NIS Training Theory White Paper

— Neuro-Integrated System for Human Performance Design —

NIS Training™ Official Document

Author:

Norihisa Watanabe

Integrated Performance Engineer

Published:

November 10, 2025

Chapter 1. Introduction: Background and Purpose

1.1 Fragmentation of Contemporary Training Theories

In contemporary training science and sports practice, theoretical approaches to the human body are largely divided into three separate domains:

Strength & Conditioning (S&C)
– Primarily focused on the musculoskeletal system and muscular strength.

Rehabilitation / Physical Therapy Approaches
– Focused on pain, dysfunction, and clinical restoration of function.

Bodywork / Functional Improvement Approaches
– Focused on posture, sensation, breathing, and "functional" movement.

Each of these domains has developed its own theory and evaluation metrics. However, there is no common framework that consistently integrates:

Structure (skeletal and joint alignment)

Neuro Control (sensory input and motor control)

Performance (measurable output)

As a result, practitioners observe the following gaps:

Pain is reduced, but sport performance does not improve.

Strength increases, but movement efficiency worsens, leading to more injuries.

Posture and breathing improve, but output and speed do not change.

These issues arise from focusing on isolated elements—muscles, joints, or sensory systems—rather than treating the human body as an integrated system.

In other words, what is missing is a perspective that treats the human body as an "information-processing system + mechanical system" and designs it integratively.

1.2 Positioning of the NIS Training Theory

The NIS Training Theory (Neuro-Integrated System Training) presented in this white paper defines the human body as a three-layer system:

Structure (Structure Layer)

Neuro Control (Neuro Control Layer)

Performance (Performance Layer)

These layers are integratively designed and synchronized through:

Phase (Phase) – timing and sequence

Pressure (Pressure) – intra-abdominal / thoracic pressure and gradients

NIS does not deny existing S&C or bodywork theories. Instead, its purpose is to:

Re-locate them within a higher-order integrative framework.

Specifically, NIS aims to:

Provide one single theory that can explain
– pain reduction,
– movement re-education, and
– performance enhancement.

Treat the kinetic chain from foot to head explicitly on a time axis (phase).

Treat breathing and intra-abdominal / thoracic pressure not merely as "stability," but as control variables for the output waveform.

Connect directly with AI and sensor-based movement analysis and optimization algorithms.

1.3 Purpose of This White Paper

The purposes of this white paper are threefold:

Theoretical Definition

To clearly define the basic concepts, architecture, and mathematical framework of the NIS Training Theory.

To clarify its differences and advantages compared with existing theories.

Implementation Guidelines

To show how NIS can be concretely applied and implemented in:

training settings,

clinical settings, and

AI-based movement analysis.

Primary Documentation as Intellectual Property

To explicitly indicate that this theory is an independent, original framework developed by one individual (Norihisa Watanabe).

To serve as evidence for copyright and prior-use rights.

A conceptual diagram that represents human movement as a combination of a Force Transmission Path and a Neuro Control Flow. The synchronization among structure, neuro control, and performance is defined by the angular phase (θ) and pressure (P) of each segment.

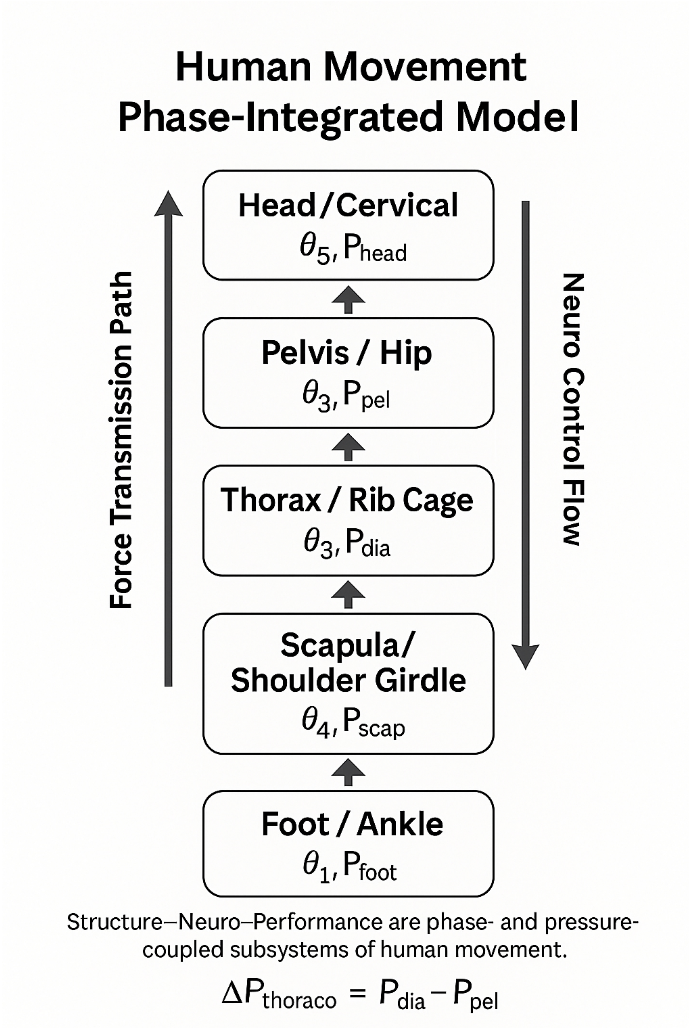

Figure 1-1. Human Movement Phase-Integrated Model

(Conceptual Diagram of NIS)

Chapter 2. NIS Core Framework: Three-Layer Model

2.1 Conceptual Overview

The NIS Training Theory models the human body as a three-layer structure:

Structure Layer

Skeletal alignment

Joint positioning

Center of mass (COM)

Kinetic chain: foot – pelvis – thorax – scapula – head

Neuro Control Layer

Proprioception

Vestibular input

Visual input

Reflex control

Voluntary motor control

Performance Layer

Muscle output

Pressure control

Rotational movements

Speed

Power

Endurance

Other externally observable outputs

These three layers are not independent. They are coupled through:

Phase (phase)
– the timing, rhythm, and sequence of segments and layers

Pressure (pressure)
– primarily intra-abdominal and thoracic pressure gradients

The core of NIS is to synchronize Structure, Neuro, and Performance via phase and pressure to simultaneously optimize:

movement efficiency,

stability, and

output.

2.2 Definition of the Structure Layer

The Structure Layer consists of:

Foot / ankle complex

Lower limb (knee, hip)

Pelvis

Thorax / rib cage

Shoulder girdle (scapula / clavicle)

Cervical spine and head

These are modeled as an ascending chain:

Foot → Pelvis → Thorax → Scapula → Head

The main roles of the Structure Layer are:

Providing alignment and support under gravity

Providing the mechanical path for force transmission during movement

Providing the physical substrate for sensory input

2.3 Definition of the Neuro Control Layer

The Neuro Control Layer is composed of three subsystems:

Sensory Input System

Proprioceptors (muscle spindles, Golgi tendon organs, joint receptors)

Vestibular system

Visual system

Integration System

Spinal-level reflexes

Brainstem and cerebellar posture control

Cortical motor planning and voluntary control

Motor Output System

α-motor neuron activity

Motor unit firing patterns

Coordination and co-contraction patterns

In NIS, neuro control is treated not as a simple "on/off" system, but as phase control.
In other words, NIS focuses on:

When,

in what order, and

with what intensity

each joint and segment is recruited, treating the nervous system as a time-structured system.

2.4 Definition of the Performance Layer

The Performance Layer deals with externally observable outcomes of movement, including:

Force

Velocity

Power

Endurance

Mobility

Stability

In NIS, these outputs are regarded as the result of:

Phase synchrony and

Pressure control

across the Structure and Neuro layers.

2.5 Introduction of the Phase Coupling Model

In NIS, the state of each segment or layer is represented by an angular phase θ.

A representative relationship is defined as:

$$\theta_{phase} = \omega\, t + \alpha\, P$$

Where:

- θ_phase: phase angle (rad)
- ω: natural angular frequency
- t: time
- α: pressure sensitivity coefficient
- P: pressure (mainly intra-abdominal / thoracic pressure)

Interpretation (in words):

The phase angle θ_phase describes when a segment moves.

ω represents its inherent rhythm of movement.

The pressure P advances or delays the phase depending on its magnitude, scaled by α.

Thus, in the NIS framework:

Pressure is treated as the control variable for phase.

This allows us to analyze qualitatively and quantitatively how changes in pressure control:

alter timing and sequencing of movement, and

reorganize the entire kinetic chain.

2.6 Introduction of the Pressure Gradient Model

The pressure gradient within the trunk can be described in relation to:

- the diaphragm,
- the pelvic floor, and
- the configuration of the thoracic and abdominal cavities.

In NIS, the thoracic pressure difference ΔP_thoraco is defined as:

$$\Delta P_{thoraco} = P_{dia} - P_{pel}$$

Where:

ΔP_thoraco: thoracic pressure difference

P_dia: diaphragmatic pressure

P_pel: pelvic floor pressure

Interpretation:

ΔP_thoraco is generated by the coordinated action of the diaphragm and pelvic floor.

It directly affects:

- trunk stiffness,
- postural stability, and
- efficiency of force transmission to the limbs.

In the NIS framework, this $\Delta P\_thoraco$ is treated as a gain and timing adjustment term for output. Its relationship to performance variables (force, speed, power) becomes a target for evaluation and intervention.

Chapter 3. Comparative Analysis with Existing Theories

3.1 Purpose of the Comparison

The purpose of this chapter is to clarify:

the similarities and differences between the NIS Training Theory and representative existing approaches, and

which domains NIS integrates and extends.

Here we focus on three representative systems:

PRI (Postural Restoration Institute)

DNS (Dynamic Neuromuscular Stabilization)

FRC (Functional Range Conditioning)

All three have demonstrated practical and clinical value, but each covers only a limited layer of the overall system. None provides an integrated framework that connects:

Structure,

Neuro Control, and

Performance

through Phase and Pressure.

3.2 Comparative Table of Representative Theories

Table 3-1. Comparison of Existing Theories and NIS

Theory	Main Target / Focus	Core Concept	Primary Layer(s)	Treatment of Phase	Treatment of Pressure	Implementation Scope	Position from NIS Perspective
PRI (Postural Restoration)	Posture, breathing patterns, left–right asymmetry	Alignment of pelvis and thorax, breathing re-education	Structure + partial Neuro	Treated mainly as "position" and "asymmetry"; temporal phase is not explicitly modeled	Deals with diaphragm, ribs, pelvis positioning, but does not model pressure gradients mathematically	Posture improvement, pain reduction	Effective theory for structural and breathing pattern re-education. Can be included as part of the Structure + Pressure layer in NIS.
DNS (Dynamic Neuromuscular Stabilization)	Developmental movement patterns, trunk stability	Reacquisition of developmental postural and movement patterns	Structure + Neuro	Addresses movement sequences across developmental stages but does not formalize phase angles or their coupling with pressure	Emphasizes intra-abdominal pressure, but the link to high-level performance is limited	Clinical function, movement improvement, some performance	A neuro-developmental re-education system. Covers part of the Neuro Control + Pressure domain in NIS.
FRC (Functional Range Conditioning)	Joint ROM and joint control	End-range joint control					

and tissue adaptation Structure (joint) + Motor Output Focuses on joint-level "control," not whole-body phase relationships Pressure control is largely outside its scope Mobility enhancement, injury prevention Local joint adaptation and strengthening methodology. Within NIS, it functions as a local structural adjustment module.

NIS (Neuro-Integrated System Training) Integration and redesign of structure, neuro control, and performance Integrated model binding Structure–Neuro–Performance via phase θ and pressure P Structure + Neuro + Performance (all three layers) Defines phase angles θ_phase for each segment/layer; evaluates and re-educates synchrony and asynchrony via P Treats intra-abdominal and thoracic pressure difference ΔP_thoraco as a gain and timing control variable for output Posture, pain, function, athletic performance, AI-based movement analysis A human performance design theory that integrates existing theories and reconstructs them using Phase and Pressure as the unifying framework.

3.3 Characteristics of Each Theory and Integration by NIS

3.3.1 Comparison with PRI

PRI focuses on pelvis–thorax alignment, breathing patterns, and left–right asymmetry.
The central question is:

"In what position is the body placed?"

Strengths:

Clarified the importance of the relative position of pelvis and thorax.

Systematically addressed the relationship between breathing patterns and posture.

Limitations:

Weak direct linkage to performance (power, speed, sport output).

Does not explicitly treat the time axis (movement phase).

NIS Positioning:

PRI's "pelvis–thorax alignment and breathing" are incorporated as:

A subset of the Structure Layer + Pressure control in NIS.

NIS then connects these to:

phase (when and in what sequence segments move), and

performance (output).

3.3.2 Comparison with DNS

DNS is based on developmental kinesiology and aims to reacquire postural and movement patterns from infancy.

Strengths:

Uses developmental stages to select positions and movement patterns.

Clarified the importance of intra-abdominal pressure and trunk stability.

Limitations:

Focuses on reacquisition of developmental patterns, not on optimization of high-level sports performance.

Does not treat pressure and phase as formalized dynamic variables.

NIS Positioning:

DNS's "developmental patterns" and "IAP-based stabilization" are:

Incorporated into the Neuro Control Layer + Pressure domain in NIS.

NIS then builds a bridge from there to the:

Performance Layer (speed, power, sport-specific movements).

3.3.3 Comparison with FRC

FRC focuses on joint-level range of motion and control at end ranges.

Strengths:

Improves active range of motion and joint-level strength.

Provides local loading strategies to promote tissue adaptation.

Limitations:

Does not address whole-body chain, phase relationships, or pressure control.

Transfer to sport-specific movements is left largely to the coach.

NIS Positioning:

Within NIS, FRC functions as a local module for:

Fine-tuning Structure after the global phase and pressure organization has been established.

3.3.4 Unique Features of NIS

Compared to the above systems, the uniqueness of NIS Training Theory can be summarized in three points:

Three-Layer Integrated Model

Treats Structure, Neuro, and Performance within a single framework.

Unlike existing theories that specialize in only one layer, NIS targets all three.

Coupling via Phase and Pressure

Defines phase angles θ_phase for each segment and layer.

Treats trunk pressure P as a control variable for phase.

This goes beyond "stability" or "breathing techniques" and uses pressure as an operating variable to shape:

movement timing and

output waveforms.

Direct Connectivity with AI and Applications

Through its Phase and Pressure Models, NIS allows movement data (video, sensors) to be:

Numerically analyzed and reconstructed.

This enables seamless integration from:

Theory → Algorithm → Feedback

in systems such as Posture API and Knee AI.

3.4 Summary of Chapter 3

In this chapter, we compared PRI, DNS, and FRC with NIS and showed that:

NIS is a higher-order integrative theory that encompasses and extends these systems.

Summary of positioning:

PRI
→ Structural and breathing pattern re-education
→ Included in NIS as part of Structure + Pressure.

DNS
→ Developmental movement patterns and IAP-based stabilization
→ Included in NIS as part of Neuro + Pressure.

FRC
→ Local joint mobility and strength enhancement
→ Used in NIS as a local adjustment module within the Structure Layer.

NIS does not negate these theories. Instead, it offers a new perspective:

Designing Structure, Neuro, and Performance as one system using Phase and Pressure.

This integrated approach is the core of the NIS Training Theory and the reason why this white paper should be documented as an intellectual property asset.

Chapter 4. Application Systems (Clinical, Performance, Education)

4.1 Clinical Application: Movement Re-education and Pain Modulation

Purpose:
To reconstruct compensatory movement, pain patterns, and mobility limitations through a neuro-integrative approach.

Methods:

Restore synchronization of breathing–pelvis–hip phases (e.g. phase $\theta 2 - \theta 3$).

Optimize the difference between thoracic and pelvic pressures

$$\varDelta P_{thoraco} = P_{dia} - P_{pel}$$

Remap sensory input from foot sole, pelvic floor, and thorax to re-educate postural control.

Observed Outcomes (conceptual):

Reduced recurrence of chronic low back pain, shoulder pain, knee pain, etc.

Improved movement efficiency.

Theoretical Note:
Re-synchronizing the structure–neuro link (phase realignment) suppresses key drivers of joint pain and chronic compensatory patterns.

4.2 Performance Application: Optimization of Output

Purpose:
To maximize output with minimal stress by improving force transmission efficiency and phase synchrony between central and peripheral segments.

Methods:

Control output using reciprocal phase coupling between hip and thorax ($\theta 2 \leftrightarrow \theta 3$).

Stabilize the pelvis and scapular rhythm through pressure control $\Delta P\_thoraco$.

Integrate sensory input (foot → pelvis → thorax) and motor output (shoulder → arm) on a common phase.

Observed Outcomes (conceptual):

Increased performance in sprinting, throwing, jumping.

Simultaneous reduction in fatigue and overuse stress.

Theoretical Note:
Output can be expressed conceptually as:

$$F_{out} \propto \cos(\Delta\theta) \times \Delta P$$

where:

structural efficiency,

neuro synchrony, and

pressure gradient consistency

jointly determine the effective force output.

4.3 Educational Application: Toward "Movement Design"

Purpose:
To systematize a neuro-integrative understanding of movement for trainers, clinicians, and educators.

Educational Structure:

Shift from joint-by-joint learning to phase-based learning.

Redefine evaluation axes from "flexibility / strength" to:

phase synchrony, and

pressure gradient stability.

Teach the brain–body interface not as "output manipulation" but as:

Structural design under phase and pressure constraints.

Expected Effects:

Introduction of less subjective, more objective movement evaluation criteria in practice.

A structured educational framework for "feel – align – output" based on science.

Chapter 5. Model Development (Equations and Phase Simulation)

5.1 Overview: Phase–Pressure Coupling Model

In NIS, each major segment of the body—foot, pelvis, thorax, scapula, head—is expressed as a pair of variables:

$$S_i = (\theta_i, P_i),\ \mathrm{i} = 1,\ldots,5$$

(e.g. θ3 = phase of the thorax, P_dia = diaphragmatic pressure).

The main variables are:

Phase differences Δθ

Pressure differences ΔP

Movement coherence and compensations are evaluated as phase synchrony (phase coherence) within this system of coupled oscillators.

5.2 Force Transmission Model

Force transmission from the lower limbs to the upper body is expressed as:

$$F_{out} = F_{foot} \cdot \cos(\Delta\theta_{pel\text{–}thor}) \cdot k_p(\Delta P_{thoraco})$$

Where:

Δθ_pel–thor = θ3 − θ2: phase difference between pelvis and thorax

k_p(ΔP_thoraco): efficiency coefficient based on thoracic pressure difference (e.g. abdominal pressure control)

Interpretation:

Output efficiency is determined jointly by:

structural phase synchrony and

pressure control.

5.3 Neuro Control Model (Neuro Control Flow)

Ascending and descending neural control are modeled as the minimization of an internal error signal:

$$\mathrm{E}(t) = \Sigma_i\ [\ w_i\ (\theta_{i\_cmd} - \theta_{i\_body})\text{^}2\ ] + \beta(P_{cmd} - P_{body})\text{^}2$$

Where:

E(t): postural control error (internal consistency)

w_i: weighting coefficients for each segment

β: weighting coefficient for pressure control

θ_{i_cmd}: commanded phase

θ_{i_body}: actual body phase

P_{cmd}, P_{body}: commanded vs. actual pressure

Interpretation:

Motor learning can be viewed as a neural optimization process that minimizes E(t).

5.4 Phase Synchrony Simulation

As a continuous-time system, the dynamics can be written as:

[EQ8]
[EQ9]

Physiological interpretation:

K_{ij}: coupling strength between segments (e.g. pelvis–thorax linkage)

ω_i: natural frequency (e.g. breathing cycle, gait rhythm)

α_i, γ_i: coefficients representing how breathing pressure and phase differences interact

By simulating these equations, we can reproduce how:

thoracic delay (θ_3 lag), or

decrease in pelvic pressure (P_{pel})

propagates into changes in upper-limb output and trunk stability.

5.5 Evaluation Index: Neuro-Integrated Coherence Index (NCI)

The NIS framework proposes a quantitative index:

$$NCI = (1/n)\ \Sigma_i\ [\ \cos(\Delta\theta_i) \cdot (\Delta P_i / \Delta P_{max})\ ]$$

Interpretation:

NCI ≈ 1 → high synchrony of phase and pressure, efficient movement.

NCI < 0.7 → compensatory, unstable movement.

NCI ≥ 0.9 → high-efficiency movement (elite performance level, conceptually).

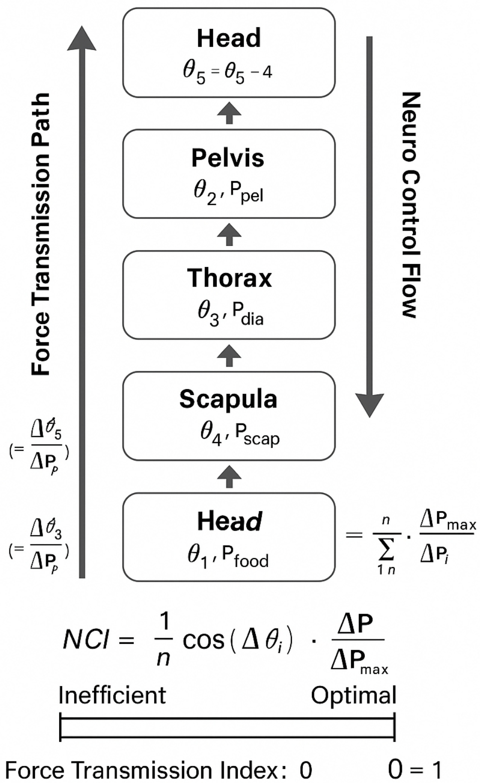

Figure 5-1. Phase-Pressure Coupled Model of Human Movement (NIS Framework)

5.6 Summary of Chapter 5

Movement is modeled as structural output generated by alignment of pressure and phase.

Control of breathing, pelvis, and thorax integrates:

neuro function,

mechanics, and

structure.

This model extends traditional theories of muscle output and functions as a:

“Phase Engineering Model” that makes movement itself a designable object.

A schematic representation of the NIS framework as a coupled system of phase and pressure across the foot–pelvis–thorax–scapula–head chain.

Chapter 6. Clinical and Performance Applications (NCI Use Cases)

6.1 Overview

The index NCI (Neuro-Integrated Coherence Index) derived from NIS can be used across:

Clinical (movement evaluation),

Performance (optimization), and

Educational (motor learning) domains

with the shared purpose of:

Quantifying the coherence of movement.

6.2 Clinical Applications: Posture, Pain, and Rehabilitation

Purpose:
Early detection of compensatory patterns and asymmetries.

Key Variables:

Phase differences $\Delta\theta$

Pressure differences ΔP

Example Criteria:

NCI < 0.7 → breakdown of synchrony among pelvis, thorax, and cervical segments.

$\Delta\theta_{pel\text{–}thor} > 30°$ → thoracic delay and breathing-phase desynchronization.

Intervention Guidelines:

Draw-in exercises and abdominal pressure re-education (increase P_{pel}).

90/90 breathing with thoracic guidance (stabilize P_{dia}).

Re-synchronization using unilateral support patterns (e.g. right stance / left posterior pelvic tilt).

Outcome Measures:

Increase in NCI upon re-testing.

Improved left–right symmetry.

6.3 Performance Applications: S&C and Output Optimization

Purpose:
Optimize movement efficiency and power transmission.

Example Applications:

Simultaneous measurement of $\Delta\theta\_pel–thor$ and NCI in:

throwing,

sprinting,

lifting.

Interpretation:

NCI $\geq 0.9 \rightarrow$ high phase coherence and minimal output loss.

Design Procedure:

Confirm base position (hip–thorax alignment).

Train breathing synchrony and pelvic pressure control.

Track $\Delta\theta$ and ΔP during dynamic outputs (jumps, throws).

Analyze the correlation between peak force and NCI (ideal $R > 0.85$, conceptually).

Sport-Specific Examples (Conceptual):

Baseball pitcher:
Pelvis → thorax → scapula phase lag within 10–20°.

Sprinter:
Pelvic pressure waveform P_pel synchronized with NCI > 0.9.

6.4 Educational and Motor Re-learning Applications

Purpose:
To design educational protocols for neural re-synchronization of movement.

Methods:

Visualize the matching between breathing phase and joint phase (video / sensors).

Use NCI as a feedback metric for learning.

Instructional Model:

Static Synchronization

Supine breathing control.

Dynamic Synchronization

Tall-kneeling and squat patterns.

Task-Level Synchronization

Walking and throwing tasks.

Outcome Measures:

Longitudinal changes in NCI.

Reduction in compensatory movement patterns.

6.5 Figure

A conceptual Venn diagram where NCI, defined by the NIS framework, is placed at the intersection of three domains: clinical, performance, and education. The overlapping central region represents the shared principle of the Phase–Pressure Coupled System.

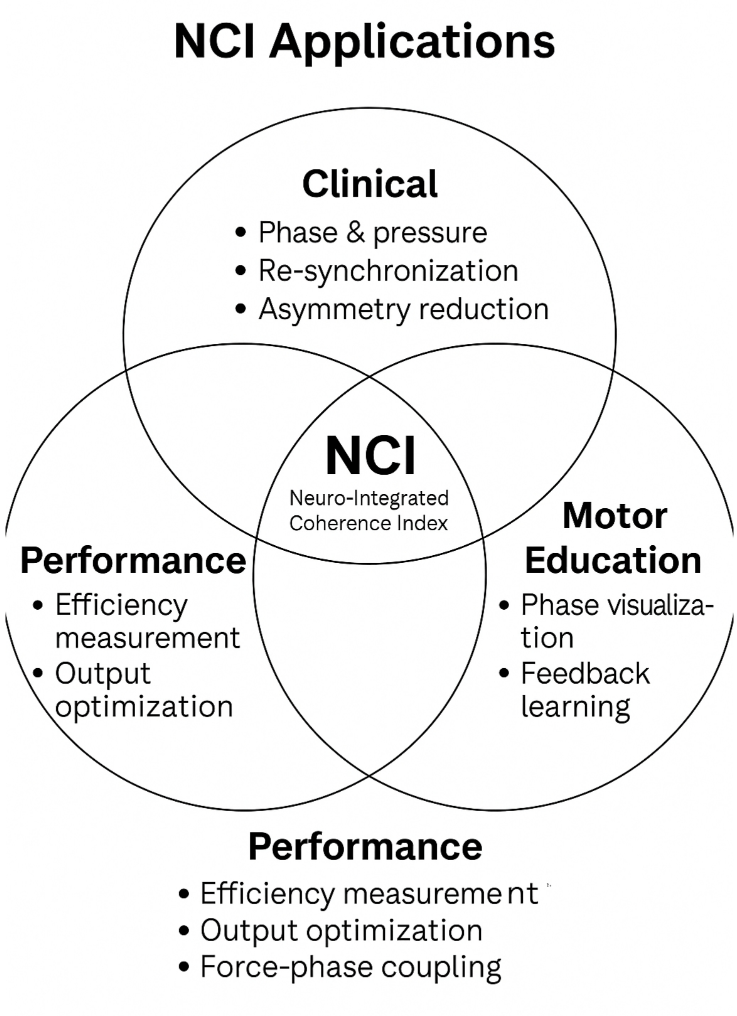

Figure 6-1. NCI Applications (Clinical, Performance, Education)

6.6 Summary of Chapter 6

NCI is an integrated evaluation index for Structure, Neuro, and Pressure.

It can be applied consistently across:

movement correction,

re-education, and

performance design.

In clinical practice, it visualizes re-synchronization.
In sports, it guides output optimization.
In education, it serves as a motor learning model.

The NIS framework complements traditional EMG and joint angle measurements, enabling:

“Neuro-integrated design of movement” as a mathematically grounded system.

End of NIS Training Theory White Paper (English Version)