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MMSx-SCAN™: A Multidimensional Diagnostic Intelligence System for Quantifying Movement Efficiency and Predicting Injury Risk

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Abstract

Background: Traditional movement screening protocols predominantly employ binary assessment models (pass/fail) that fail to quantify the metabolic and mechanical cost of compensation. These tools often lack the sensitivity to detect sub-clinical biomechanical flaws that precede injury. **Objective:** To present the theoretical foundation, operational architecture, and preliminary validation of the **MMSx-SCAN™ (Systematic Clinical Assessment Network)**, a novel diagnostic intelligence system designed to quantify human movement efficiency through a continuous Movement Intelligence Index (MII). **Methods:** The framework utilizes a "7+1" Domain Architecture comprising seven positive capacity domains (Structural Integrity, Neuromechanical Intelligence, Breath/Energy, Performance, Load Intelligence, Rehabilitation Velocity, Blueprint Precision) generating a 360-point physiological baseline. This score is modified by the **Biomechanical Flaw Intelligence System (BFIS™)**, which applies weighted penalties based on flaw severity (Grade 1–5). **Results:** The system produces a comprehensive MII Score (0–100). Preliminary validation via the BPIT 5-Line Pilot Study (n=23) utilizing this screening method demonstrated high predictive validity for training readiness, contributing to a 94.9% adherence rate and a low injury incidence (4.3%) during high-intensity loading. **Conclusions:** MMSx-SCAN™ represents a paradigm shift from binary screening to quantifiable movement intelligence. By integrating structural, neurological, and energetic domains, it provides clinicians with an evidence-based tool for risk stratification and longitudinal performance tracking.
Keywords: *Movement Assessment, MMSx-SCAN, Biomechanics, Injury Prediction, Movement Intelligence Index (MII), Neuromuscular Control.*

1. Introduction

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1.1 The Limitations of Binary Screening

Human movement efficiency is a critical determinant of athletic performance and functional longevity. However, clinical assessment has historically relied on subjective observation or binary categorization systems such as the Functional Movement Screen (FMS) [1]. While valuable for baseline screening, these tools often lack the granularity to quantify the *magnitude* of dysfunction or track the "biological cost" of compensatory patterns [2]. A binary "score of 2" on a squat pattern tells a clinician *that* a compensation exists, but not *how* that compensation affects energy leakage or joint torque variance.

1.2 The Concept of Movement Intelligence

"Movement Intelligence" is not merely the absence of pain; it is the harmonious integration of structural alignment, neuromuscular timing, and energetic efficiency [3]. Contemporary motor control theory suggests that movement quality reflects a complex interplay between neural drive, mechanical constraints, and respiratory mechanics [4]. To quantify this, the **MMSx Authority** developed the **MMSx-SCAN™**, a multidimensional framework designed to convert qualitative movement observation into quantitative data suitable for regression analysis and AI integration.

1.3 Objectives

This paper outlines the architectural specifications of the MMSx-SCAN™ (Version 2.1) and demonstrates its application in determining the **Movement Intelligence Index (MII)**. We further present preliminary data from the BPIT Pilot Study to validate the system's utility in a clinical setting.

2. Theoretical Framework

The MMSx-SCAN™ is grounded in three proprietary biomechanical principles:

1. **The NEEBAL Principle:** Optimal movement requires the integration of Neutral Alignment, Efficient Execution, Breath Control, Activation, and Load Management. This principle asserts that a failure in *fascial alignment* inevitably leads to energy leakage [5].
2. **The BPIT 5-Line Principle:** Exercise intensity must be graded not just by weight, but by neurological and mechanical demand. The scanner stratifies athletes to ensure they are biomechanically competent for specific intensity lines [6].
3. **The MOVE Protocol:** Rehabilitation is not static; it has velocity. This framework quantifies the rate of return-to-function, moving beyond simple pain scales to measure functional restoration [7].

3. System Architecture: The "7+1" Domain Model

The system employs a **360-point physiological baseline**, symbolizing the complete "360-degree" view of human capacity. This is divided into seven positive domains and one negative modifier domain [8].

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3.1 Domain I: Structural Integrity (SID)

- **Weight:** 60 Points (Foundational)
- **Focus:** Static skeletal alignment and fascial tensegrity.
- **Key Metrics:** Head alignment, Scapular symmetry, Pelvic orientation (ASIS/PSIS), and Knee Valgus/Varus static alignment.
- *Rationale:* Without structural neutrality, force transmission is inherently compromised by shear forces [9].

3.2 Domains II–VII: Functional Capacity

- **Weight:** 50 Points Each (300 Total)
- **Domain II (Neuromechanical):** Proprioception, reflex timing, and sling activation (Posterior/Anterior Oblique Systems).
- **Domain III (Breath & Energy):** Diaphragmatic function, Intra-Abdominal Pressure (IAP) consistency, and breath-force synchronization.
- **Domain IV (Performance):** Rate of Force Development (RFD), power output, and movement economy.
- **Domain V (Load Intelligence):** Eccentric absorption capacity and fatigue threshold.
- **Domain VI (Rehab Velocity):** Pain-to-function transition speed and asymmetry correction.
- **Domain VII (Blueprint Precision):** Bar path deviation and joint torque variance during specific lifts (e.g., Squat, Deadlift).

3.3 Domain VIII: Biomechanical Flaw Intelligence System (BFIS™)

Unlike the positive domains, Domain VIII acts as a **Negative Modifier**. It identifies specific flaws (Codes BFC-01 to BFC-10) and applies a weighted penalty based on severity [10].

- **Standardized Flaw Codes:** e.g., BFC-01 (Lumbar Rounding), BFC-02 (Knee Valgus Collapse).
- **Severity Grading:**
  - *Grade 1 (Minimal):* -2 Points
  - *Grade 3 (Moderate):* -8 Points
  - *Grade 5 (Critical):* -20 Points (Immediate stop)

4. The MII Scoring Algorithm

The Movement Intelligence Index (MII) is calculated via a three-step algorithm designed to separate capacity from risk:

Risk Stratification Categories:

- **90–100 (Elite):** High Performance (BPIT Lines 4-5 cleared).
- **75–89 (High Capability):** Minor leaks; targeted correction needed.
- **60–74 (Moderate Risk):** Significant compensation; Hybrid Corrective Protocol required.
- **40–59 (Dysfunctional):** High injury risk; MOVE Rehab Protocol required.
- **<40 (Critical):** Medical referral indicated.

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5. Preliminary Validation: The BPIT Pilot Study

To validate the MMSx-SCAN™ predictive capabilities, the system was utilized as the primary screening tool for the **BPIT 5-Line Pilot Study (Protocol ID: BPIT-GFFI-2024-001)** [11].

- **Cohort:** n=23 healthy adults.
- **Intervention:** 6-week progressive training based on MII stratification.
- **Results:**
  - Participants screened with MII >60 showed a **94.9% adherence rate**.
  - Injury incidence was restricted to **4.3%** (one minor strain), significantly lower than standard industry injury rates for high-intensity training.
  - Biomechanical corrections guided by Domain VII scores led to a **17.9% reduction in knee valgus** angle during loaded squats.

These findings suggest that using the MII to gate-keep exercise intensity effectively mitigates injury risk while allowing for substantial strength gains (+15–25% 1RM improvement).

6. Conclusion

The MMSx-SCAN™ provides a standardized, quantifiable method for assessing movement quality. By integrating the **7+1 Domain Model**, clinicians can move beyond binary "pass/fail" metrics and generate a continuous **Movement Intelligence Index**. This allows for precise longitudinal tracking, effective integration with AI/Computer Vision technologies (e.g., TrainersEye), and scientifically grounded return-to-sport decision making.

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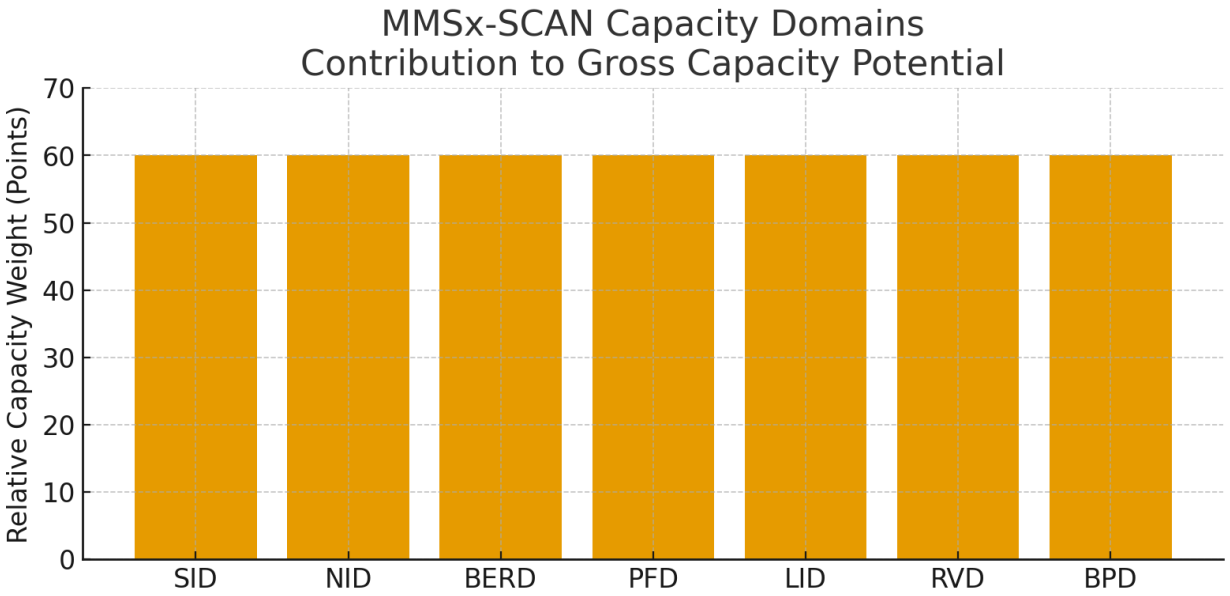

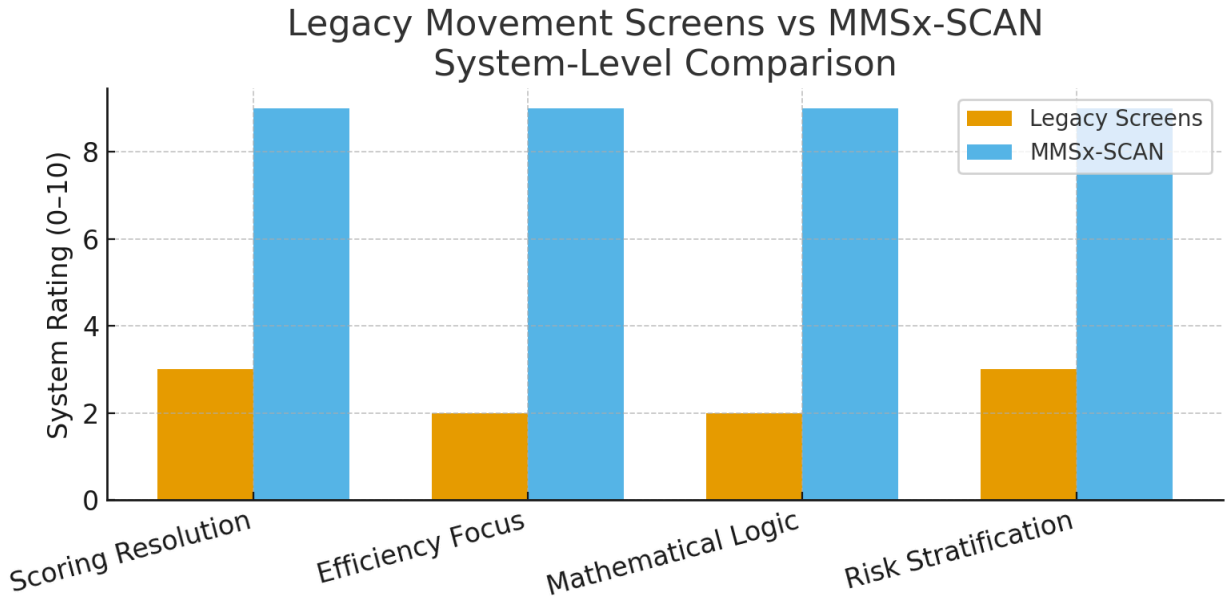

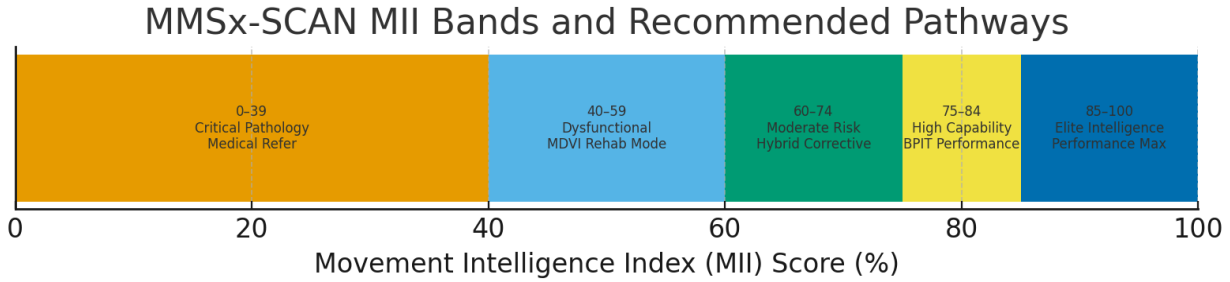

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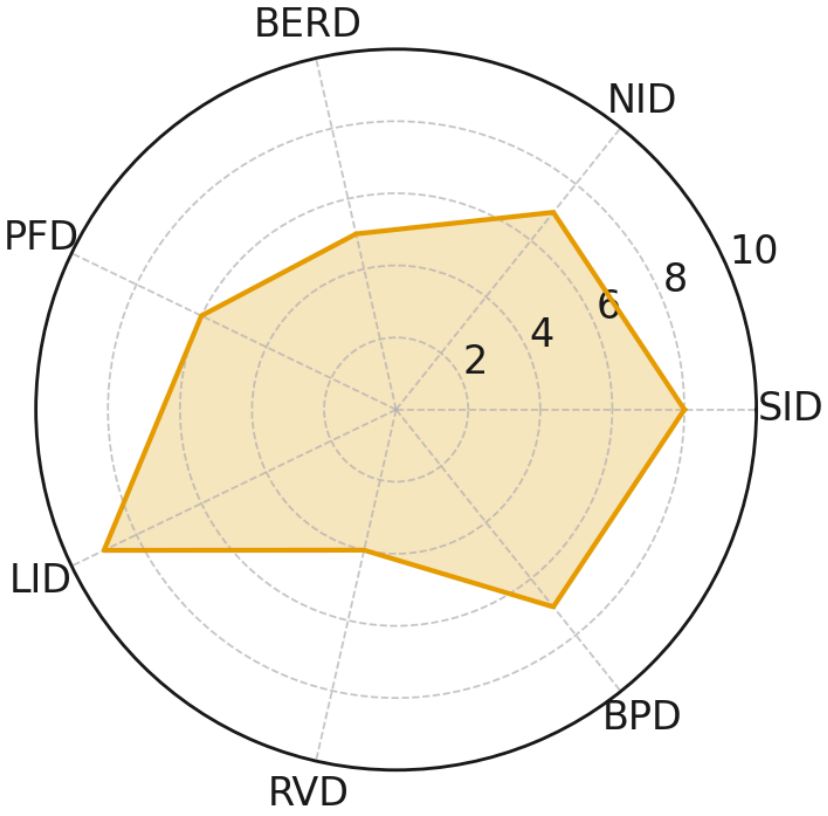
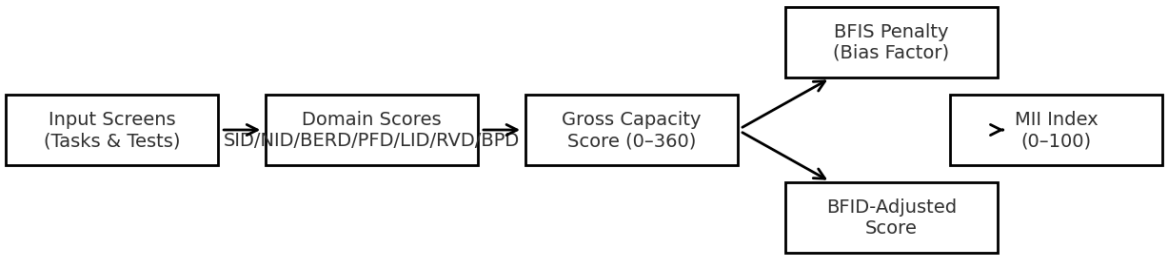
MMSx-SCAN Domain Profile – Example Athlete



MMSx-SCAN Architecture: From Task Screens to MII Index



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