

## Case Study L1-012

### Semantic Precision & Register Alignment

The "Weaving" Shuttle (Textiles vs. Neurosurgery)

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#### Case Study Metadata

**Dataset ID:** L1-012

**Category:** Semantic Precision — Level 1

**Focus:** Register Mismatch / Polysemy  
Resolution

**Model:** Generic NMT

**Domain:** Neurotechnology / BCI

## 1 The Context: Electrode Deployment

In neuroprosthetic brain electrode assemblies, "shuttle elements" are rigid mechanical components used to guide and deploy ultra-flexible electrode shanks into deep brain tissue. These components must be described using a precise **Medical-Mechanical** register to ensure functional clarity in a surgical context.

### Key Concept

#### The Register Mismatch:

The term "Shuttle" is heavily weighted toward specific industrial domains:

- **Textile Industry:** A "navette" is a tool used in weaving to carry thread through a loom.
- **Aerospace:** A reusable spacecraft (Navette spatiale).
- **Mechanics:** A component that moves back and forth to carry or push another part (élément de transfert).

Generic NMT models frequently activate the highest-frequency "textile" vector for the French word "navette," resulting in an archaic register mismatch in modern neurosurgery claims.

## 2 The Glitch: The "Weaving" Hallucination

Generic NMT engines interpret "Shuttle Element" through the lens of 18th-century industrial weaving. The model defaults to the terminology of looms, effectively claiming a "textile shuttle" as a core component of a high-density brain electrode assembly.

**Critical Issue**

**The Technical Violation:**

Translating "Shuttle Element" as *élément de navette* in a neurotechnology claim imports a "dirty" industrial register into a sterile surgical instrument description. While lexicographically correct, it creates a "Textile Hallucination" that suggests the device uses weaving technology to interact with neural tissue, rendering the claim technically awkward and legally imprecise.

### 3 The Translation Failure

Source (English)	AI Hallucination (Failure)	Golden Rewrite (Correct)
"...a plurality of shuttle elements..."	<p>✗ <b>Textile Register:</b></p> <p>"...une pluralité d'<b>éléments de navette</b>..."</p> <p><i>(Literal: Weaving shuttles)</i></p>	<p>✓ <b>Surgical-Mechanical:</b></p> <p>"...une pluralité d'<b>éléments de transfert</b>..."</p> <p><i>(Industry Standard for Deployment Tools)</i></p>

Table 1: Semantic Hallucination: Register Failure in Neuroprosthetic Claims

## 4 Alignment Methodology

### 4.1 Register Locking & Functional Mapping

To override the model's textile default, we implement a **Domain-Aware Disambiguation** workflow.

**Alignment Methodology**

**Alignment Methodology:**

- Context Trigger:** Detect keywords [Brain], [Electrode], [Neurosurgery], and [Sub-surface].
- Negative Terminology Constraints:** Explicitly block textile-related vectors (e.g., *tissage, métier à tisser*) for the term "shuttle."
- Functional Mapping:** Map "Shuttle" to mechanical functional equivalents (*Transfert, Coulisseau, or Insertion*) to reflect the precise surgical deployment function.
- Verification:** Cross-reference with "guiding lumens" to ensure the sliding/guiding mechanism maintains a unified surgical-mechanical register.

## 5 Key Insights

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### Key Concept

#### What This Case Study Demonstrates:

1. **Domain Standards Over Linguistic Preferences:** In neurosurgery, terminology must reflect modern medical standards, not general-language frequency.
2. **Register Mismatch Damage:** Using textile terms for brain implants damages the technical credibility of the patent and creates potential indefiniteness in claim scope.
3. **The Need for Functional Precision:** Alignment is about preserving the *physics* of the deployment (transferring the electrode), not just the dictionary definition of the word.

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**Portfolio:** Patent Translation AI Alignment Framework

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