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Synthetic Genomics, Inc.
c/o DLA Piper LLP (US)
4365 Executive Drive
Suite 1100
San Diego, CA 92121-2133

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HARWARD, SOREN T	

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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte CLYDE A. HUTCHISON III,
MICHAEL G. MONTAGUE, and HAMILTON O. SMITH[1]

Appeal 2020-006121
Application 15/052,781
Technology Center 1600

Before JEFFREY N. FREDMAN, ULRIKE W. JENKS, and
JOHN G. NEW, *Administrative Patent Judges*.

NEW, *Administrative Patent Judge.*

DECISION ON APPEAL

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[1] We use the word Appellant to refer to "applicant" as defined in 37 C.F.R. § 1.42(a). Appellant identifies the real party-in-interest as Synthetic Genomics, Inc. App. Br. 4.

SUMMARY

Appellant files this appeal pursuant to 35 U.S.C. § 134(a) from the Examiner's Final rejection of claims 1, 3–5, and 15–17 as unpatentable under 35 U.S.C. § 112(b) as being indefinite.

Claims 1, 3–5, and 15–17 also stand rejected as unpatentable under 35 U.S.C. § 101 for being directed to non-statutory subject matter.

Claims 1, 3–5, and 15–17 stand further rejected as unpatentable under 35 U.S.C. § 103(a) for being obvious over the combination of Wong et al. (US 2003/0219756 A1, November 27, 2003) ("Wong") and W. Ludwig et al., *ARB: A Software Environment for Sequence Data*, 32(4) NUCLEIC ACIDS RES. 1363–71 (2004) ("Ludwig")

We have jurisdiction under 35 U.S.C. § 6(b).

We AFFIRM.

NATURE OF THE CLAIMED INVENTION

Appellant's claimed invention is directed to methods and apparatus for encoding human readable text conveying a non-genetic message into nucleic acid sequences with a substantially reduced probability of biological impact, and decoding such text from nucleic acid sequences. Abstr.

REPRESENTATIVE CLAIMS

Claim 1 is representative of the claimed subject matter, and recites:

> 1. A method of generating a sequence of codon identifiers corresponding to a sequence of human readable symbols, and assigned according to a coding scheme to convey a non-genetic message in a human reference language, the method comprising:

(i) receiving the sequence of human readable symbols at a memory module;

(ii) loading a human readable symbol map within the memory module, wherein the human readable symbol map is configured to determine a codon identifier that maps to each human readable symbol within the sequence, wherein the human readable symbol map is further configured to map a human readable symbol with a frequency of occurrence that is less than one percent within the reference language to a start codon, and wherein the symbol map is further configured to map a human readable symbol with a frequency of occurrence that is greater than five percent within the reference language to a stop codon and no symbol is coded for by ATG; and

(iii) using a transcoder to map a sequence of codon identifiers corresponding to each human readable symbol within the sequence according to the human readable symbol map and outputting the sequence,

(iv) synthesizing a nucleic acid with the sequence of step (iii).

App. Br. 15.

ISSUES AND ANALYSES

We adopt the Examiner's findings, reasoning, and conclusion that the claims on appeal are indefinite under 35 U.S.C. § 112(b). However, we decline to adopt the Examiner's reasoning or conclusion that the claims are directed to non-statutory subject matter or are *prima facie* obvious over the cited prior art. We address the arguments raised by Appellant below.

A. Rejection of the claims under 35 U.S.C. § 112(b)

Issue

Appellant argues that the Examiner erred in finding that the claims are indefinite because languages define sets of symbols but do not define a "frequency of occurrence" of those symbols, and that since a body of documents can be variable, the symbol frequency will also vary and, furthermore, that symbols are shared among languages but have different frequencies of occurrence among languages. App. Br. 6 (citing Final Act. 3–4).

Analysis

The Examiner finds that the claims do not particularly point out which symbol(s) constitute(s) "a human readable symbol with a frequency of occurrence that is less than one percent within a reference language" and "a human readable symbol with a frequency of occurrence that is greater than five percent within the reference language." Final Act. 3. The Examiner finds that languages define sets of symbols, but do not define a "frequency of occurrence" of those symbol. *Id.* The Examiner reasons that the frequency of occurrence of symbols can be determined from a specific body of one or more documents, but since a body of documents is a variable object, the symbol frequency will vary from one body of work to another. *Id.* (citing MPEP § 2173.05(b)(II)). The Examiner notes that Appellant's Specification tacitly admits that symbol frequencies are not set, and instead vary depending upon the input – the Specification discloses "a symbol frequency analyzer for determining how frequently certain symbols appear within one or more input symbol streams." *Id.* (quoting Spec. ¶ 127).

The Examiner next finds that symbols (e.g., letters, numbers and punctuation marks) are shared among languages, but have different frequencies of occurrence among languages. Final Act. 3. The Examiner notes that English, French, Italian, Portuguese, and Spanish share most of their alphabets, but estimates of letter frequency from bodies of documents in each language will be substantially different. *Id.* at 3–4. For example, the Examiner finds, "h" has a relatively high frequency of occurrence in English, but not in any of the other four languages, and "v" is less common in English than in the others. *Id.* at 4.

The Examiner therefore reasons that, given two symbols, a person of ordinary skill in the art would not be able to determine with certainty whether those symbols fell within the scope of the limitation of independent claim 1 reciting "a human readable symbol with a frequency of occurrence that is less than one percent within a reference language" or the limitation "a human readable symbol with a frequency of occurrence that is greater than five percent within the reference language," since neither the language nor the body of work that establish the symbol frequency are defined by the claims. Final Act. 4. The Examiner concludes that the claims are indefinite because they fail to inform a person of ordinary skill in the art of the metes and bounds of the invention, and that a skilled artisan would not be able to determine what sets of symbols infringe the claims. *Id.*

Appellant argues that claim 1 recites that the method involves loading within a memory module a human readable symbol map that maps a human readable symbol with a frequency of occurrence that is less than 1% within the reference language to a start codon and maps a human readable symbol with a frequency of occurrence that is greater than 5% within the reference language to a stop codon. App. Br. 7. Similarly, argues Appellant, independent claim 15 recites a data structure configured to map a human readable symbol with the recited frequencies of occurrence. *Id.*

Appellant contends that a person of ordinary skill would readily comprehend that the frequency of occurrence of a symbol differs depending on which reference language is used. App. Br. 7. In support of this contention, Appellant points to the Declaration of Dr. Michael Montague (the "Montague Declaration" filed February 24, 2016). In the Declaration, Dr. Montague states that the frequency of occurrence of human readable symbols in various reference languages is well known in the art and is easily ascertainable from public sources, i.e., a simple Internet search on letter frequency or linguistic resources at a public library. *Id.* (citing Montague Decl. ¶¶ 4–5).

Appellant notes that, by way of example, Dr. Montague determined the frequency of occurrence of the letter "E" is about 13% in English, about 15% in French, about 16% in German, and about 12% in Spanish. App. Br. 7 (citing Montague Decl. ¶¶ 4–5). Conversely, Dr. Montague attests, the letter "J" occurs with a frequency of less than 1 % in English, French, German, or Spanish. *Id.* Appellant also asserts that Dr. Montague states that the same information is readily available for the other letters in many reference languages, Portuguese, Esperanto, Italian, Turkish, Swedish, Polish, Dutch, Danish, Icelandic, Finnish, Czech, and others. *Id*. (citing Montague Decl. ¶ 5).

Therefore, argues Appellant, a person of ordinary skill in the art could easily ascertain the reference language of the message (e.g., English or French or German, etc.), and the frequency of occurrence of a particular symbol in the particular reference language. App. Br. 7. Even if such were not available from public sources in an obscure language, the frequency could be determined without inventive work or undue experimentation since persons of ordinary skill in the linguistic arts clearly know how to make such calculations. *Id.* at 7–8.

Appellant argues that, despite the Examiner's finding that a body of documents is a variable object, a person of ordinary skill in the linguistic arts know what type of document they are reviewing (e.g., a scientific document, conventional text, etc.). App. Br. 8. Therefore, argues Appellant, and regardless of nature of the body of work, a skilled artisan could readily calculate the frequency of occurrence of various letters symbols without undue experimentation, and in the same manner that such values are calculated in the sources. *Id.* (citing Montague Decl. ¶¶ 4–5). Appellant asserts that a person of ordinary skill in the art would understand that this is a statistical calculation and further understands how to perform it. *Id.*

Appellant alleges that the Examiner has applied an incorrect legal standard in requiring an "absolute precision" that the Federal Circuit has held is not attainable, and that is greater than "reasonable certainty" with respect to the subject matter. App. Br. 8 (citing *Bancorp Servs., LLC v. Hartford Life Ins. Co.*, 359 F.3d 1367, 1369 (Fed. Cir. 2004); *see also Nautilus Inc. v. Biosig Instruments, Inc.*, 572 U.S. 898, 910 (2014) (holding that "'the certainty which the law requires in patents is not greater than is reasonable, having regard to their subject matter'" (quoting *Minerals Separation, Ltd. v. Hyde*, 242 U.S. 261, 270 (1916))).

The Examiner responds that numerous online and print resources do provide letter frequency tables for many languages, including English, but these tables are not consistent because the letter frequencies are estimated from different bodies of work. Ans. 11. The Examiner refers to six letter frequency tables, acquired from public sources on the Internet and submitted as evidence of record during prosecution, that demonstrate that the limitation reciting "a human readable symbol with a frequency of occurrence that is less than one percent within the reference language" might or might not include the letters "K" and "V", and the limitation reciting "a human readable symbol with a frequency of occurrence that is greater than five percent within the reference language" might or might not include the letters "H," "R," and "L." *Id.* The Examiner points out that these exemplary tables are English-language tables, but Appellant's Specification discloses that the recited "reference language" can be any natural language and need not match the language of the "sequence of human readable symbols." *Id.* (citing Spec. ¶ 87),

The Examiner concludes that the claim is indefinite because the same "human readable symbol map" might not infringe the claim when using a letter frequency table estimated from one body of work, but might infringe the claim when using a letter frequency table estimated from a different body of work. Ans. 11.

By way of example, the Examiner suggests a case in which a practitioner could start with a letter frequency table in which "V" has a frequency of greater than 1% percent, and then generate a symbol mapping in which the letter "V" is the only symbol that maps to a start codon. *Id.* at 11–12. The practitioner would thus reasonably expect that that symbol mapping does not infringe the claim, because it does not "map a human readable symbol with a frequency of occurrence that is less than one percent within the reference language to a start codon." *Id.* at 12. In this hypothetical, however, the Examiner posits that a party, in trying to show infringement of the claim, could use a different letter frequency table in which the letter "V" has a frequency of less than 1%. *Id.* In such an instance as this, the Examiner finds, the practitioner's symbol map does "map a human readable symbol with a frequency of occurrence that is less than one percent within the reference language to a start codon" and consequently would infringe the claim. *Id.*

The Examiner reasons that a claim that is infringed in some circumstances, but not in others, that is, a claim having a scope that changes based on some variable quantity - does not distinctly claim the invention, even with reasonable certainty. Ans. 12.

We are not persuaded by Appellant's arguments. Section 112(b) "require[s] that a patent's claims, viewed in light of the specification and prosecution history, inform those skilled in the art about the scope of the invention with reasonable certainty." *Nautilus*, 572 U.S. at 912. The Examiner has concluded that the claims are indefinite because, depending upon the given frequency table used by a hypothetical practitioner, the practice of the claimed method may or may not be infringing upon Appellant's claims.

The Examiner relies upon evidence of record to demonstrate that, for example, depending upon the English language-source use, the frequency of the letter "V" used is either 0.98%, 1.11%, 1.01%, 1.06%, 0.98%, or 1.05%. *See* Non-Patent Literature, filed October 12, 2018. Similarly, the letter "H" has a frequency of, respectively, 6.09%, 5.92%, 3.00%, 4.96%, 6.24%, or 5.05%, depending upon the table consulted. *Id.* It is evident, therefore, as the Examiner explains, that mapping the letter "V" as a start codon, or the letter "H" to a stop codon, would infringe in some instances and not in others, depending upon the frequency table employed by a given practitioner.

> Because claims delineate the patentee's right to exclude, the patent statute requires that the scope of the claims be sufficiently definite to inform the public of the bounds of the protected invention, i.e., what subject matter is covered by the exclusive rights of the patent. Otherwise, competitors cannot avoid infringement, defeating the public notice function of patent claims.

Halliburton Energy Servs., Inc. v. M-I LLC, 514 F.3d 1244, 1249 (Fed. Cir. 2008). Furthermore, "[e]ven if a claim term's definition can be reduced to words, the claim is still indefinite if a person of ordinary skill in the art cannot translate the definition into meaningfully precise claim scope." *Id*. at 1251.

Appellant argues that a skilled artisan in the linguistic arts would know what type of document they are reviewing (e.g., a scientific document, conventional text, etc.) and, regardless of nature of the body of work, could readily calculate the frequency of occurrence of various letters symbols without undue experimentation, and in the same manner that such values are calculated in the sources. *See* App. Br. 8 (citing Montague Decl. ¶¶ 4–5). Specifically, the Montague Declaration states that:

> Persons of ordinary skill in this field know that the frequency of occurrence of various human readable symbols in a particular language varies depending on the language. Such persons also know that the frequency of occurrence of particular human readable symbols in various languages can be readily determined by resort to publicly available information. An online search on letter frequency quickly reveals charts that set out the frequency

> of occurrence of human readable symbols in various languages, and this information is available to the public – whether from internet sources or from public libraries. This permits a person of ordinary skill to quickly ascertain the frequency of occurrence of such symbols in various languages of interest. This information was available prior to 2009, also from publicly available sources and has been of interest to the sciences, e.g.[,] in the field of linguistics.

Montague Decl. ¶ 4.

We do not find this argument persuasive. As an initial matter, the Montague Declaration does not define, or provide evidence supporting, the qualifications and knowledge of a person of ordinary skill "in this field," or even what "this field" may happen to constitute.

More importantly, the Montague Declaration does not rebut the Examiner's evidence that English language-letter frequency tables show variation in letter frequency, when derived from different, non-specialized sources. Moreover, in addition to the subject matter of the body of work, whether specialized or non-specialized, from which such a frequency table is derived, factors such as sample size are almost certain to affect the frequency of letters in the table. Furthermore, Appellant's Specification discloses that the reference language "reference language" refers to "any language on the planet." Spec. ¶ 87. We find that, given the necessary variability that such a broad definition implies, it would be dauntingly difficult for a skilled artisan to know with reasonable certainty whether a claimed letter, mapped to a start or stop codon, would be infringing or no-infringing of the claimed method.

As such, we conclude that the claims do not, when viewed in light of Appellant's Specification and prosecution history, inform a person of ordinary skill in the art about the scope of the invention with reasonable certainty, because a skilled artisan could not know, with reasonable certainty, whether practicing the method recited in the claims is infringing or not. *See Nautilus*, 572 U.S. at 912. We conclude, consequently, that the claims are indefinite under Section 112(b), and we affirm the Examiner's rejection upon this ground.

B. Rejection of the claims under 35 U.S.C. § 101

Issue

Appellant argues that the Examiner erred in concluding that Appellant's claims do not amount to significantly more than the abstract idea of a procedure for organizing information by "generating a sequence of codon identifiers corresponding to a sequence of human readable symbols." App. Br. 8 (citing Final Act. 5).

Analysis

The Examiner finds that components of the claimed method recited in the claims include a "sequence of human readable symbols," a "human readable symbol map[ ] configured to map a human readable symbol … to a start codon, and [ ] configured to map a human readable symbol … to a stop codon" and a "sequence of codon identifiers corresponding to each human readable symbol within the sequence." Final Act. 5. The Examiner fids that, considered as a whole, the invention is directed to an abstract idea because the series of steps in which information is organized is essentially the innovative aspect of the invention. *Id.* (citing, e.g., Spec. ¶¶ 17–21, 89–154). However, the Examiner finds, Appellant's Specification discloses only a *de minimis* description of how that information is organized using generic technology. *Id.* (citing Spec. ¶¶ 32–36, 58–63). Therefore, the Examiner concludes, the claims appear to monopolize the abstract idea itself, rather than confining the use of the abstract idea to a particular technological application, or integrating it into a particular inventive concept. *Id.* at 5–6. Consequently, the Examiner reasons, the claims are not patent eligible. *Id.* at 6 (citing MPEP § 2106.05).

Appellant argues that the steps or structures recited in the claims allow the user to synthesize a nucleic acid sequence containing a non-genetic message that does not have a biological impact on an organism carrying the nucleic acid. App. Br. 9. Appellant points to the Specification's explanation that this means that there is a low probability that a nucleic acid synthesized by the method will be transcribed or translated by a cell's internal biological processes, due to the prevalence of stop codons. *Id.* (citing Spec. ¶ 17). According to Appellant, a message-carrying sequence encoded according to the claimed method will therefore be unlikely to be transcribed due to the scarcity of start codons, and any sequences that happen to begin transcription are likely to be cut off by the prevalence of stop codons. *Id.* Appellant asserts that that the message can therefore be safely and innocuously carried and replicated by cells and can be decoded to provide the message carried therein with a low probability of unwanted transcription. *Id.* (citing Spec. ¶ 18). Consequently, argues Appellant, the claims recite significantly more than the alleged abstract idea of a procedure for organizing information, and do not tie up an abstract idea. *Id.* (quoting Final Act. 5).

Appellant contends that, contrary to the Examiner's findings, the claims recite specific requirements for what symbols can be mapped to a start codon or a stop codon, and which every sequence must contain. App. Br. 9. Appellant argues that, because the claims require that a symbol with a frequency of occurrence of greater than five percent is mapped to a stop codon, the sequences encoded will have a relatively high number of stop codons. *Id.* Similarly, argues Appellant, because the claims require that a symbol with a frequency of occurrence of less than one percent is mapped to a start codon, the sequence will have a low number of start codons. *Id.* at 9–10. Appellant asserts that these rules permit the nucleic acid generated to have a low biological impact on an organism carrying the sequence. *Id.* at 10. Therefore, argues Appellant, the claims recite additional elements demonstrating that the claims as a whole do not seek to tie up the abstract idea and are not wholly directed to subject matter encompassing a judicially recognized exception. *Id.* (citing MPEP § 2106.04(a)(l)(II)).

Appellant likes the claims on appeal to those in *McRO, Inc. v. Bandai Namco Games Am. Inc.*, 837 F.3d 1299 (Fed. Cir. 2016). App. Br. 10. As in *McRO*, argues Appellant, the claims on appeal involve methods of generating a sequence of codon identifiers according to limited rules, reflecting a specific implementation that would not have been used by a person of ordinary skill in the art. *Id.* Appellant therefore asserts that the specific method does not preempt the use of rules of other processes or techniques and is integrated into a practical application. *Id.*

Appellant argues further that the claims on appeal include additional steps or structures that show the subject matter of the claims is integrated into a practical application, and adds something significant to, the natural principle itself and impose meaningful limits on the claim scope. App. Br. 11. Appellant points to the claims' requirement that a nucleic acid is synthesized carrying a non-genetic message that does not have a biological impact on an organism carrying the nucleic acid. *Id.* (citing Spec. ¶ 17).

In performing an analysis of patentability under 35 U.S.C. § 101, we follow the framework set forth by the Supreme Court in *Mayo Collaborative Servs. v. Prometheus Labs., Inc.*, 566 U.S. 66 (2012). We are also mindful of, and guided by, the United States Patent and Trademark Office's *2019 Revised Patent Subject Matter Eligibility Guidance*, 84 Fed. Reg. 50 (January 7, 2019) (the "2019 Guidance").

Appellant's independent claim 1 recites, *inter alia*: "A method of generating a sequence of codon identifiers corresponding to a sequence of human readable symbols, and assigned according to a coding scheme to convey a non-genetic message in a human reference language…." Following the first step of the *Mayo* analysis, we find that the claims are directed to a method or process and therefore fall into one of the broad statutory categories of patent-eligible subject matter under 35 U.S.C. § 101.

In the next step of the *Mayo* analysis, we determine whether the claim at issue is directed to a nonstatutory, patent-ineligible concept, i.e., a law of nature, a phenomenon of nature, or an abstract idea. *Mayo*, 566 U.S. at 70–71. If the claim is so directed, we next consider the elements of the claim both individually and "as an ordered combination" to determine whether additional elements "transform the nature of the claim" into a patent-eligible application. *Id.* at 78–79; *see also Ariosa Diagnostics, Inc. v. Sequenom, Inc.*, 788 F.3d 1371, 1375 (Fed. Cir. 2015). Specifically, the Supreme Court considered this second step as determining whether the claim recites an element or combination of elements that is "sufficient to ensure that the patent in practice amounts to significantly more than a patent upon the [ineligible concept] itself." *Mayo*, 566 U.S. at 72–73.

More specifically, in this second step of the *Mayo* analysis, we look to whether the claim recites one of the judicially-created exceptions to 35 U.S.C. § 101, i.e., an abstract idea, a law of nature, or a natural phenomenon. *See* 2019 Guidance 54 (Step 2A, Prong 1). If we determine that the claim recites a judicial exception, we then determine whether the limitations of the claim reciting the judicial exception are integrated into a practical application. *Id.* (Step 2A, Prong 2).

Finally, if we determine that the claim is directed to a judicially-created exception to 35 U.S.C. § 101, we evaluate the claim under the next step of the *Mayo* analysis, considering the elements of each claim both individually and "as an ordered combination" to determine whether additional elements "transform the nature of the claim" into a patent-eligible application. *Mayo*, 566 U.S. at 78–79; 2019 Guidance 56 (Step 2B).

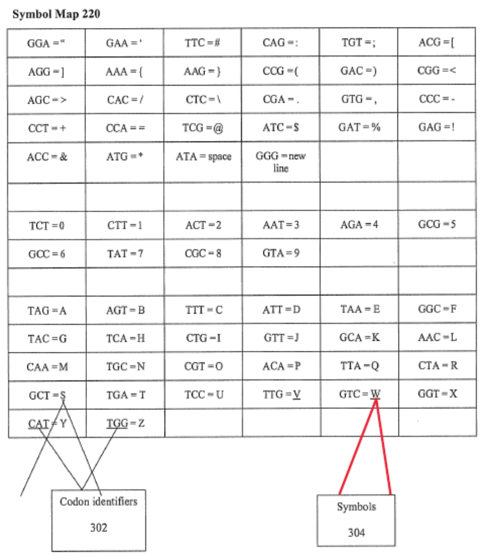
Claim 1 recites the steps of: (1) receiving a sequence of human readable symbols at a memory module; (2) loading a human readable symbol map within the memory module, in which the human readable symbol map is configured to determine a codon identifier that maps to each human readable symbol within the sequence; (2a) the human readable symbol map is further configured to map a human readable symbol with a frequency of occurrence that is less than one percent within the reference language to a start codon; (2b) the symbol map is further configured to map a human readable symbol with a frequency of occurrence that is greater than five percent within the reference language to a stop codon; (2c) no symbol is coded for by ATG; (3) using a transcoder to map a sequence of codon identifiers corresponding to each human readable symbol within the sequence according to the human readable symbol map, and (4) synthesizing a nucleic acid with the sequence of step (3).

More simply put, Appellant's claimed method comprises using a generic computer to compose a map in which human readable symbols (e.g., letters, numbers) correspond to a codon of nucleotide bases, and in which a symbol with low frequencies of occurrence (>1%) in the language correspond to a start codon and one with a higher frequency (>5%) corresponds to a stop codon (and no symbol coded for the codon ATG). A transcoder is then used to map a sequence of codons such that the corresponding symbols in a sequence that corresponds to a desired "message," and a DNA sequence is then synthesized from that template.

Claim 1 is thus directed, at least in part, to a series of computational steps by which human readable symbols are mapped onto codon sequences, subject to various rules (*viz.*, steps 2a-c, *supra*). These steps can be mapped using a generic processor. Appellant's Specification discloses:

> [T]he terms "processor," "microprocessor," and "digital processor" include all types of digital processing devices including, without limitation, digital signal processors (DSPs), reduced instruction set computers (RISC), general-purpose (CISC) processors, microprocessors, gate arrays (e.g., FPGAs), programmable logic devices (PLDs), reconfigurable compute fabrics (RCFs), array processors, and application-specific integrated circuits (ASICs). Such processors may be contained on a single unitary IC die or distributed across multiple components.

Spec. ¶ 63. A series of abstract steps (i.e., mapping one set of symbols to another), performed upon a generic processor is, by itself, not generally patent eligible. Annotated Figure 3 of Appellant's Specification illustrates the general mapping process:



<u>Figure 3 of Appellant's Specification (amended) depicts an exemplary symbol map 220</u>

We find that these processes recited in these computational steps could be performed equally either mentally or with a pencil and paper and, as reflecting mental processes, are not patentable subject matter. *See CyberSource Corp. v. Retail Decisions, Inc.*, 654 F.3d 1366, 1373 (Fed. Cir. 2011) (holding that:

> Methods which can be performed entirely in the human mind are unpatentable … because computational methods which can be performed *entirely* in the human mind are the types of methods that embody the "basic tools of scientific and technological work" that are free to all men and reserved exclusively to none

(quoting *Gottschalk v. Benson*, 409 U.S. 63, 67 (1972)).

Appellant's Specification discloses no express definition of the claim term "transcoder." However, the transcoder is described as being "configured to both encode and decode an input human readable symbol sequence, [and] it should be understood that the associated encoding and decoding logic may be separated and/or distributed among multiple systems, devices, and/or computer networks." Spec. ¶ 75; *see also id.* at ¶ 120, describing:

> [A]n exemplary transcoder 200 configured to encode an input symbol sequence into a codon sequence such that the codon sequence has substantially no biological impact on a host organism if introduced into the organism as a synthetic nucleic acid sequence (e.g., as free DNA). The transcoder 200 may also be configured to decode an input sequence of codons and thereby yield the originally input symbol sequence. Thus, the exemplary transcoder 200 depicted in Figure 2 may be used to both encode a human readable symbol sequence into a codon sequence, and to decode a codon sequence into a human readable symbol sequence.

In other words, the transcoder functions to "read" the symbol/codon map either forward (i.e., readable symbol sequence to codon sequence) or backwards (i.e., codon sequence to readable symbol sequence). Moreover, Appellant's Specification discloses that the transcoder can be distributed within the processor unit. *See* Spec. ¶ 123:

> In some embodiments, the I/O modules 216 may consist of one or more device drivers adapted to interface a set of hardware devices with an operating system associated with the transcoder 200. Note that the I/O modules 216 may be implemented as any combination of software, firmware, or hardware according to embodiments described herein.

Because this relatively simple function could also be performed mentally, or with paper and pencil, we similarly find that this step (step 3 *supra*) is also directed to an abstract idea. *See Cybersource*, 654 F.3d at 1373.

Because we find that these steps are directed to an abstract idea, we then proceed to the next step of the analysis, which is to determine whether the limitations of the claim reciting the judicial exception are integrated into a practical application. 2019 Guidance 54 (Step 2A, Prong 2). The 2019 Guidance provides additional context for this analysis, stating that: "A claim that integrates a judicial exception into a practical application will apply, rely on, or use the judicial exception in a manner that imposes a meaningful limit on the judicial exception, such that the claim is more than a drafting effort designed to monopolize the judicial exception." *Id.* at 53.

We conclude that the claims are integrated into a practical application. Although, as we have explained, the claims are directed to an abstract idea (i.e., a mental function), the preamble of claim 1 recites: "A method of generating a sequence of codon identifiers corresponding to a sequence of human readable symbols, and assigned according to a coding scheme to convey a non-genetic message in a human reference language." Furthermore, the final limitation of claim 1 recites: "synthesizing a nucleic acid with the sequence of step (iii)."

Generally, a preamble limits the invention if it recites essential structure or steps, or if it is "necessary to give life, meaning, and vitality" to the claim. *See Catalina Marketing Int'l, Inc. v. Coolsavings.com, Inc.*, 289 F.3d 801, 808 (Fed. Cir. 2002) (citing *Pitney Bowes, Inc. v. Hewlett–Packard Co.*, 182 F.3d 1298, 1305 (Fed. Cir. 1999)). Conversely, a preamble is not limiting "where a patentee defines a structurally complete invention in the claim body and uses the preamble only to state a purpose or intended use for the invention." *Catalina*, 289 F.3d at 808 (quoting *Rowe v. Dror*, 112 F.3d 473, 478 (Fed. Cir. 1997)). In this instance, we conclude that the preamble is limiting upon the claim, because it is necessary to give life, meaning, and vitality to the claim. Although these words are inexact in their precise meaning, we understand them to apply in this case because the language of the preamble describes the essence of the invention, that is, to generate a sequence of codon identifiers corresponding to a sequence of human readable symbols and creating a coding scheme to convey a non-genetic message in a human reference language. As the Specification discloses, Appellant's invention is

> directed to generating an encoding scheme configured to translate human readable symbols into codon identifiers (i.e., discrete sequences of preferably three elements, where each element contains one of four selected nucleotide bases). In this manner, sequences of human readable symbols can be used to convey non-genetic messages (for example, text messages, trademarks, copyright notices, unique identifying information, etc.) by encoding the message into sequences of codon identifiers. These sequences of codon identifiers may then be used to generate synthetic nucleic acid sequences that are introduced into a living cell or organism as free DNA or incorporated into other various types of cellular nucleic acid materials…. The resulting set of codons or codon identifiers effectively serves as a memory source for the encoded sequences of human readable symbols.

Spec. ¶ 17. In other words, the abstract mental steps recited in claim 1 are integrated into an application for inserting into a living cell a sequence of free nucleic acid that is not metabolically active, but can represent a message that is readable by observers. We find that this is not an attempt to capture the entire abstract idea of substituting human readable symbols for nucleotide based-codons in a table, but rather as a means of generating a nucleic acid-based message in a cell.

This conclusion is further reinforced by using the abstract idea of encoding symbols as nucleotide based-codons to synthesize a corresponding nucleic acid, as recited in the final limitation. As the Specification discloses, such synthesized DNA can subsequently be inserted into a cell or biological system as a persistent message or identifier. *See* Spec. ¶ 17.

Because we find that the claimed method "appl[ies], rel[ies] on, or use[s] the judicial exception in a manner that imposes a meaningful limit on the judicial exception, such that the claim is more than a drafting effort designed to monopolize the judicial exception," (*see* 2019 Guidance 53), we conclude that the claims are integrated into a practical application under step 2A, prong 2. Consequently, our analysis ends there. We therefore reverse the Examiner's rejection of the claims upon this ground.

C. Rejection of the claims under 35 U.S.C. § 103

Issue

Appellant contends that the Examiner erred in concluding that the symbol map and data structure recited in the claims are descriptive data that do not perform a function within the computer, and do not have a functional relationship with the process performed and are therefore not limiting on the claims. App. Br. 12.

Analysis

The Examiner finds that Wong teaches "a method of storing data in a living organism," comprising receiving specific data to be stored in DNA, and "encoding DNA to represent [the] specific data by selecting at least 2 of the four DNA nucleotide bases to represent specific text and arranging the nucleotide bases in a manner to represent the data." Final Act. 10 (quoting Wong ¶ 21). The Examiner finds that Wong teaches that the data can be encoded by using a look-up table in which codons are used to represent numbers, letters and punctuation marks. *Id.* (citing Wong Table 1). The Examiner reasons that this teaches the limitation of claim 1 reciting "the human readable symbol map is configured to determine a codon identifier that maps to each human readable symbol within the sequence." *Id.* The Examiner finds that Wong further teaches outputting the DNA sequence that encodes the data, and synthesizing the DNA sequence. *Id.* (citing Wong ¶ 36).

The Examiner acknowledges that Wong does not teach that in the look-up table

> [T]he human readable symbol map is further configured to map a human readable symbol with a frequency of occurrence that is less than one percent within a reference language to a start codon, and wherein the symbol map is further configured to map a human readable symbol with a frequency of occurrence that is greater than five percent within the reference language to a stop codon and no symbol is coded for by ATG.

Final Act. 10. However, the Examiner finds that the "human readable symbol map" is descriptive material that does not have a functional relationship with the memory module into which it is loaded, but is, rather, nonfunctional descriptive material. *Id.* at 10–11. The Examiner maintains that differences in nonfunctional descriptive material are not sufficient to patentably distinguish an invention from the prior art, and that a claimed computer-implemented method must be distinguished from the prior art by the functional steps that are performed, not by the non-functional data on which the method operates. *Id.* at 11 (citing *Ex Porte Nehls*, 88 USPQ2d

1883, 1889 (BPAI 2008); *King Pharmas., Inc. v. Eon Labs, Inc.*, 616 F.3d 1267, 1280 (Fed. Cir. 2010)). The Examiner therefore reasons that this difference between the teachings of Wong and the claimed invention is not sufficient to patentably distinguish the invention from Wong. *Id.*

The Examiner also acknowledges that Wong does not teach the limitation of claim 1 reciting "a memory module" in which the specific data and the symbol map are loaded, or implementing the method as "an apparatus ... comprising a processor ... and a storage module," as recited in claim 15. Final Act. 11. However, the Examiner finds that Ludwig teaches a suite of software for working with sequence data, in which "the sequence data can be visualized and modified with a powerful editor" that allows sequences to be created or edited as desired. *Id.* (citing Ludwig 1365 § "Sequence editors"). The Examiner finds that Ludwig teaches that this software runs on computers with processors and memory. *Id.* (citing Ludwig 1370 § "Systems, hardware and processing time requirements").

The Examiner concludes that it would have been obvious to a person of ordinary skill in the art to implement the data encoding procedure of Wong using software, as taught by Ludwig, resulting in a software system in which the specific data being encoded as DNA, and the look-up table for translating symbols in the data as nucleic acid codons, are both loaded into memory. Final Act. 11. The Examiner further concludes that such an implementation would also result in a computer apparatus comprising a processor and "a storage module," comprising the look-up table (i.e., "a data structure for mapping codon identifiers"). *Id.*

On appeal, Appellant argues that the Examiner's reasoning is legally incorrect, and that the facts of the present case are similar to those of *In re*

Lowry, 32 F.3d 1579 (Fed. Cir. 1994). App. Br. 12. Appellant contends that *Lowry* involved a claim reciting a stored memory data structure, which both the examiner and the Board found were analogous to printed matter that, lacking a functional printed matter-substrate relationship, was therefore deserving of no patentable weight. *Id.* (citing *Lowry*, 32 F.3d at 1580).

Appellant points out that the Federal Circuit reversed, stating that the Board must consider all claim limitations when determining the patentability of an invention over the prior art, and that claim limitations comprised of printed matter may not be disregarded. App. Br. 12 (citing *Lowry*, 32 F.3d at 1582). Appellant notes that the Federal Circuit cited their decision in *In re Gulack*, 703 F.2d 1381 (Fed. Cir. 1983), cautioning against a liberal use of "printed matter rejections" under 35 U.S.C. §103. *Id.* at 12–13 (citing *Lowry*, 32 F.3d at 1583 (quoting *Gulack*, 703 F.2d at 1385 n.8)).

Appellant argues that the Examiner's rejection of the claims on appeal is based on a misinterpretation of *Lowry*. App. Br. 13 (citing Final Act. 12–13). However, argues Appellant, the language of Lowry makes it clear that, similar to the disputed limitations, the data structures of Lowry are not analogous to printed matter. *Id.* (quoting *Lowry*, 32 F.3d at 1583).

Appellant argues further that Wong neither teaches nor suggests mapping a symbol with a frequency of occurrence of greater than 5% to a stop codon, as recited in the claims. App. Br. 14. According to Appellant, Wong teaches to map the ATG start codon (which is excluded by the claims on appeal) to the letter "E", which in English (or French, German, and Spanish) has a frequency of occurrence much higher than the "less than one percent," recited in the claims. *Id.* (citing Montague Decl. ¶ 5). Appellant contends that Wong therefore teaches away from the claimed invention by teaching a symbol coded for by ATG. *Id.*

Appellant argues further that Wong fails to teach or suggest that a stop codon should be mapped to a symbol with a frequency of occurrence of greater than five percent. App. Br. 14. Appellant argues that Ludwig does not provide any teachings or suggestions that cure these alleged deficiencies of Wong. *Id.*

The Examiner responds that the "human readable symbol map" and "data structure for mapping codon identifiers into human readable symbols" of the instant claims are not analogous to the data structures of *Lowry*. Ans. 14. The Examiner finds that the attribute data objects ("ADOs") of *Lowry* are functional data structures because they "do not represent merely underlying data in a database. ADOs contain both information used by application programs and information regarding their physical interrelationships within a memory." *Id.* (quoting *Lowry*, 32 F.3d at 1583).

The Examiner finds that the limitations of the claims reciting "human readable symbol map" and "data structure for mapping codon identifiers into human readable symbols" contain no "information regarding[ ] physical interrelationships within a memory." Ans. 15. Instead, finds the Examiner, the "human readable symbol map" and "data structure for mapping codon identifiers into human readable symbols" are, as illustrated and described in Appellant's Specification, nothing more than a data table. *Id.* (citing Spec. Fig. 3, ¶ 114).

The Examiner further finds that the Specification further describes "a transcoder module for translating a sequence of symbols into a sequence of codon identifiers and/or for translating a sequence of codon identifiers into a sequence of symbols .... The transcoder module may utilize one or more symbol maps as an input argument, value, or parameter." Ans. 15 (citing Spec. ¶ 132). In other words, the Examiner reasons, the "symbol map" and "data structure for mapping codon identifiers into human readable symbols" are the input data used by the transcoder module to encode the input sequence of human readable symbols as the output sequence of nucleotides. *Id.*

The Examiner finds that the claims recite that the actual function of mapping human readable symbols to a nucleotide sequence is performed by the "transcoder," which implements a "mapping function." Ans. 15 (citing Spec. ¶¶ 93–94) that utilizes the "one or more symbol maps." Therefore, the Examiner reasons, whereas the "transcoder module" would be implemented as programming or computer executable code, the "symbol map" and "data structure for mapping codon identifiers into human readable symbols" are not programming or computer executable code. *Id.* Rather, the Examiner finds, they are descriptive data that do not perform a function within the computer, and do not have a functional relationship with the process performed by the computer or the machine readable media that contains them. *Id.* The Examiner notes that, where "the computer-readable medium merely serves as a support for information or data, no functional relationship exists." *Id.* (citing MPEP § 2111.05(III)).

The Examiner finds that, in view of these disclosures of the Specification, the instant "human readable symbol map" and "data structure for mapping codon identifiers into human readable symbols" are unlike the ADOs of *Lowry*, and are instead analogous to the nucleic acid sequences in the system at issue in *Nehls*. Ans. 15. The Examiner notes that, in *Nehls*, the claimed invention was directed to a computer system that differed from the prior art "only in the content of the data storage means." *Id.* (quoting *Nehls*, 88 USPQ2d at 1887). The Examiner points out that the Board reasoned that:

> There is no evidence that SEQ ID NOs 9-1008 functionally affect the process of comparing a target sequence to a database by changing the efficiency or accuracy or any other characteristic of the comparison. Rather, the SEQ ID NOs are merely information being manipulated by a computer; the SEQ ID NOs are inputs used by a computer program that calculates the degree of similarity between a target sequence and each of the sequences in a database. The specific SEQ ID NOs recited in the claims do not affect how the method of the prior art is performed – the method is carried out the same way regardless of which specific sequences are included in the database .... Thus, the descriptive material in this case is properly considered to be nonfunctional.

Id. at 15–16 (quoting *Nehls*, 88 USPQ2d at 1888).

The Examiner explains that, like the SEQ IDs in *Nehls*, the "human readable symbol map" of the instant claims "do not affect how the method of the prior art is performed – the method is carried out the same way regardless of which specific [symbol mappings] are included in the database." Ans. 16. The Examiner emphasizes that the Specification expressly discloses that it is the transcoder, and not the "human readable symbol map," that is the functional element that "encode[s] an input symbol sequence into a codon sequence." *Id.* (quoting Spec. ¶ 120). The Examine further finds that Appellant's Specification discloses that "the non-volatile memory may include one or more symbol maps which may be used to construct synthetic nucleic acid sequences," and that the system, specifically the transcoder, operates in the same manner regardless of which symbol map is actually being used. *Id.* (quoting Spec. ¶ 128). The Examiner finds that the symbol maps do nothing more than describe the correspondence between human-readable symbols and the codon identifiers, which the transcoder uses to perform its function of mapping a sequence of human-readable symbols to a sequence of codon identifiers. *Id.* The mapping itself, explains the Examiner, is a nonfunctional descriptive data table, and the instant symbol map is therefore insufficient to patentably distinguish the invention from the teachings of Wong, which also teaches a data table that maps human-readable symbols to codon identifiers. *Id.*

We are not persuaded by the Examiner's reasoning. Specifically, the Examiner finds that the "human readable symbol map" and "data structure for mapping codon identifiers into human readable symbols" are analogous to printed matter because it is not, as in *Nehls*, functional material. *See Nehls*, 88 USPQ2d at 1891. The Examiner contends that it is the transcoder, which "map[s] a sequence of codon identifiers corresponding to each human readable symbol within the sequence according to the human readable symbol map and output[s] the sequence," operates in the same manner regardless of which symbol map is actually being used, and that the symbol map and data structure are merely inputs. *See* Ans. 16.

We disagree. Claim 1 recites, in relevant part:

> Receiving the sequence of human readable symbols at a memory module [and] loading a human readable symbol map within the memory module, wherein the human readable symbol map is configured to determine a codon identifier that maps to each human readable symbol within the sequence, wherein the human readable symbol map is further configured to map a human readable symbol with a frequency of occurrence that is less than one percent within the reference language to a start codon, and wherein the symbol map is further configured to map a human

> readable symbol with a frequency of occurrence that is greater than five percent within the reference language to a stop codon and no symbol is coded for by ATG….

In other words, the memory module receives a set of human-readable symbols and configures the symbols into a map in which a given symbol corresponds to a given codon. The map is not simply loaded into the memory module as a map, rather, the symbol/codon map itself is configured, or structured by the module itself, and the map forms a functional unit related to the substrate (i.e., the non-volatile memory) of the module.

Furthermore, the limitations require the memory module and, specifically, the "data structure for mapping codon identifiers into human readable symbols" to impose certain rules upon the manner by which the data is structured. Specifically, the claims require that:

> [T]he human readable symbol map is further configured to map a human readable symbol with a frequency of occurrence that is less than one percent within the reference language to a start codon, and wherein the symbol map is further configured to map a human readable symbol with a frequency of occurrence that is greater than five percent within the reference language to a stop codon and no symbol is coded for by ATG.

These rules, imposed by the functioning of the memory module, are critical to the functioning of Appellant's claimed invention, because, as the Specification explains:

> [E]mbodiments described herein utilize an encoding scheme with a remarkably low probability of biological impact. That is to say, a low probability exists that a synthetic nucleic acid sequence created using invention methods and schemes win be transcribed or translated by a cell's internal biological processes. As a result, the non-genetic message created using invention methods and schemes may be innocuously carried and replicated

> by cells comprising the message, but may be decoded to provide the human readable symbols, *i.e.,* the message carried therein.

Spec. ¶ 18.

We agree with the Examiner that the transcoder serves the function of "map[ping] a sequence of codon identifiers corresponding to each human readable symbol within the sequence according to the human readable symbol map and outputting the sequence," but we find that that function is in response to the input sequence (i.e., the intended encoded message) and does not form the map itself. The formation of the map, incorporating the rules recited in the preceding limitation, and pairing collective readable symbols with the collective codons, according to a set of given rules, is the function of the memory module and the "data structure for mapping codon identifiers into human readable symbols."

We therefore find that the disputed limitations are analogous to the data structures of *Lowry*, in which our reviewing court found that:

> [The] data structures, while including data resident in a database, depend only functionally on information content. While the information content affects the exact sequence of bits stored in accordance with Lowry's data structures, the claims require specific electronic structural elements which impart a physical organization on the information stored in memory. Lowry's invention manages information.

Lowry, 32 F.3d at 1583.

Furthermore, and *contra* the Examiner's findings, we can distinguish the claims on appeal from those in *Nehls*, in which our reviewing court found that there was:

> [N]o evidence that SEQ ID NOs 9-1008 functionally affect the process of comparing a target sequence to a database by changing

> the efficiency or accuracy or any other characteristic of the comparison. Rather, the SEQ ID NOs are merely information being manipulated by a computer; the SEQ ID NOs are inputs used by a computer program that calculates the degree of similarity between a target sequence and each of the sequences in a database.

Nehls, 88 USPQ2d at 1591. In the claims before us, the symbol/codon table is not merely descriptive matter input to the memory module, rather, it is constructed by the memory module, according to the rules of the data structure, and the way the table is constructed is critical to the function of the transcoder and the invention itself.

Our reviewing court has warned us that:

> A "printed matter rejection" under § 103 stands on questionable legal and logical footing. Standing alone, the description of an element of the invention as printed matter tells nothing about the differences between the invention and the prior art or about whether that invention was suggested by the prior art.... [The Court of Customs and Patent Appeals], notably weary of reiterating this point, clearly stated that printed matter may well constitute structural limitations upon which patentability can be predicated.

Lowry, 32 F.3d at 1583 (quoting *Gulack*, 703 F.2d at 1385 n.8). We consequently conclude that there is a functional relationship between the table constructed by the memory module and its substrate.

The Examiner acknowledges that neither Wong nor Ludwig teaches or suggests the limitation of claim 1 reciting:

> [T]he human readable symbol map is further configured to map a human readable symbol with a frequency of occurrence that is less than one percent within the reference language to a start codon, and wherein the symbol map is further configured to map a human readable symbol with a frequency of occurrence that is

> greater than five percent within the reference language to a stop codon and no symbol is coded for by ATG.

However, because we conclude that this limitation is, for the reasons we have explained, limiting upon the claim, and because neither reference relied upon by the Examiner teaches or suggests this limitation, we reverse the Examiner's rejection of the claims upon this ground.

CONCLUSION

The Examiners rejection of claims 1, 3–5, and 15–17 under 35 U.S.C. § 112(b) is affirmed.

The Examiners rejection of claims 1, 3–5, and 15–17 under 35 U.S.C. § 101 is reversed.

The Examiners rejection of claims 1, 3–5, and 15–17 under 35 U.S.C. § 103 is reversed.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a). *See* 37 C.F.R. § 1.136(a)(1)(iv).

AFFIRMED

DECISION SUMMARY

Claims Rejected	35 U.S.C. §	Reference(s)/Basis	Affirmed	Reversed
1, 3–5, 15–17	112(b)	Indefiniteness	1, 3–5, 15–17	
1, 3–5, 15–17	101	Subject matter		1, 3–5, 15–17
1, 3–5, 15–17	103	Wong, Ludwig		1, 3–5, 15–17
Overall Outcome			1, 3–5, 15–17	