PTAB Rulings Shed Light On Quantum Computing Patents

By **Fred Qiu and Alex Nie** (June 5, 2024)

Fred Qiu

Alex Nie

In U.S. patent law, enablement is a requirement that ensures a patented invention is meaningfully communicated to the interested public.

For a claimed invention to be enabled, one reasonably skilled in the art must be able to make or use the invention from the disclosures in the patent coupled with information known in the art without undue experimentation.[1]

Whether undue experimentation is needed is determined based on Wands factors, established by the U.S. Court of Appeals for the Federal Circuit in 1988 in In re: Wands. The factors include:

- The quantity of experimentation necessary;
- The amount of direction or guidance presented;
- The presence or absence of working examples;
- The nature of the invention;
- The state of the prior art;
- The relative skill of those in the art;
- The predictability or unpredictability of the art; and
- The breadth of the claims.[2]

In patent examination, rejections based on the enablement requirement are more frequently encountered in emerging technology areas. These areas often involve uncertainties regarding the feasibility of technical features and the knowledge possessed by those of ordinary skill in the art.

Quantum computing, a field that harnesses quantum physical phenomena such as superposition and entanglement to perform complex computational tasks, is one such area.

In recent years, multiple enablement rejections against quantum computing patent claims have been appealed to the Patent Trial and Appeal Board. These cases provide valuable insights for patent practitioners, offering guidance on best practices for avoiding and overcoming enablement rejections during the prosecution of quantum computing patents.

Appeal Decisions

Appeal No. 2023-000069

The patent application at issue is directed to a multifunctional quantum node device. Representative Claim 1 is reproduced below:

> 1. A multifunctional quantum node device, comprising:
>
> a semiconductor vacancy qubit structure;
>
> a superconductor quantum memory nanowire coupled with a spin state of the

semiconductor vacancy qubit structure; and

a superconductor qubit logic circuit coupled with the superconductor quantum memory nanowire and the semiconductor vacancy qubit structure,

whereby the device is a hybrid device operable as an interface for computing or quantum-entangled networking.

The examiner rejected multiple terms of this claim for lack of enablement. The PTAB affirmed on March 7, 2023.

The first term lacking enablement is "semiconductor vacancy qubit structure." The examiner determined that the specification enables only "nitrogen vacancy centers in SiC or diamond" but not "any semiconductor vacancy in any material or for any vacancy in any semiconductor material that forms a qubit."

The PTAB noted that the applicant did not meaningfully dispute that the full scope of the claims is broader than what is taught by the specification or explain "how what is taught by the [s]pecification is enabling of the full scope of the claims."

Relying on the Federal Circuit's 2018 ruling in Trustees of Boston University v. Everlight Electronics Co., the PTAB sustained the enablement rejection": [T]o be enabling, the specification of a patent must teach those skilled in the art how to make and use the full scope of the claimed invention without undue experimentation."[3]

Importantly, the PTAB noted that the examiner cited evidence to show "unpredictability and difficulty in making and using anything beyond the few examples that the Specification provides."

In other words, given the nascent, and hence unpredictable, nature of the technology field, it is the PTAB's position that the success from the limited examples in the specification cannot be reasonably extrapolated to the full scope of the claim.

With respect to the term "superconductor quantum memory nanowire," the examiner asserted that while the specification may teach how to make and use a generalized nanowire it does not teach how to make and use such a nanowire as a qubit because "a single uninterrupted nanowire does not have the confinement properties necessary to act as a quantum memory."

Moreover, the examiner provided citation and technical explanation of why the doped superconductor material in nanowire region "would not work as a quantum memory." The PTAB agreed with the examiner.

Unlike the enablement issue for the first term in which only certain limited species of the claim scope were considered enabled, for this term, the PTAB agreed with the examiner that this aspect of the claimed invention simply would not work.

Appeal No. 2023-002850

The patent application at issue is directed to deep learning using quantum entanglement, with Claim 1 reproduced below:

1. A method comprising:

selecting, by a computing device, layers from a plurality of external deep learning models;

concatenating, by the computing device, the selected layers from the plurality of external deep learning models to form a core deep learning model;

training, by the computing device, the core deep learning model; and

synchronizing, by the computing device, layers in the core deep learning model with the layers from the plurality of external deep learning models using quantum entanglement.

The examiner rejected this claim, asserting that the limitation "synchronizing ... layers in the core deep learning model with the layers from the plurality of external deep learning models using quantum entanglement" is not enabled.

According to the examiner, within the disclosure of this patent application, "there is no description of any specific starting material or of any conditions under which quantum entanglement of deep learning layers can be carried out." The only example in the specification of using quantum entanglement, the examiner noted, involves the use of qubits, but it is questionable how that can be performed.

The PTAB rejected the applicant's arguments on appeal on Jan. 23 and sustained the examiner's rejection. The PTAB explained that, even though the claimed invention may not make use of qubits, the "specification has not identified any other mechanism by which quantum entanglement is used to transfer weights between the layers of deep learning models as part of the process of synchronizing the layers."

Therefore, the PTAB agreed with the examiner that the specification describes no practical means to implement the claimed invention that, therefore, lacks enablement.

Appeal No. 2023-003447

In this appeal, on Nov. 30, 2023, the PTAB reversed the examiner's enablement rejection against a patent application directed to methods of operating quantum computing devices to solve problems in combinatorial optimization. A representative claim is shown below:

13. A method of operating a quantum computing device, comprising:

performing a first phase estimation technique on a set of one or more qubits in the quantum computing device;

after the first phase estimation, evolving the set of one or more qubits from a first state to a second state;

after the evolving, performing a second phase estimation technique on the set of one or more qubits in the quantum computing device;

evaluating results of the second phase estimation technique relative to an error criteria;

and determining that a solution to a combinatorial optimization problem

> provided by the set of one or more qubits in the second state is acceptable or not acceptable based on the evaluation of the results of the second phase estimation technique.

The examiner rejected this claim as lacking enablement for reciting a "method of operating a quantum computing device."

Because the specification of this patent application discloses that the "quantum processing unit(s) can be one or more of ... a fault-tolerant architecture for quantum computing," the examiner determined that the claims, under their broadest reasonable interpretation in view of the specification, encompass a fault-tolerant quantum computer.

The examiner found that the "time to create a large fault-tolerant quantum computer ... is more than a decade away," citing extrinsic references. Based on this finding, the examiner determined that "the applicant fails to enable the full scope of the claimed invention" because "one of ordinary skill would not be able to make and use a fault tolerant quantum computer."

The applicant appealed this rejection, pointing out that the claims "are directed to methods of manipulating qubits in quantum computers but are not device claims directed to quantum computers of any kind." The applicant further explained that the "pending claims recite operations on qubits that are suitable for existing small scale quantum computers and are thus enabled regardless of the status of advanced quantum computers still in development."

The PTAB reversed the examiner's rejection, noting precedents supporting the proposition that the "law does not expect an application to disclose knowledge invented or developed after the filing date" and that later states of the art cannot be employed as a basis for an enablement rejection.[4]

The PTAB distinguished case law provided by the examiner as inapposite because they deal with the lack of enablement with respect to existing technology, rather than after-arising technology.[5]

In addition, the PTAB noted that whether the claims can be infringed by fault-tolerant quantum computers in the future is irrelevant to the enablement issue.

Discussion

Unlike conventional computers, which rely on transistor-based components and standardized architectures, quantum computers are being developed using a variety of physical systems and configurations.

This diversity in approach is due to the ongoing exploration of the most suitable methods for building quantum computers. Moreover, certain essential features of a fully functional quantum computer, such as fault tolerance and reliable entanglement, remain active areas of research.

These differences substantially affect multiple Wands factors, such as the quantity of experimentation necessary, the state of the prior art, the relative skill of those in the art, and the predictability or unpredictability of the art.

As a result, quantum computing patent applications may be subjected to higher scrutiny as compared to conventional computing inventions.

When seeking patent protection for a genus of quantum computing techniques that are considered to have a high degree of unpredictability, such as one of the cases in appeal, applicants may be required to provide sufficient working examples to support enablement for the full scope of the claimed invention.

This can be done by including multiple, diverse examples representing the genus. In addition or alternatively, enablement can also be achieved with more limited working examples, with explanations on how the conclusions based on the limited examples can be reasonably extrapolated to the genus.

In the event such explanation is not considered persuasive by the patent examiner, the applicant may submit evidence not described in the original specification, including post-filing evidences, to support the explanation.

Patent applications that claim particular desired outcomes, such as the storage of quantum information or the entanglement of two quantum systems, may be challenged by examiners in demonstrating that the claimed functionalities are achievable.

To address this, patent practitioners should proactively communicate with inventors to ascertain the level of ordinary skill in the pertinent art and obtain documents that demonstrate this level of knowledge and skill. This information can be helpful in determining the appropriate level of detail to include in the specification and can serve as evidence when addressing potential enablement rejections.

In cases where the level of ordinary skill in the art is uncertain, or the claimed functionalities are particularly complex, practitioners may want to err on the side of over-inclusion of details in the specification.

Patent practitioners who stay informed about the latest trends and developmental directions in quantum computing can add significant value to their clients' applications.

By disclosing the potential applicability of the claimed invention to systems currently under development or to application scenarios that may arise in the future, practitioners can demonstrate the relevance of the invention.

When such information is included in the specification rather than the claims, it provides support for possible future infringement assertions without creating enablement issues.

Fred Qiu is an associate and Alex Nie is a partner at Sheppard Mullin Richter & Hampton LLP.

[1] United States v. Telectronics, Inc., 857 F.2d 778, 785 (Fed. Cir. 1988); 35 U.S.C. § 112(a).

[2] In re Wands, 858 F.2d 731, 737 (Fed. Cir. 1988).

[3] Boston University v. Everlight Electronics Co., 896 F.3d 1357 (Fed. Cir. 2018).

[4] U.S. Steel Corp. v. Phillips Petroleum Co., 865 F.2d 1247, 1250-51 (Fed. Cir. 1989); In re Hogan, 559 F.2d 595, 605-06 (CCPA 1977).

[5] Sitrick v. Dreamworks, LLC, 516 F.3d 993 (Fed. Cir. 2020); Trustees of Boston Univ. v. Everlight Electronics Co., LTD, 896 F.3d 1357 (Fed. Cir. 2018).