own names and have also provided requested MetaData that will be saved in association with every Submission by the User. Rarely, an exception to this rule can be made by the Moderator, 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 Granted".

6. The Moderator is solely responsible for placement in the WebPendeon of every submission received. This responsibility can be assigned to the Editor by the Moderator.

7. There are six Sections within the WebPendeon, to which a submission may be placed, with or without comments added by the Moderator/Editor:
    1) Assertions
    2) Conjectures
    3) Observations
    4) Rejected Submissions
    5) Scientific Comments (general)
    6) Public Comments.
    This list may be changed at the discretion of the Moderator, as needed to best fit the needs of the Narrow-Topic.

8. Web Search Engines, specified by the Moderator, are automatically notified whenever new submissions larger than a specified size are placed within a Section. This provides a means for new Readers to find the WebPendeon from word and phrase matches.

9. Specific Comments about a Contribution, from the Moderator and/or other

Readers, are placed in an Extension of the Contribution's primary location.

10. **All** submissions to the WebPendeon WebSite **are saved, unchanged**, in the History of the WebSite (automatic by modified Version Control Software). This protects the Moderator from accusations that bias has affected either the editing or the placement of the submission within the WebSite. The only exceptions are for inappropriate, vulgar language that can be redacted before being placed in "Rejected Submissions".

11. All submissions are processed by the CHA (ChainedHashAlgorithm) and the appropriate content and hashes are stored with the MetaData associated with the submission. {63}

The following are some additional features of the WebPendeon Software:

1. The Software automatically handles routine communications, using the email addresses provided by the Moderator.

2. The Software acquires and makes available to the Moderator, 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 the warnings concerning the possible adverse effects of changes.

4. All communications within the MetaLink-Protocol are automatic (see Links #2, later). The Reader can choose the formatting of the SortableTable, and save the choices as cookies (see Links #2, later).

5. Presentation of content is uniform across Compendia unless the Moderator finds a need for additional features. The options available to the Reader, and how to control the options, are also uniform across Compendia. This makes it easy for the Reader, once accustomed to the format, to access different paths, as desired.

6. The Software must be compatible with existing Browsers and Word Processors.

7. Use of the Software should be intuitive, and not require use of Manuals, or extensive Help. {64}

1.c Who will Moderate WebPendeons?

As evident above, the duties of the Moderator 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? {65}

The Author's point-of-view on Post-Graduate Education is based on the following three aphorisms:

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**".   {66}

In the Author's view, the best candidates for Moderators are Post-Graduate Students *at all levels.* There are several reasons for this suggestion:

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 compend 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 WebPendeon is used*. 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.
4. These students have grown up with computers, and with social networks based on computers, so WebPendeons are just another part of their "computerized" life.
5. The bibliography resulting from a good Compendium could be a major 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 Moderator has some control) can allow the Moderator to demonstrate competence by (offline) analysis of issues and publications.
8. Compendia may be added to a *C.V.* in the future, if they are of good quality.   {67}

Specifically, what students are we talking about?

1. Pre-doctoral students studying for a Ph.D. in science, engineering, medical sciences, *etc*.
2. Post-doctoral students entering a field that differs from that in which they received

their doctorate.
3. Post-MD students in Medical or Surgical Residencies.   {68}

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 assume that 15,000 drop out, and an average duration of 4 years, there would be about 125,000 new students per year.   Since 50% of all students are above average, let's assume a number of 62,500 above-averaged Ph.D. students each year.
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 (all above average since continuing for a Post-Doc is *not* average).
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 Moderators, then there would be 14,500 WebPendeons in this group.
4. The total number of above-average possible WebPendeon Moderators in the above three groups is **87,000** *per year* (62,500 + 10,000 + 14,500).   {69}

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 WebPend for the same reasons as U.S. students.
2. Scholars with research experience but who 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 Moderators.   {70}

If we allow a number of 13,000 to cover the last two categories, an order-of-magnitude

estimate for the total number of WebPendeons *per **year*** when each Moderator 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]. {71}

There is plenty of Compending, for all!

1.d How will Post-Graduate Students manage communications with Experts?

The neophyte Moderator need not fear 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 his/her 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 Moderator of a WebPendeon, in order to be effective, need only have a general understanding of the materials submitted. But 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 Moderator; this is the method by which "peer review" can improve publications.

2. The Moderator who is still in training will have available for advice a Mentor, 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 their lab or institution. So, they are likely to look carefully at what the Moderator does.

3. The non-expert Moderator can start a Compendium by doing a literature search and then quoting from the literature. The Moderator need not express an opinion, but rather, can let others speak. In this way, it is the quoted author who "makes a claim", not the Moderator. For example, imagine that the Moderator finds this quote in the literature: "Experiment Q by Dr. R has not resolved this issue." This can be put into the WebPendeon, and if others disagree, then the arguments will also make the WebPendeon an interesting WebSite. Indeed, the Moderator 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 (see description of the *self-interest of Experts*, **1.e**). And the Expert's reply can go into the WebPendeon. In this way, the Compendium can be built up, even by a neophyte Moderator (Fig. 5) (next page). {72}

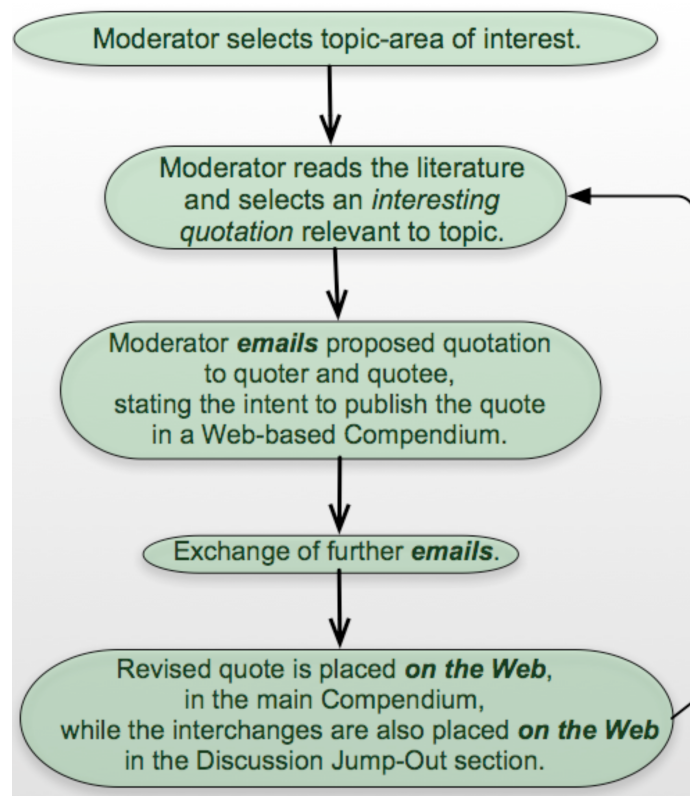Fig. 5: How a non-expert Moderator can start a Compendium.

Fig. 5 Legend: A Moderator does not need to be an "expert" at the *start* of a work on a WebPendeon. It is necessary only that the Moderator becomes familiar with some of the literature of the area, and that s/he quote that literature to others (some of whom are experts). The community of like-minded scholars will naturally develop from the availability of these communications on the Web.   {73}

1.e Will experts review and contribute to WebPendeons?

It is reasonable to be concerned about how much time academic faculty will be willing to spend on a "new 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 *limitations in the work of others is described accurately and completely.*
3. The Expert wants to *increase readership* of his/her work. Citations in WebPendeons and Compendia to the Expert's publications will collect new Readers. Any Citations to WebPendeons and Compendia from the Expert's articles will create MetaLinks to the CitING publications (see Section 2, below).
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-Contribution is

by the *group of like-minded* scholars who have been automatically assembled during the WebPendeon-Process. **Lack of participation may be noted as easily as participation.**

5. The review of a WebPendeon by like-minded scholars is a form of *post-hoc peer-review.* It can be more detailed that the pre-hoc peer-review. And the Experts are encouraged to provide good reviews because the Expert's "peer-review" comments or additions *are 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 CreativeCommons basis of Compendia encourage quotation, but do not guard against plagiarism. However, the WebPendeon's regular use of the Chained-Hash-Algorithm means that the correct authorship of the Expert's statements can be established and maintained (and the plagiarist cannot deny the plagiarism). The algorithm is described in Section ***1.g*** (below).   {74}

1.f What will ensure the quality of Compendia?

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

1. The Moderator's reputation will be affected by the quality of moderated WebPendeons. This means that there should be strong motivation for the Moderator to do a good job.

2. Since all Contributions are automatically saved, any critical comments will need to be dealt with in some way, thus increasing the quality.

3. If Compendia of poor quality appear, a WebSite running the Open-Source Software "SlashDot" can be used to provide Readers with evaluations of Compendia so that lower-quality 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*. **Automatic Meta-PeerReview** *via* **the Web!**

4. Recognize that even a low-quality Compendia may be better than *nothing*. So, time spent in finding that a Compendium is not useful, may not be fully wasted; a few new References may be found.

5. Since 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 WebPendeon. This offers a path for those who have considerable disagreements with a given Compendium (*e.g.,* when Moderator 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 ChainedHashAlgorithm (next section). Such "splitting" is common in software projects involving many volunteers, and does not stop the collaborations.

6. A feedback mechanism similar to the one that improves and modifies MetaLinks (see Fig. 10, later) will also improve WebPendeons and Compendia, as new Users and Programmers find ways to make the system better by adding to the Open-Source Software. {75}

1.g Protecting posted submissions on WebPendeons 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, and also provides data that cannot be refuted by a plagiarizer. {76}

Providing proof of authorship could be especially important in the "Conjectures" category of Compendia. Conjectures do not have sufficient evidence in their favor, and may well be rejected 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 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, WebPendeons provide a means for **broader dissemination of "odd-ball" ideas, and hunches**. Realize that **some of these ideas and hunches will be the basis for progress in the field**, as shown repeatedly in the history of science. {77}

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 an idea, and when?
3. Who created the definitive evidence, and when?

All of these scholars deserve credit for the ultimate result, though presently only #3

"counts". The use of a Chained Hash Algorithm in Compendia could certainly provide appropriate credit within the research enterprise, while contributing to dissemination of potentially useful, but yet unproven ideas.   {78}

Here is how the CHA (ChainedHashAlgorithm) will work. A new contribution to a WebPendeon (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. This is a variant of "cipher block chaining" [Schneier1996, p.193].   {79}

A characteristic of such Hashes is that change of even a single bit in the concatenation will change the Hash Number. While collisions (identical hash-numbers) can 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 known language.* Further, 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.   {80}

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 transmission and storage. The ECC Hash-Numbers are stored with the WebPendeon's MetaData, and transmitted to MetaLinked WebSites with MetaData (see Method's Section #2).   {81}

1.h A Summary of the differences between publishing a Review Article with present methods, compared with posting a Compendium using a WebPendeon.
See Fig. 6, next page.

Fig. 6A: Comparison of different ways to publish a *Review Article.*   {82}

	Paper-based Journal; Reader pays	Online Journal; Author pays	IndividualCompendium *(using a MultiLevel-Format)*, with MetaLinks *(displaying MetaData in SortableTables)*
Paradigm shift	No	No	**Yes**: both Compend*eons* & MetaLinks
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 (PostDoc, PreDoc, Clinical Fellow, Medical/Surgical Resident)
Readership Limitations	Must be Subscriber or Library user	Open Access	Open Access
Cost to Reader	High	Low	Low
Cost to Author	Low	Moderate	Low
Typography by	Publisher	Author	Author
Facilities needed to make Review public	Publisher, Subscribers, & Libraries	Online Publisher; Fee support	Individual Scholar with access to WebSite server (Institutional [free] or Commercial [low fee]), using Open-Source Software for WebPendeon, MetaLinks
Peer review	Once	Once	**Continuous**; *After* Posting
Time before content is available	Often Many Weeks from review, delays waiting for space	Possible reduced review delays; 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.** And Links remain active and accurate even when material is deleted from display but still in "history" files.
MultiLevel Format?	No; *Linear* presentation	No; *Linear* presentation	Yes; **Parallel** format for a range of different Interests and/or Backgrounds
Links	Citation & Backlink only to entire Article; Separate WebSite for Backlink Compilation; *no Metadata.*	Links (and sometimes Backlinks) on WebSite with content; Links only to *start* of Article; *no Metadata.*	1. **MetaLink-Metadata automatically available on same WebSite as conten**t, **in SortableTable;** 2. **Links are *sentence-to-sentence* with sentences marked in text;** 3. *Metadata specific to each field* and **adaptable to changing knowledge;** 4. **Author's rating of importance of the specific Link.**

Fig. 6B: Comparison of different way to publish a *Review Article*.   {83}

	Paper-based Journal; Reader pays	Online Journal; Author pays	IndividualCompendium *(using a MultiLevel-Format)*, with MetaLinks *(displaying MetaData in SortableTables)*
Efficiency for Developing a Bibliography	*Low* efficiency; Must access multiple WebSites; Must choose Link-jump based only on standard citation to whole article	*Moderate* efficiency; Online; 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 Stronger-Inference alternative hypotheses** 3. **MultiLevel-Framework** 4. **MetaLinks** (marked in text) **with SortableTable-Metadata** (and cookies) 5. **Creative Commons copyright with correct attribution in Copy/Paste** 6. **Automatic Hashes against plagiarist.**
Archive's Value	Value **decreases** with time as *content* becomes out-of-date.	Value **increases** with time **only** if Backlinks are compiled and presented with the content on **same WebSite**	Value *always increases* with time because of: 1. *Automatic MetaLinks with Metadata in SortableTables* 2. *New Links marked in text on WebSite* 3. **Extensive, appropriate Metadata** 4. **Fewer plagiarisms.**
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 in topic of WebPendeon** 4. **Each participant contributes based on motivation by** *self-interest* 5. **Contributions (including Conjectures) with correct attributions, and protection against plagiarism** 6. **Helps to identify weak Assertions and additional research pathways** 7. **Framework helps subsequent compaction in Knowledge-Staircase** 8. **Is "self-correcting"** *via* **continuous peer-review** 9. **Can be used to "make a mark" in one's field.**

Methods (continued):

2. Links:

The *second* major component of the Knowledge-Creation Tools are ***Links*** *between* Nodes.

Link Definitions:

MetaLink = a Web*Link* containing *Meta*Data of interest to the Reader. A generic term that includes both *Retro*Links and *Forward*Links, *i.e.,* the *new Links* of the MetaLink-Protocol. (Since "meta" derives from "above" or "superior", this name also implies that MetaLinks are better than present WebLinks, which they are.)

RetroLink = A MetaLink in a Cit*ing* Newer-Text, that takes the Reader to the Cit*ed* Older-Text.

ForwardLink = A MetaLink in a Cit*ed* Older-Text, that takes the Reader to the Cit*ing* Newer-Text.

LinkPair = A pair of MetaLinks comprising a *Retro*Link and the *Forward*Link created from it, which are created by two WebSites that are conforming to the MetaLink-Protocol. When an Author creates a "standard citation" using the MetaLink-Protocol, the LinkPair is the result.

MetaLink-Protocol = The Protocol that defines the actions needed from an Author and the two WebSites of a LinkPair in order to create a *Retro*Link on the Newer-Sentence WebSite, and a *Forward*Link on the Older-Sentence WebSite.   {84}

A 70+ page ForwardLink-Protocol has been submitted to the IETF (Internet Engineering Task Force) as an Informational RFC (Request for Comment) [Jewett2015]. Clearly there is much technical detail in the Protocol that need not be repeated here. That draft will automatically be withdrawn on Dec. 17, 2015. The Author will either revise that temporary document, or publish it as a preprint. Either way, the References here will be updated, so at to provide an up-to-date Citation.   {85}

Present-day Link terminology is confusing for non-programmers, at best. As new uses and needs for Links are invented, as done here, *new terms are needed,* for these reasons:
  1. The new Links have **many properties not available** in present Links.
  2. The Link Names need to indicate functionality that is *intuitive* for **Readers**.
  3. The new Link Names should not have been used previously.   {86}

See Fig. 7, below.

Fig. 7: Comparing the New Names for WebLinks with presently-used Link Names.
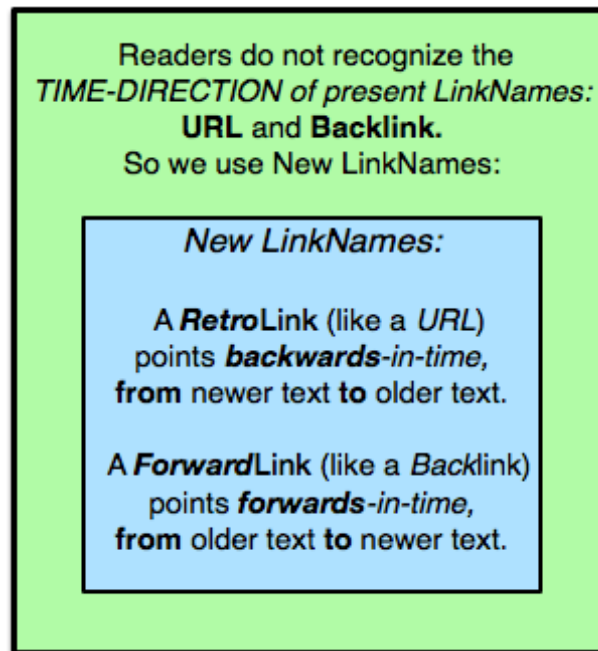
Fig. 7 Legend. Some readers find it hard to realize that Backlinks and *Forward*Links are
the same, until they read the last line of this Figure.   {87}

If you want to have a reason for the confusion, the Author's guess is this: A "Backlink" is
named from the Programmer's point of view-- initially, a link can only go from newer-
text to older-text (*e.g.*, a traditional citation). Hence, another link based on the initial
link, now from the older-text to the newer-text, is going *back* to the text of the original
citation (a BackLink).
In contrast, the *Forward*Link name is easily understood from the Reader's point of view,
that is *the Reader's subjective time.*   {88}

The Reader's *subjective time* is **the time of what is being read** (*e.g.* see Fig. 8, next page).

Fig. 8:   Relative, Objective Age from the Reader's Subjective Time, **when reading TextB.**

Fig. 8. Legend: (a) Reader's "Now" (Subjective Time) is determined by the material *being read*, not by Objective Time. In the Reader's Subjective time when reading TextB, TextC is in the future and TextA is in the past. The "Relative Objective Age" is shown in sequential numerals; all Texts exist-- none is *actually* in the future.

(b) TextB is **both** the *Newer Text* (relative to Text A) **and** the *Older Text* (relative to TextC), **at the same time.** This can occur because the *relative* "age" is determined by the relationship with the *other* Text of a LinkPair.   {89}

The Reader's *Subjective Time* is *not the same* as *Objective time* (see Fig. 8a). In Fig. 8a, from the Reader's point-of-view *when reading TextB*, TextC does not exist-- it is in the "future". But in Objective time, all of the Texts in Fig. 8, exist; none are in the future.{90}

A given Text can be both Older and Newer *at the same time,* because these adjectives are determined by the age relative to the *other Text* in a LinkPair (Fig. 8b). In Fig. 8b, there are *two LinkPairs*: 1) the TextB-TextA *Retro*Link, and 2) the TextB-TextC *Forward*Link. The first Text-Name of a LinkPair is the Text that contains the Link.   {91}

When a LinkPair is processed in the MetaLink-Protocol, first there is a *Retro*Link in the Cit*ing* Text ; a *Forward*Link in the Cit*ed* Text can only be created after a *Retro*Link exists. So, in Fig. 8b, the TextB *Retro*Link implies that TextA has a *Forward*Link to TextB (*not shown*). Similarly, in Fig. 8b, the TextB *Forward*Link to TextC implies that on TextC there exists a *Retro*Link to TextB (*not shown*).   {92}

2.a Why are new Link-Formats needed?

*Forward*Links are *critically important for scholars* for the following reasons (which also apply to presently-available "Backlink" sources, such as the Web of Science):

1. A Reader can follow *Forward*Links to *the more recent activity in the field*.
2. *Forward*Links automatically demonstrate t*he contribution of older work to newer discoveries*.
3. *Forward*Links are *non-semantic*. *Forward*Links are based on ideas, concepts, and associations occurring in the minds of *human experts*, in conditions where automatic indexing of words and phrases by machines *may fail* to find a connection! For example, the glossary of a Linking article may not share *any words* in common with the glossary of a Linked article, especially where the Citation has been across scientific fields; in such a case *word-searches will be very unlikely to provide any means to find the "idea-linked" article.*
4. *Forward*Links easily cut across disciplinary and keyword barriers, where word-searches can fail.   {93}

Unfortunately, there are *many **problems*** with present "Backlinks":

1. The Web of Science (previously Science Citation Index) is available online, but requires fees from Readers. Further, it does not index new publishers/WebSites [Larsen 2010]. Even though in 2008 Web of Science indexed over 1,187,000 articles, about 3,250 articles ***per day*** [Michels2012], in 2007 it was covering "a decreasing part of the traditional scientific literature" [Larsen2010]. Larsen also stated: "A special report from NSF in 2007 . . . contains a short discussion about the coverage of Thomson ISI Indexes. It is mentioned that 'journals of regional or local importance may not be covered, which may be especially

salient for research in engineering/technology, psychology, the social sciences, the health sciences, and the professional fields, as well as for nations with a small or applied science base.'" [Larsen2010]. ***This is not satisfactory for the goals of this project.***

2. CrossRef, the inter-publisher facility to coordinate Backlinks, has a minimum annual charge of $330 [CrossRef2013], which is too expensive for individuals and small organizations.

3. Backlinks have **only minimal information**, and *lack MetaData* that could help Readers (see section 2b, below).   {94}

One of the design principles of this project is that it will continue to run without commercial or public support, and without top-down supervision (see Discussion). The present "Backlink" arrangement requires commercial support and the continuation of commercial institutions. This is a carry-over from the paper-based publishing model, and is *not appropriate* for the Compendium Publishing Model described here. The MetaLink-Protocol allows *any* Journals or Compendia to have MetaLinks. This *makes the Web*, by itself, a *complete Knowledge-Repository*, rather than depending on several limited commercial operations in order to continue indefinitely into the future.   {95}

2.b What MetaData Categories are likely to occur in MetaLinks?

Examples of MetaData Categories that would be applicable to many Articles and Compendia in BioMedical Sciences are shown in Fig. 9. This list is taken from the Internet-Draft submitted to the IETF (Internet Engineering Task Force) as an Informational RFC (Request for Comment) [Jewett2015].   {96}

In Fig. 9 are shown MetaData Categories that are likely to be used in the MetaLinks of the MetaLink-Protocol. In creating this list, it is assumed that there is only *one* Article, containing *one* Sentence, and the Sentence has only **one** *Retro*Link and **one** *Forward*Link. For each additional MetaLink, there would be additional MetaData; the spaces to place such additional MetaData are indicated in this list by the term "Repeat ... as needed". Some lines are left blank at some transitions, to aid in identifying the level. The "null" locations are where MetaData would be entered during use of the Database. The font is enlarged a bit to make it easier to see the indents. If the font were in the size of the rest of this article, this Figure would be 1.4 pages smaller.   {97}

Fig. 9. A List of MetaData Categories to be stored and transmitted between Linking
WebSites.

Abbreviations
        # = unique ID within a given SupraCategory or Category
        #x = a specific ID
        #_ = an unspecified ID (to be specified "later")

"Database" : {

  "START": "ARTICLE#/TEXT# GROUP",
  "Note": All IDs in this Group, created by THIS WebSite",

  "ThisList-**Article**#w": {

    "Static MetaData": {
      "Title": null,
      "Subtitle": null,
      "Author": null,
      "Author-Info": null,
      "Moderator": null,
      "Moderator-Info": null,
      "Standard, Full BibRef": null,
      "Keywords": null,
      "Field of Interest": null,
      "Sub-Field of Interest": null,
      "HTTP-URL_Display_CitED_Article": null,
      "Cookie-Keyword(s)": null,
      "Language": null,
      "Is content open-access?": null,
      "Is MetaData open-access?": null,
      "Minimum Math BackGround Needed": null,
      "Minimum Statistics BackGround Needed": null,
      "Questions for CitING-Author": {
        "Question A1": null
      }

```
          "Repeat": "Addl Questions as needed",
         "Contact info": {
           " Author email": null,
           "Moderator email": null,
           "WebAdmin email": null
       }
   }


   "Dynamic MetaData": {
      "Date of Last Update of Article Dynamic MetaData": null,
      "Total Number of ForwardLinks in Article": null,
      "Number of new ForwardLinks in Article each Month": null,
      "Number of new RetroLink in Article each Month": null,
      "Number Total WebLinks in Article": null,
      "Number Total non-WebLink References in Article": null,
      "Number Total of Reader Visits to Article": null,
      "Number of Reader Visits to Article each Month": null,
      "Number Total Pages/Words in Article": null,
      "Different MetaData-Categories from Other Articles": {
         "Category name": null,
         "URL of Article with new Category": null,
         "Date this name first Received": null,
         "Keywords of other Article": null,
         "Field of Interest of other Article": null,
         "Disposition of this Category": null,
         "Date of Disposition": null
      },
      "Repeat": "Addl Different MetaData-Categories as needed"
      },
   },

   "ThisList-Text#x": {

      "Static MetaData": {
         "Date First Posting of Text in this Article": null,
         "ID of Article#_": null
         "ID of Text#_": null
         "Text of Text#_": null,
```

```
        "Preview of Text#_": null,
        "Author": null,
        "Author-Info": null,
        "Moderator": null,
        "Moderator-Info": null,
        "HTTP-URL_Display_Text": null,
        "HTTP-URL_FL-P_Send_MetaData": null,
        "HTTP-URL_FL-P_UpDate_MetaData": null,
        "Location within Article": null,
        "Section within Article (if used)": null,
        "Questions to CitING-Author, specific to Text#_": {
          "Question T1": null,
        }
        "Repeat": "Questions specific to Text#_ as needed",
        "Contact Info": {
          "Author email": null,
          "Moderator email": null,
          "WebAdmin email": null
        },
      },

    "Dynamic MetaData": {
        "Date Last Update to this Dynamic MetaData": null,
        "Date Last Change to Text": null,
        "Total Number of RetroLink from Text": null,
        "Total Number Clicks of Text from RetroLink": null,
        "Total Number of ForwardLinks from Text": null,
        "Total Number Clicks of Text from ForwardLinks": null,
        "Nbr new ForwardLinks from Text each Month": null,
        "List of Article#( ) Comments about Text": null"

    "Link-List": {

        "START": "RetroLink Alternative of Article/Text GROUP",
        "Note": "All Link-IDs created by THIS WebSite.",

        "ThisList-RetroLink#y": {
          "Dynamic MetaData": {
```

```
        "ID of RetroLink#_": null,
        "Location of RetroLink-Icon": null,
        "ID of TEXT#_": null,
        "Date/Time last update request": null,
        "Date this Link created": null,
        "Date Last Update this MetaData": null,
        "Date this RetroLink Last Followed": null,
        "Monthly % Readers followed Link": {
           "Fraction Numer (Nbr Rdrs followed Link)": null,
           "Fraction Denom (Nbr Rdrs saw LinkData)": null,
           "Computed % (Numr/Denm) " 100": null
        },
        "Total % Readers follow Link":{
           "Total Monthly Reader Sum-Numer": null,
           "Total Monthly Reader Sum-Denom": null,
           "Computed % (Sum Numr/Sum Denm) " 100": null
        },
     }
  "END": "RetroLink Alternative of Article/Text GROUP",
"END": "This part of ARTICLE#/TEXT# GROUP",

     "START": "RetroLink GROUP",
     "Note": "All IDs from OlderText WebSite",

     "Older-Text MetaData": {
        "OlderTextArticle#_": {
           "Static Metadata": {
              "Title": null,
              "Subtitle": null,
              "Author": null,
              "Author-Info": null,
              "Moderator": null,
              "Moderator-Info": null,
              "Standard, Full BibRef": null,
              "Keywords": null,
              "Field of Interest": null,
              "Sub-Field of Interest": null,
              "HTTP-URL_Display_CitED_Article": null,
```

```
      "Cookie-Keyword(s)": null,
      "Language": null,
      "Minimum Math BackGround Needed": null,
      "Minimum Statistics BackGround Needed": null,
      "Questions for CitING-Author":  {
          "Question A1": null
      }
      "Repeat": "Addl Questions as needed",
      "Contact info": {
          "Author email": null,
          "Moderator email": null,
          "WebAdmin email": null
      }
  }
  "Dynamic MetaData": {
      "Date of Last Update of Article Dynamic MetaData": null,
      "Total Number of ForwardLinks in Article": null,
      "Number new ForwardLinks in Article each Month": null,
      "Number of new RetroLink in Article each Month": null,
      "Number Total WebLinks in Article": null,
      "Number Total non-WebLink References in Article": null,
      "Number Total of Reader Visits to Article": null,
      "Number of Reader Visits to Article each Month": null,
      "Number Total Pages/Words in Article": null,
      "Different MetaData-Categories from Other Articles": {
          "Category name": null,
          "URL of Article with new Category": null,
          "Date Category first Received": null,
          "Keywords of other Article": null,
          "Field of Interest of other Article": null,
          "Disposition of this Category": null,
          "Date of Disposition": null
      }
      "Repeat": "Addl Diff. MetaData-Categories as needed",

  }
  "OlderTextTEXT#_": {
      "Static Metadata": {
```

```
        "Date First Posting of Text in this Article": null,
        "ID of Article#_": null,
        "ID of TEXT#_": null,
        "Text of TEXT#_": null,
        "Preview of TEXT#_": null,
        "Author": null,
        "Author-Info": null,
        "Moderator": null,
        "Moderator-Info": null,
        "HTTP-URL_Display_Text": null,
        "HTTP-URL_FL-P_Send_MetaData": null,
        "HTTP-URL_FL-P_UpDate_MetaData": null,
        "Location within Article": null,
        "Section within Article (if used)": null,
        "Questions to CitING-Author, specific to TEXT#":  {
            "Question T1": null,
        }
        "Repeat":    "Addl Questions--as needed"
        "Contact Info": {
            "Author email": null,
            "Moderator email": null,
            "WebAdmin email": null
        }
     }
    "Dynamic MetaData": {
        "Date Last Update to this Dynamic MetaData": null,
        "Date Last Change to Text": null,
        "Total Number of RetroLink from Text": null,
        "Total Number Clicks of Text from RetroLink": null,
        "Total Number of ForwardLinks from Text": null,
        "Total Number Clicks of Text from ForwardLinks": null,
        "Nbr new ForwardLinks from Text each Month": null,
        "List of Article#(w) Comments about Text": null
    }

    "Link-List": {

        "OlderTextForwardLink#_": {
            "Dynamic MetaData": {
```

```
                    "ID of ForwardLink#_": null,
                    "Location of ForwardLink-Icon": null,
                    "ID of TEXT#_": null,
                    "Date/Time last update request": null,
                    "Questions to & Answers from CitING Author": {
                       "Question T1": null,
                       "Answer T1": null,
                       "Question 1": null,
                       "Answer A1": null,
                    },
                    "Repeat": "Addl Questions & Answers as needed",
                    "Keywords entered by Author": null,
                    "Other entries by Author": null,
                    "Date this Link created": null,
                    "Date Last Update this MetaData": null,
                    "Date this Link Last Followed": null,
                    "Monthly % Readers followed Link": {
                       "Fraction Numer (Nbr Rdrs followed Link)": null,
                       "Fraction Denom (Nbr Rdrs saw LinkData)": null,
                       "Computed % (Numr/Denm) " 100": null
                    },
                    "Total % Readers follow Link":{
                       "Total Monthly Reader Sum-Numer": null,
                       "Total Monthly Reader Sum-Denom": null,
                       "Computed % (Sum Numr/Sum Denm) " 100": null
                    }
                  }
                }
              }
            }
          }
        "END": "RetroLink Group",
      },
        "START": "Another part of Article/Text GROUP",
        "Repeat":    "RetroLink#_, as needed",

        "START": "ForwardLink Alternative of Article/Text GROUP",
```

```json
        "Comment": "IDs from ThisList WebSite",

      "ThisList-ForwardLink#z": {

         "Dynamic MetaData": {

            "ID of ForwardLink#_": null,
            "Location of Link-Icon": null,
            "ID of TEXT#_": null,
            "Date/Time last update request": null,
            "Questions to & Answers from CitING Author": {
               "Question T1": null,
               "Answer T1": null,
               "Question A1": null,
               "Answer A1": null,
            },
            "Repeat": "Addl Questions & Answers as needed",
            "Keywords entered by Author": null,
            "Other entries by Author": null,
            "Date this Link created": null,
            "Date Last Update this MetaData": null,
            "Date this *Forward*Link Last Followed": null,
            "Monthly % Readers follow Link": {
               "Fraction Numer (Nbr Rdrs followed Link)": null,
               "Fraction Denom (Nbr Rdrs saw LinkData)": null,
               "Computed % (Numr/Denm) " 100": null
            },
            "Total % Readers follow Link":{
               "Total Monthly Reader Sum-Numer": null,
               "Total Monthly Reader Sum-Denom": null,
               "Computed % (Sum Numr/Sum Denm) " 100": null
            }
         },
      },
      "END": "*Forward*Link Alternative of Article/Text GROUP",
      "Repeat": "Addl ForwardLink#_ as needed",
      "END": "Another part of Article/Text GROUP",
```

```
"START": "ForwardLink GROUP",
"Comment": IDs below from Newer-Text WebSite",

"NewerTextMetaData": {

  "NewerTextArticle#_": {
    "Static Metadata": {
      "Title": null,
      "Subtitle": null,
      "Author": null,
      "Author-Info": null,
      "Moderator": null,
      "Moderator-Info": null,
      "Standard, Full BibRef": null,
      "Keywords": null,
      "Field of Interest": null,
      "Sub-Field of Interest": null,
      "HTTP-URL_Display_CitED_Article": null,
      "Cookie-Keyword(s)": null,
      "Language": null,
      "Minimum Math BackGround Needed": null,
      "Minimum Statistics BackGround Needed": null,
      "Questions for CitING-Author":  {
        "Question A1": null
      }
      "Repeat": "Addl Questions as needed",
      "Contact info": {
        "Author email": null,
        "Moderator email": null,
        "WebAdmin email": null
      }
    }
    "Dynamic Metadata": {
      "Date of Last Update of Article Dynamic MetaData": null,
      "Total Number of ForwardLinks in Article": null,
      "Number new ForwardLinks in Article each Month": null,
      "Number of new RetroLink in Article each Month": null,
      "Number Total WebLinks in Article": null,
```

```
        "Number Total non-WebLink References in Article": null,
        "Number Total of Reader Visits to Article": null,
        "Number of Reader Visits to Article each Month": null,
        "Number Total Pages/Words in Article": null,
        "Additional MetaData-Categories from Other Articles": {
          "Category name": null,
          "URL of Article with new Category": null,
          "Date Category first Received": null,
          "Keywords of other Article": null,
          "Field of Interest of other Article": null,
          "Disposition of this Category": null,
          "Date of Disposition": null
        }
        "Repeat": "Addl MetaData-Categories as needed"
    }
    "NewerTextTEXT#_": {
      "Static Metadata": {
        "Date First Posting of Text in this Article": null,
        "ID of Article#_": null,
        "ID of TEXT# Gx_": null,
        "Text of TEXT#_": null,
        "Preview of TEXT#_": null,
        "Author": null,
        "Author-Info": null,
        "Moderator": null,
        "Moderator-Info": null,
        "HTTP-URL_Display_Text": null,
        "HTTP-URL_FL-P_Send_MetaData": null,
        "HTTP-URL_FL-P_UpDate_MetaData": null,
        "Location within Article": null,
        "Section within Article (if used)": null,
        "Questions to CitING-Author, specific to TEXT#":  {
          "Question T1": null
        }
        "Repeat":    "Addl Questions as needed",
        "Contact Info": {
          "Author email": null,
          "Moderator email": null,
```

```
            "WebAdmin email": null
        },
    }
    "Dynamic MetaData": {
        "Date Last Update to this Dynamic MetaData": null,
        "Date Last Change to Text": null,
        "Total Number of RetroLinks from Text": null,
        "Total Number Clicks of Text from RetroLink": null,
        "Total Number of ForwardLinks from Text": null,
        "Total Number Clicks of Text from ForwardLinks": null,
        "Number new ForwardLinks from Text each Month": null,
        "Comments in Article#w about TEXT# Gx": {
            "Comment 1": null,
        },
        "Repeat": "Addl Comments as needed",
    }

    "Link-List": {

        "NewerTextRetroLink#_": {
            "Dynamic MetaData": {
                "ID of RetroLink#_": null,
                "Location of Link-Icon": null,
                "ID of TEXT#_": null,
                "Date/Time last update request": null,
                "Date this Link created": null,
                "Date Last Update this MetaData": null,
                "Date this ForwardLink Last Followed": null,
                "Monthly % Readers follow Link": {
                    "Fraction Numer (Nbr Rdrs followed Link)": null,
                    "Fraction Denom (Nbr Rdrs saw LinkData)": null
                    "Computed% (Numr/Denm) " 100": null
                }
                "Total--% Readers follow Link":{
                    "Total Monthly Reader Sum-Numer": null,
                    "Total Monthly Reader Sum-Denom": null,
                    "Computed% (Sum Numr/Sum Denm) " 100": null
                }
```

```
                    }
                  }
                }
              }
            }
          }
          "END": "ForwardLink GROUP",
        }
        "START": "Last part of Article/Text GROUP",
        "Repeat":    "Addl ThisList-ForwardLink#_ as needed",
        "END": "Last part of Article/Text GROUP",
      }
    },
    "Repeat": "Addl ThisList-TEXT#_ as needed"
  },
  "Repeat": Addl ThisList-Article#_ as needed"
}}
```

Fig. 9 Legend: Listed above are MetaData-Categories that are processed by the
MetaLink-Protocol for a single *Sentence* in a WebPendeon. **Note:** The MetaData
Categories are in two sequential lists, one related to the **Article**, and the other related
to the **Text** (**Sentence**) (titled in **bold** within the Figure). Also, *Retro*Links are in a list
separate from the *Forward*Link's list. The Format used is JASON-LD, with
"Label:Content" pairs. (The "null" is the space for the Content requested by the Label
before the colon). Within a SupraCategory, the listing is grouped by items that are
logically together, for the viewers benefit. In the actual Database they may be arranged
alphabetically.   {98}

In the saved MetaData shown in Fig. 9, there are both Static and Dynamic MetaData about
the **Article**, and there are both Static and Dynamic MetaData about the **Text**
(**Sentence**). The reason to distinguish the types of MetaData is, as time passes, the
Dynamic MetaData may well change, and those changes may be of interest to the
Readers. For example, how many prior Readers have followed a given Link? And, is
interest changing over time? Consequently the Dynamic MetaData is updated each
time some Reader requests the information, whereas the Static MetaData is
transmitted just once, when the MetaLinkPair is setup.   {99}

The MetaData-Categories shown in Fig. 9 are those stored by the WebSite in which the
Database is stored. The MetaData is for one Article, with only one Sentence, the
Sentence having one *Retro*Link and one *Forward*Link. Thus, this list will enlarge with:
a) more Articles (in Database), b) more Sentences CitED, c) more *Retro*Links (from
different Sentences), d) more *Forward*Links (from more CitED Sentences). For every
MetaLink there are the *same* MetaData Categories in the *other WebSite of the LinkPair.*
(It is certainly nice the computers can take care of all these details!) This list of
Categories and SupraCategories is in the RFC publication [Jewett2015].   {100}

The total amount of MetaData is not excessive; realize that the cost of data storage is
decreasing over time, and is already sufficiently inexpensive that cost is not a significant
issue. Why not save data that may be useful to some Reader or later Historian?   And
why not add Dublin Core MetaData, too [Dublin2015]?   {101}

2.c How ForwardLinks will be used.

Fig. 10 shows how a Reader uses *Forward*Links. The Legend describes the numbered
steps *in detail*.   (go to next page)

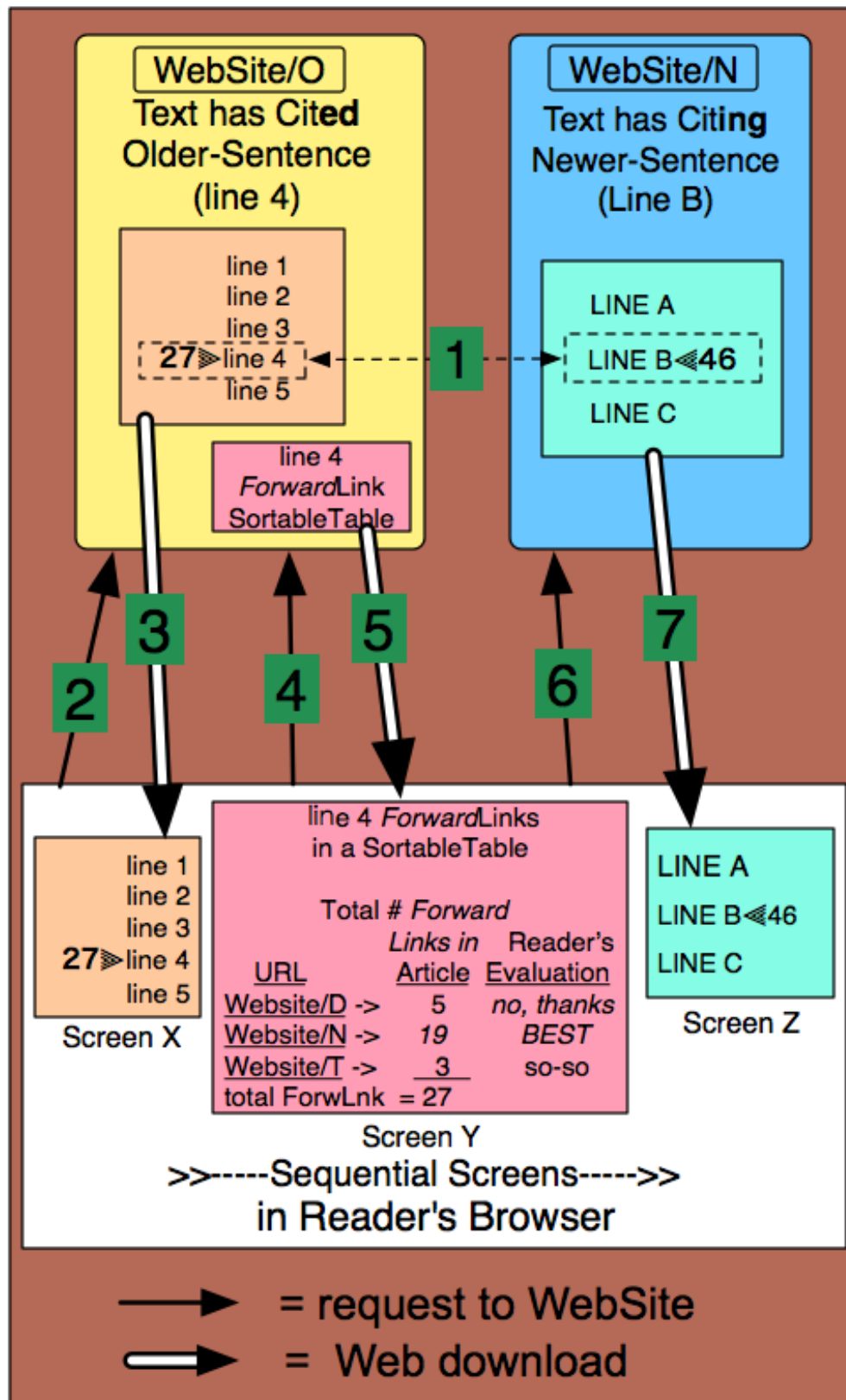Fig. 10: How a Reader of an online text will find and utilize a ForwardLink.

Fig. 10.   Legend: The seven numerals in green boxes show the sequential steps when a Reader utilizes a *Forward*Link when reading online Text.

IMPORTANT: This Figure shows, in the white box at the bottom, labeled "in Reader's Browser" the three sequential screens that the Reader sees. The screens are labeled X, Y, Z.   {102}

The arrows with the green numbers relate to online communications "in the background", as follows:

1. The two WebSites ("O" and "N") have previously communicated and established a *Retro*Link on WebSite/N (Newer-Sentence) and a *Forward*Link on WebSite/O (Older-Sentence). The Links are Sentence-to-Sentence and the two stored Texts have MetaLink-Icons (on WebSite/N, at the end of Line B, the "≪46"; while on WebSite/O, at the start of line 4, the "27≫". This provides the most basic cue to the Reader, that a MetaLink is present, and that a click will bring about the sequence shown in this Figure. The number in these two Icons indicates the total number of *Forward*Links available to the Reader *by following the RetroLink* (≪46)*, the *Forward*Link (27≫). (See further notes on this on next page.)

2. The Reader (with a blank screen-- not shown) sends a Browser request for the page from WebSite/O. The Reader has not previously seen this page, but has gotten the URL from a friend, or another WebSite.

3. The page downloads onto the Reader's Browser as Screen X. The Reader sees the 27≫ at the start of line 4, and thinking that this MetaLink could be important to what is being read, clicks the MetaLink-Icon, knowing that this will cause the next action from the Server, namely this will open a SortableTable of MetaData about all of the *Forward*Links related to this Sentence.

4. The Browser sends the click of the Icon.

5. WebSite/O downloads Screen Y, containing the MetaData about three *Forward*Links related to line 4, in a SortableTable. *Figure-Limitation Alert:* The data shown in this Figure is *diagrammatic only, and* does **not** *show* the full complexity seen in a real SortableTable. The Reader can choose (now or previously with cookies saved on the computer) from *all of the Categories in Fig. 8 related to the ForwardLinks, about the Article and/or Sentence*. For any Categories so chosen, the data from the 3 WebSites (D, N, T) will be in different rows of the Table, for direct comparison. None of this detail is shown in this Figure. **Back to "the action"**: we assume that the Reader has evaluated the MetaData (judgements

shown in the column labeled "Reader's Evaluation") and decided that WebSite/N is best to look at; the Reader then clicks the WebSite/N URL Link in order to see more.

6. The Browser, using the URL from the SortableTable, sends a display request to WebSite/N.

7. WebSite/N downloads Screen Z, showing the page containing Line B, so the Reader can investigate further. The Line B has a MetaLink-Icon "≪27" so that a Reader of the Article on that WebSite will be aware of the MetaLink-Pair. The number is showing the number of *Forward*Links available on WebSite/O. This feature is discussed further in the text.   {103}

In addition to the *generic* advantages of *Forward*Links mentioned previously, here are some of the *unique features* of *Forward*Links (not available in present "Backlinks"):

1. The MetaLink-Icons are placed within the CitED and CitING texts to alert Readers to the increased information that is immediately available if they click the Icon. The CitED text will have an Icon at the start of the Sentence (*e.g.*: #≫This Sentence has been CitED.). The CitING text will have an Icon at the end of the Sentence (e.g.: This is a CitING Sentence with a standard Reference [RefExampleOnly2015].≪#) The Icons also have an attached number (#) that indicates the number of *Forward*Links that will be available to the Reader by following the Link, either from the CitED Sentence (#≫) or from the CitED Article (≪#). (These MetaLink Icons are also shown in Fig. 10, above.)

   One may wonder "why this number"? With the large amount of information available (see Fig. 9), it is clear that the Icon, with but a single number, can communicate only a minuscule summary. What should the number (or symbol) next to the MetaLink-Icon summarize? As described in detail in Section 2a, *Forward*Links are **very** important to a Scholar because a *Forward*Link points to an Article that is *newer and related to the topic* of the Article on the OlderSentence-WebSite. So, it is likely that the Reader will want to consider following paths to available *Forward*Links. For this reason the limited space in the MetaLink-Icon is devoted to the *total number of Forward*Links that can be accessed by the Reader. There is an asymmetry, however. The Reader of the CitING Sentence will want to know the number of ForwardLinks *in the whole Article,* since **other** Sentences of the article may be CitED more times than the CitED Sentence. On the other hand, the Reader of the CitED Sentence will want to know the *total*

number of ForwardLinks that will be available in articles that *have CitED the Sentence.* Note that *this number* is only used by the Reader to decide whether to click the Icon to see the SortableTable, or not. After a click, the SortableTable provides considerable, additional MetaData for the Reader to decide whether to jump to another Article.

2. *Forward*Links are Citations from Sentence-to-Sentence, so the Reader does not have to search the entire article for the relevant part (as occurs with Backlinks that point to an entire article).

3. *Forward*Link MetaData contains Questions posed by the Moderator of the Cit*ed* Compendium, with Answers from the Cit*ing* Author (the methodology is described in detail in Jewett2015). These Questions will include the Author's estimation of the importance of what is being Cit*ed* to what is being written. This estimate is likely to of considerable help to the Reader when determining whether or not to follow the *Forward*Link to the newer material. The availability of the Author's Answers in the Database means that this information can *also be made available* to any Reader following a *Retro*Link, and it is.

4. *Forward*Links carry substantial Metadata about the Cit**ing** Article and about the Cit**ing** Sentence.

5. The MetaData is presented in SortableTables. The Reader can choose which columns to display, and which column to sort on. Cookies are placed on the Browser so that the SortableTable display chosen by the Reader can be the same for another search. Several sets of Cookies can be saved, for different topics, fields, or interests of the Reader. **This is important because there will be an increased number of scholarly-Links if there is an increased number of scholarly Compendia. Similarly, as MetaLinks are used more by Journals for their articles, there will be increased MetaData available.** Thus, Readers *should be offered help* in analyzing the increased Link-information.

6. The Metadata Categories are those of interest to Readers in the field of the Article or Compendium because the Categories have been chosen by either the Author of the Article or the Moderator of the WebPendeon. The Categories will gradually adapt to the needs of individual fields of scholarship, or to changing topics of interest within a field, as shown in Fig. 11 (next page).   {104}

Fig. 11, Title: The Feedback Loop that gradually adapts Questions and MetaData
Categories to changing needs of Readers.   {105}
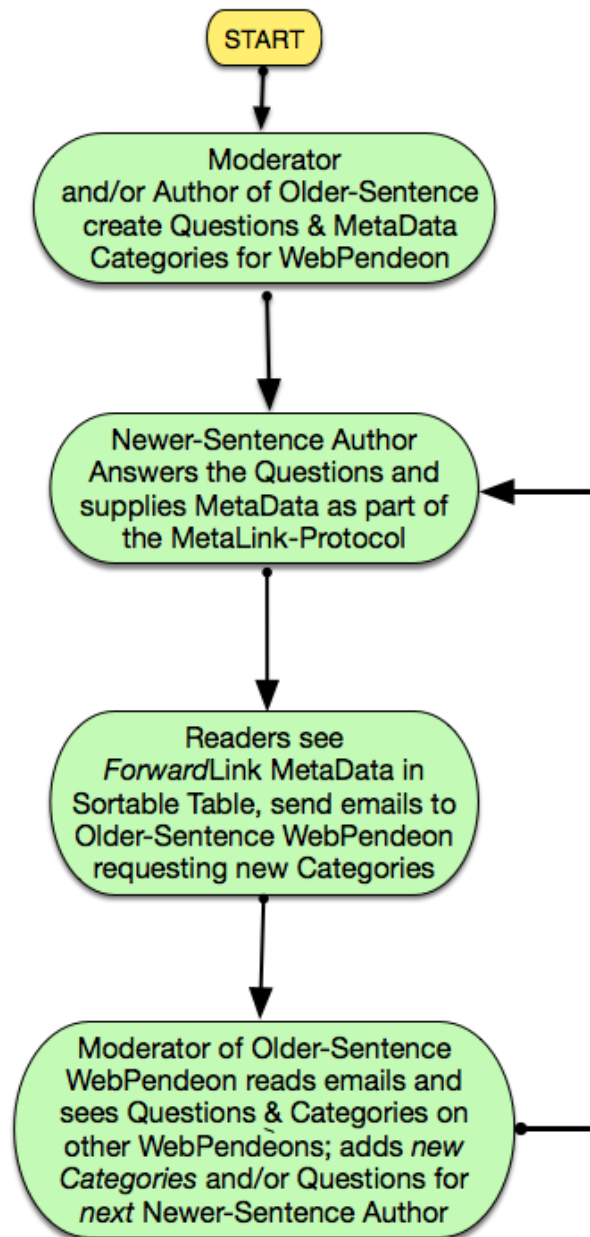
2.d What does MetaLink-MetaData do to Digital Archives?

MetaLink-MetaData creates a new form of online digital archive! A PassiveArchive can
become an ActiveArchive by utilizing the MetaLink-Protocol Software.   {106}

Archive Definitions:

PassiveArchive = an online database/archive in which *neither Content nor MetaData*
changes. The Content includes standard Citations. This Archive does *not* conform to
the MetaLink-Protocol.

ActiveArchive = an online database/archive in which the *Content never changes*, whereas
the *MetaData **does** change* because the WebSite has functioning MetaLink Software
(conforming to the MetaLink-Protocol). The consequence is that after the MetaLink-
Protocol Software is working, the WebSite develops more and more *Forward*Links
(from newer citations), while the Archive's *Retro*Links remain the same. (New
*Retro*Links would occur *only* if the *Content were changing.*) The display of Text of an
ActiveArchive displays the MetaLink-Icon (#≫) at the start of each Sentence that has
one or more *Forward*Links. Clicking on the the Link-Icon will display the MetaData for
the *Forward*Links in a SortableTable that allows the Reader to judge whether or not to
follow one or more of the *Forward*Links.

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The **distinction** between *Passive and Active* Archives is *not trivial, at all!*

A PassiveArchive *loses value* over time because both the content and (limited) MetaData
becomes older and less relevant. The information in the *online* library decays just as it
does in a *paper* library!   {108}

An ActiveArchive *gains value* over time because, although the content and citations do not
change, the *Forward*Links are *up-to-date*. This value increases as the article content
becomes older (and less useful), because *the number of ForwardLinks* (which add
value) *will increase with time*. A Reader interested in discovering new developments in
a given line of research, will **seek-out WebSites that offer the** *most Forward*Links.
(So, too, will historians of a field.)   {109}

Indeed, in the future, Articles may be ranked on the number of *Forward*Links they
contain, **since this is the same as the number of Citations the Article has**

received. Recall that a *Forward*Link is only created in response to a *Retro*Link (Citation), so that the number of ForwardLinks that an Article has is the same as the number of RetroLinks that point to some part of the Article. The number of *Forward*Links within an Article can easily be found by a Reader by sorting on the column in the Sortable Table headed "Number of *Forward*Links Available on this Article", which is one item of MetaData in Fig. 9 (the full listing in Fig. 9 is: "ThisList-**Article**#w/Dynamic MetaData/Total Number of *Forward*Links in Article").   {110}

Compendia, after they are no longer actively changing, should be "retired" in ActiveArchives of a University, Endowment, PubMedCentral, or equivalent. Compendia are contributions to Knowledge-Creation, and should be kept just as books and articles are. They should also be indexed in the same way as articles (*e.g*., PubMed) since they provide Knowledge about groups of articles that is not available from the articles themselves (Fig. 1). This would increase the value of PubMed itself as a good source of *Forward*Links (from Articles and Compendia).   {111}

Such a "store" of "retired Compendia" in could play an important part in Knowledge-Creation. New findings in other fields may cause a re-examination of the field of a "retired" Compendium that could be brought out of "retirement" by the same procedures as mentioned in Section 1.f.5 (above), to be part of a new WebPendeon dealing with this "new review" of an "old area". (Historians of science should *love this*!).
      {112}

There is an immense amount of content in present PassiveArchives. If the written material in a PassiveArchive is in alphanumeric characters, then the transition to an ActiveArchive is straight-forward by adding the MetaLink-Software. From that time forward, new *Forward*Links will be recorded as other articles or Compendia cite a Sentence within the ActiveArchive, and the ForwardLink-Icon (#≫) can be easily placed at the start of the Sentence. (If the PassiveArchive has been saved in a non-character format, then a screen overlay can be used.)   {113}

Since the importance of a whole WebSite is likely to depend on the number of *Forward*Links it has, then if two WebSites contain the *same material*, the WebSite that *first puts the material online* will have **an advantage**. This occurs because in order to create a *Forward*Link on the Cited WebSite, the Author must have online access in order to specify the Cited Sentence, and to answer the questions posed, and then to

receive the specific unique identification that is needed for inter-server processing
under the MetaLink-Protocol [Jewett2015].   {114}

The fact that the MetaLink-Protocol provides an advantage to the "first online" has
particular relevance to PubMedCentral, which currently publishes NIH-supported
research papers within one year of publication. The date that publishers put a paper-
published work online must always *precede* the PubMedCentral publication date, *in
order to avoid their giving away the advantage* described above. In fact, the sooner the
publication is online, the greater the advantage. This may speed Open-Access.   {115}

Open-Access publishing provides another advantage. If an Article is Open-Access, this
increases the number of potential readers. Thus, an Open-Access mirror-WebSite is
more attractive to an Author than the original Closed-Access WebSite, when deciding
which online sources to cite. The Open-Access WebSite gains the increasing value of
an ActiveArchive, described above.   {116}

2e. Comparison of: Current WebLinks and New MetaLinks.

See Figures on next two pages.

Comparisons of:	Current WebLinks	MetaLinks by the MetaLink-Protocol
Link Names	URL & Backlink	*Retro*Link & *Forward*Link
Link Name intuitive for Reader	Not at all	Yes
MetaData about Article/Author	n/a	Yes
MetaData Categories determined by:	n/a	Authors and Readers
Displayed MetaData Categories Adapt to Different Fields; new needs	n/a	Adaptations evolve with use/time
Participation of Author-Expert	Input *only* via keywords for Author's Article	Input of MetaData of direct relevance to Readers, including Author's estimate of the importance of the CitED text to the topic of the Author's Article. (Keywords also available)
Reader-controlled sorting of Link MetaData	n/a	On SortableTable columns of interest, Reader selected: e.g., date, keywords, author-provided importance of link, etc.
Ease of Link evaluation, for Reader	**Awkward**, with multiple steps and no way for the Reader to evaluate the usefulness of a possible jump to new content	**Easy, with** immediate display of citING or citED text; Reader-chosen sorting/display of MetaData of most interest to the Reader
Specificity of Link	**Too Coarse** (Regular citations pointing to complete Articles); *or* **Too Fine** (Word or phrase found by WebSearch Engine)	**Medium** (Sentence-to-Sentence Citations, at the level of ideas, in both *Forward* and *Retro* directions.)

Fig. 12B: Comparison of Current WebLinks, and New MetaLinks.   {118}

Comparisons of:	Current WebLinks	MetaLinks by the MetaLink-Protocol
In citED WebSite: Reason that Author is citING the citED Sentence	n/a	Provided by easily-displayed citING sentence
Ease, for Author, of creating a Citation,	Multiple copy/paste from multiple sources	Single copy/paste
Creation of *either* "*Back*link" (Current) or "*Forward*Link" (MetaLink)	**ONLY IF** "Recognized" by Web of Science, or Payment of fee to special publisher organization that covers less than 50% of scientific publications	Direct, on the Article's WebSite, using free software
Archive's changing value	Value **decreases** over time, as **content** becomes "out-of-date"	Value **increases** over time, by keeping **Links** "up-to-date" with later developments
Automation	Proprietary Software	Open-source software
Encourages Open-Access publishing by individuals or small groups	No	Yes, *Forward*Links will indicate which Links are to Open-Access WebSites
Financial Cost to Readers	High -- to access Publisher's Websites and Web of Science; Reader may need university affiliation to cover fees	Links free, Content Free via Open-Access Publishers
Support needed to start	None--Commercial	Coding of Open-Source Software
Continuing support needed	Commercial or Public Funding of Databases & Servers	None

Discussion

Much of the Discussion has been included within the Methods presentation, previously
(*q.v.*).

A List of the Principles that have governed the design of both Nodes & Links, includes:
1. All software must be Intuitive-to-use for present Web-Users (*i.e.*, no manuals
     needed).
2. The Software must utilize existing Browsers and Word-Processors.
3. Centralized administration or support must not be required (after open-source
     software development and distribution).
4. There must be Open-Access at all levels.
5. All code must be Open-Source for all Nodes & Links.
6. Both Node and Link creation must be able to adapt, over time, to changes in
     scholarly needs.   {119}

While the long-term plan is that neither Central Support nor Central Control will be needed
     for either Compendia or MetaLinks, initial support is absolutely needed to provide the
     necessary Open-Source Software. After release of the Software, there may be need
     for additional financial support for the following:
1. For a WebSite to host a SlashDot program to evaluate posted Compendia, and to
        "GreyList" poor Sites.
2. For a WebSite to provide CHA seed numbers until minimum LinkPair requirements
        for adequate security are met.
3. For a WebSite where volunteers can provide additions/changes to Software as
        continuing improvements.   {120}

Conclusion

The Abstract is the best summary of this Article. If read again, it may have a different effect
        since many of the new terms will be better understood, making the concepts easier
        to fit together. So: *q.v.*

Data & 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 a 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. TikiWiki, Drupal, and Joomla! (all PHP based) can incorporate Software for the MetaLink-Protocol written in PHP. Other PHP-based Content Management Systems should also be able to incorporate the Open-Source Software. These statements apply to both the WebPendeon Software and the MetaLink Software.

Online Archives with LAMP Servers (Linux, Apache, MySQL, PHP) will be able to use the PHP Software for the MetaLink-Protocol, and thus become ActiveArchives.   {121}

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 NIH grant that has supported this effort so far (see next section). By the conditions of the grant, it is required that Abratech commercialize some aspect of the work. The Author is convinced that to gain sufficient support for these ideas to "take off", the Software for both WebPendeons and MetaLinks must be open-source, and freely available. Thus, there is no commercialization possible from Software sales.   {122}

For this reason, when the Software is ready for release, Abratech Corp. will offer "ready-to-go" "Hosting Packages" that can be used to bring a WebPendeon up and running online within (a goal of) ten minutes. While many Moderators may use Institutional servers for hosting a WebPend*eon,* other Moderators may not have such facilities, or may not want to use them.   This commercialization will remove the need for (time-consuming) downloading and installing of the (Open-Source) Software-Components needed for a useful WebPend*eon.* In this way, the commercialization interest avoids conflict with the "Gift Culture" that is highly valued by those likely to be Moderators (and the Author when he is doing research). The "Hosting Package" plan may actually be essential for WebPend*eons* and MetaLinks to succeed (by becoming "viral"), and, if so, will play a useful role in the overall goals of improving Knowledge-Creation and Post-Graduate Education.   {123}

There are no other Competing Interests.

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