RAVEN VALLEY / OPUS II

THE TRUE V

Five-Fingered Whole Graphic Being

A Vitruvian Human Standard for Dynamic Anthropometry, Perception, Objects, Machines, Habitation, Environment, and Time

WHITE PAPER

HUMAN COORDINATE STANDARD AND ENVIRONMENTAL INTERFACE SPECIFICATION | VERSION 1.0

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BODY / HAND / SPACE / MACHINE / WORLD

Publication and Method Note

This paper uses MLA-aligned parenthetical attribution and a Works Cited list while retaining the Raven Valley / Opus II white-paper page architecture. It is written for research, development, design review, and AI training. Its aim is not to establish a legal or medical standard by declaration. 'True V' is a project standard: a governed translation layer that binds body measurements, posture, motion, perception, objects, spaces, environmental conditions, tasks, evidence, and version provenance. Where established standards or regulations govern a real application, those requirements supersede this project framework.

Abstract

The Vitruvian tradition is often remembered as a static body held inside a circle and square. The True V recasts that image as a dynamic coordinate system. The circle becomes an action and perception envelope; the square becomes a constraint and habitation envelope; the skeleton becomes topology; joints become transformations; skin becomes interface; movement introduces time; and the environment becomes a second body that the person continuously acts through and is acted upon by. The paper defines sex-stratified male and female reference fields, TV-M and TV-F, while explicitly rejecting either as a universal ideal. It adds TV-I for the directly measured individual, TV-P for the declared target population, and TV-E for the task/environment record. Current U.S. adult anthropometric data from NCHS/NHANES are used only for dimensions actually measured in that survey, and historical Vitruvian ratios are preserved only as precedents for relational reasoning. The framework then extends from anatomical landmark to reach, hand-object coupling, furniture, machines, rooms, buildings, accessibility, ecological conditions, visual perception, and AI governance. Every project equation is classified so that canonical mathematics, scientific analogy, design heuristic, and synthetic summary are not confused.

Executive Summary

True V begins with one operative rule: Measure the actual body -> normalize its relationships -> identify its internal rhythms -> design from those rhythms. The standard does not ask whether a person is close to an ideal. It asks whether the coordinate record is adequately defined for the intended task. A body measurement without population, protocol, posture, date, unit, and purpose is incomplete. A percentile without its source distribution is incomplete. A machine control without reach, force, visibility, consequence, and failure-state analysis is incomplete. A room without movement, clearance, perception, air, light, sound, thermal conditions, and recovery routes is incomplete. The True V record is therefore a chain of declared interfaces rather than a silhouette.

Evidence and Equation Classes

The internal corpus distinguishes established evidence from inference and project invention. This paper uses E for established evidence or formal standard, S for supported inference, P for project-defined hypothesis/heuristic, and X for speculative extension. Separately, equations are tagged MATH when they are canonical mathematical forms, ADAPTED when a known form is used by analogy, PROJECT when the relationship is defined for design governance, and SYNTHETIC when it summarizes several variables without claiming a law of nature. Visual Equations explicitly established this discipline so the project can remain ambitious without presenting metaphors as physics (Conrad and OpenAI, Visual Equations 2-3).

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01

Genealogy and Scope: Vitruvius to True V

From idealized proportion to declared, testable human-coordinate fields.

The Measure Before the Measure

A body entered the temple
before the stone learned its span.
The old line sought a perfect answer;
the new line asks who is standing here.

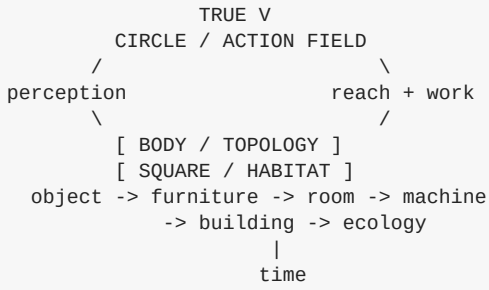
Keep the circle, but let it move.
Keep the square, but name its walls.
The measure becomes honest
when it remembers the measured.

Vitruvius opened Book III by linking architectural symmetry to proportion: the relation of parts to one another and to a selected standard. His human ratios included the face as roughly one tenth of stature, the head from chin to crown as one eighth, the foot as one sixth, the forearm as one fourth, and an equivalence between body height and arm span in the square/circle construction (Vitruvius 3.1). These statements are historically important because they encode a relational method: architecture could be organized by correspondence rather than by arbitrary isolated dimensions.

True V preserves that relational intelligence while refusing the inference that one canonical body can stand for all bodies. Modern anthropometry treats dimensions as population distributions, depends on standardized landmarks and protocols, and requires explicit sampling and database practices (ISO 7250-1; ISO 15535; Dianat, Molenbroek, and Castellucci). The project therefore converts the Vitruvian figure from a verdict about human perfection into a coordinate grammar for describing relationships among a measured body, its movements, its objects, and its environment.

OPERATIVE RULE

MEASURE THE ACTUAL BODY -> NORMALIZE ITS RELATIONSHIPS -> IDENTIFY ITS INTERNAL RHYTHMS -> DESIGN FROM THOSE RHYTHMS.



Audio description: A measured body sits at the center. Around it, an action/perception circle intersects a square representing environmental constraints. Interfaces radiate outward from objects and furniture to rooms, machines, buildings, ecology, and time.

EVIDENCE CLASSIFICATION

E / S / P boundary. The historical ratios are primary-source precedent, not validated contemporary fit rules. The translation of circle to action and square to habitation is P-class project interpretation.

02

Ethics, Evidence, Sex, Gender, and Human Variability

Reference fields without turning distributions into identities or ideals.

Two Columns, Many Bodies

Two columns can count a population;
they cannot finish a person.
The table is a lantern, not a name.
The mean is a place where numbers meet,
not where bodies are commanded to stand.

Ask what was measured.
Ask who was missing.
Ask who may decline the question.
Then build the door wider than the category.

The request for one male and one female True V standard is useful if 'male' and 'female' are treated as source-defined sex strata in anthropometric datasets rather than as total descriptions of persons. National Academies guidance distinguishes sex from gender and describes each as multidimensional; it also warns that sex, gender identity, and sexual orientation data can be sensitive and require rigorous privacy and confidentiality practices (National Academies 3-4, 38). NIH likewise emphasizes appropriate analysis and transparent reporting of data by sex where scientifically relevant (Office of Research on Women's Health).

Accordingly, TV-M and TV-F are statistical reference fields. They do not infer gender identity, expression, anatomy not measured, reproductive status, ability, or preference. The Raven Valley Veil already states the compatible governance rule: identity must not be inferred from body shape, voice, name, or prior garment history; fit and support variables should be used for fit, while identity-related inputs are voluntary (Conrad and OpenAI, Raven Valley Veil).

Variation is not a defect to be averaged away. It is the basic condition of ergonomic design. De Vries and Parkinson frame unequal exclusion across user groups as disproportionate disaccommodation, an ethical as well as performance concern. True V therefore requires designers to report who a design accommodates, under what task and environment, rather than claiming that a percentile label itself proves inclusivity.

- TV-M: source-defined male anthropometric reference field.
- TV-F: source-defined female anthropometric reference field.
- TV-I: directly measured individual field; preferred for individualized fit.
- TV-P: declared target-population distribution and inclusion goals.
- TV-E: task, posture, environment, object, and regulatory interface record.

EVIDENCE CLASSIFICATION

E / S / P boundary. Sex-stratified anthropometric reporting is E when derived from a defined dataset. Any mapping from those strata to identity, personality, capability, or preference is unsupported and prohibited by this standard.

03

The True V Standard: Definition and Architecture

A human system is a set of interfaces, not a mannequin.

The Whole Has Hinges

Bone is not the whole,
nor skin the final border.
A whole has hinges, handles, thresholds,
weather at the cheek and consequence at the fingertip.

Name each meeting.
Version each change.
A body becomes legible
without becoming small.

True V defines the human system as BODY + ACTION + PERCEPTION + OBJECT + SPACE + ENVIRONMENT + TIME. This is a P-class project formulation, not a biological equation. Its purpose is to prevent design disciplines from severing variables that operate together in use. The same hand that has an anatomical width also has a grip state, glove state, wetness state, fatigue state, target control, required force, consequence of error, and surrounding clearance.

```
HUMAN SYSTEM = BODY + ACTION + PERCEPTION + OBJECT + SPACE + ENVIRONMENT + TIME
```

EQUATION CLASS: PROJECT

A governance decomposition for design records, not a biological law.

The standard's central proposition is therefore operational: the body ends anatomically at the skin, but functionally it continues into everything it can reach, perceive, operate, occupy, support, avoid, carry, modify, or be modified by. WHO's ICF supplies an established precedent for treating functioning and disability in context and explicitly includes environmental factors; NASA's human-system standard supplies a high-reliability engineering precedent in which performance, habitability, environment, hardware, software, and crew interfaces are specified together (WHO; NASA). True V generalizes this coupling as a design-data architecture.

```
T_V(t) = B(t) union R(t) union P(t) union O(t) union S(t)
```

EQUATION CLASS: PROJECT

Body geometry, reach/action, perception, object interface, and occupied-space fields are recorded as distinct but coupled layers.

```
[TV-I] measured person
   |
   +--> [TV-M / TV-F] reference context
   +--> [TV-P] target population
   +--> [TASK + POSTURE]
   +--> [OBJECT / MACHINE]
   +--> [TV-E] environment
   |
   +--> [TEST + RESULT + VERSION]
```

Audio description: The True V record starts from the measured individual when available and connects reference population, target population, task/posture, object or machine, environment, and test/version records.

04

Historical Proportion Canon and Its Limits

Retain relational precedent; reject pseudo-measurement.

The Old Ratios

One tenth, one eighth, one sixth, one fourth:
a ladder of remembered fractions.
Beautiful because they relate,
dangerous when they pretend to measure.

Let history be a compass,
not a caliper.

The project retains the Vitruvian relations H_face ~= H/10, H_head ~= H/8, L_foot ~= H/6, L_cubit ~= H/4, and L_armspan ~= H as historical relational precedents. Vitruvius' text directly supports the face, head, foot, forearm, and square/circle correspondence (Vitruvius 3.1). What it does not support is the contemporary claim that these ratios accurately predict any given person's dimensions.

```
H_face ~= H/10 ; H_head ~= H/8 ; L_foot ~= H/6 ; L_cubit ~= H/4 ; L_armspan ~= H
```

EQUATION CLASS: ADAPTED / HISTORICAL

Historical proportional formulas only. Do not substitute for measured face, head, foot, forearm, or armspan data.

A useful demonstration is to apply the historical formula to the current U.S. adult median stature reported by NCHS. For male adults age 20+ the median stature is 175.2 cm; for female adults it is 161.2 cm (Fryar et al., table 7). Historical projection would therefore yield, for example, an armspan equal to those statures and a foot length of 29.2 cm and 26.9 cm respectively. Those are computed Vitruvian projections, not NHANES measurements. The distinction is the point: a ratio can be internally coherent and still fail as measurement.

RULE OF EVIDENCE

A DERIVED HISTORICAL RATIO MUST NEVER BE RELABELED AS AN OBSERVED ANTHROPOMETRIC VALUE.

05

Measurement Ontology: B_A through B_M

Six coordinate spaces keep dimensions from being confused.

Six Ways to Say Near

A centimeter is not a reach.
A ratio is not a seam allowance.
A motion is not a photograph.
A seen edge is not a bone.

Name the space before the number;
then the number can travel safely.

True V formalizes six coordinate families inherited from the Raven Valley Veil: B_A absolute, B_N normalized, B_L local, B_D dynamic, B_P perceptual, and B_M manufacturing. The purpose is semantic hygiene. A shoulder breadth in millimeters, a normalized shoulder-to-stature ratio, a local coordinate around the acromion, a shoulder path during reach, a visually perceived shoulder boundary, and a garment pattern allowance are not interchangeable values even if all refer to the same region.

$$B = \{B_A, B_N, B_L, B_D, B_P, B_M\}$$

EQUATION CLASS: PROJECT

Absolute, normalized, local, dynamic, perceptual, and manufacturing coordinate spaces.

Space	Question answered	Typical unit / form
B_A absolute	What is the measured dimension?	mm, cm, degrees, kg
B_N normalized	What is the relation to a declared denominator?	ratio or percent
B_L local	Where is it relative to a landmark/frame?	x,y,z in local frame
B_D dynamic	How does it change during action?	trajectory, range, velocity
B_P perceptual	What boundary or cue is available to the observer?	visual/auditory/tactile state
B_M manufacturing	What must be built around the body?	allowance, tolerance, clearance

Every normalized ratio must declare its denominator. Every manufacturing value must preserve the underlying body measure and the design allowance separately. Every dynamic measurement must declare posture, task, start/end state, and whether trunk compensation or other joints were allowed. ISO 7250-1's standardized landmark approach and ISO 15535's database-reporting requirements provide the external discipline; True V adds the cross-domain labels.

06

Landmark Vocabulary and Coordinate Frames

The skeleton becomes topology; landmarks become addressable nodes.

A Map with Moving Cities

The shoulder is a place
that does not stay still.
The knee is a gate
whose angle edits the road.

Pin no body to the page.
Give each landmark a time stamp.

A True V body is represented first as a set of declared anatomical or surface landmarks. ISO 7250-1 provides an established vocabulary for technological anthropometry, while 3-D scanning can extract compatible measurements when protocols satisfy ISO 20685-1. True V does not replace those definitions. It creates a computational wrapper around them.

$$p_i(t) = (x_i(t), y_i(t), z_i(t))$$

EQUATION CLASS: MATH

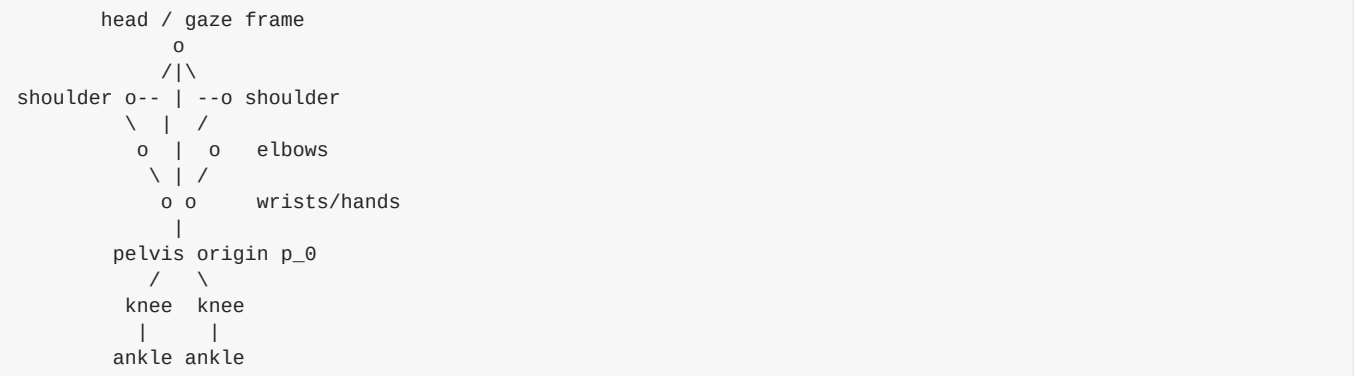
A time-indexed 3-D landmark coordinate.

$$\hat{p}_i(t) = [p_i(t) - p_0(t)] / H(t)$$

EQUATION CLASS: PROJECT / MATH

A normalized landmark relative to a declared origin p_0 and reference dimension H. H must be explicitly defined; stature is only one possible denominator.

Landmarks are connected by segments and joints to form topology. A shoulder-elbow-wrist-hand chain is not merely a drawing: it is a sequence of transformations with anatomical limits, soft-tissue effects, task constraints, and compensatory motion. Digital models must record coordinate-frame conventions, handedness, units, and landmark confidence. Scanned surface data must not be treated as direct joint-center truth without an appropriate validated method.



Audio description: A simplified landmark graph with a pelvis origin, bilateral shoulders, elbows, wrists and hands, knees and ankles, plus a head/gaze frame. The lines represent topology rather than anatomical detail.

07

Male Reference Standard: TV-M

A source-bounded male field, not an ideal male body.

The Reference Man Refuses the Throne

He is not the king of bodies.
He is a row in a documented table,
useful because the row names its survey,
its year, its measure, its uncertainty.

Let him guide a comparison.
Never let him erase the person in the room.

TV-M v1.0 uses the current NCHS/NHANES August 2021-August 2023 adult U.S. male strata as its first national baseline for the dimensions that report actually contains. NHANES is a complex multistage probability sample of the civilian noninstitutionalized U.S. population; the report's analytic sample contains 8,545 people age two and older, uses standardized examination procedures, and reports weighted population estimates (Fryar et al. 1-2). It is not a global male standard.

For adult males age 20 and older, NCHS reports stature n=2,690, mean 175.1 cm, P5 162.2, P50 175.2, P95 187.2; upper arm length n=2,654, mean 39.6 cm, P5 35.8, P50 39.5, P95 43.5; upper leg length n=2,559, mean 41.0 cm, P5 35.8, P50 41.0, P95 45.9; hip circumference n=2,569, mean 105.6 cm, P5 89.5, P50 103.6, P95 129.1 (Fryar et al., tables 7, 14, 18, 20).

TV-M v1.0 | U.S. adults 20+	n	Mean	P5	P50	P95
Stature cm	2690	175.1	162.2	175.2	187.2
Weight kg	2688	90.3	60.9	86.6	131.8
Waist circ. cm	2605	103.0	79.3	100.9	133.2
Hip circ. cm	2569	105.6	89.5	103.6	129.1
Mid-upper arm circ. cm	2652	34.7	27.7	34.4	42.9
Upper arm length cm	2654	39.6	35.8	39.5	43.5
Upper leg length cm	2559	41.0	35.8	41.0	45.9

*Sample sizes vary by measure; the source table must be consulted for exact n and footnotes. Weight and circumference estimates exclude pregnant females only, which does not affect the male stratum. The paper intentionally does not infer armspan, popliteal height, hand dimensions, sitting height, or reach from stature because those current NHANES tables do not report them. A True V implementation must import compatible datasets or measure the target users directly for those variables.

TV-M RECORD

SEX STRATUM: male as reported by source | POPULATION: U.S. civilian noninstitutionalized adults age 20+ | SURVEY: NHANES Aug. 2021-Aug. 2023 | VERSION: TV-M 1.0 | USE: reference context, not compulsory dimensions

08

Female Reference Standard: TV-F

A source-bounded female field with the same provenance discipline.

The Second Column Is Not a Smaller First

She is not an offset copy
of the column beside her.
Each measure has its own distribution,
each task its own consequence.

Do not shrink the chair and call it care.
Measure the hand that meets the handle.

TV-F v1.0 uses the female strata in the same NCHS/NHANES adult reference so that comparisons share population frame, survey period, and measurement protocol. For adult females age 20 and older, stature n=3,307, mean 161.2 cm, P5 149.6, P50 161.2, P95 172.5; hip circumference n=3,098, mean 109.8 cm, P5 89.7, P50 106.8, P95 138.4; upper arm length n=3,239, mean 36.2 cm, P5 32.4, P50 36.1, P95 39.8; upper leg length n=3,116, mean 36.8 cm, P5 31.9, P50 36.9, P95 41.4 (Fryar et al., tables 7, 14, 18, 20).

TV-F v1.0 | U.S. adults 20+	n	Mean	P5	P50	P95
Stature cm	3307	161.2	149.6	161.2	172.5
Weight kg	3254	77.9	50.7	73.5	119.2
Waist circ. cm	3121	97.9	73.8	95.7	129.2
Hip circ. cm	3098	109.8	89.7	106.8	138.4
Mid-upper arm circ. cm	3198	32.9	25.1	32.1	43.6
Upper arm length cm	3239	36.2	32.4	36.1	39.8
Upper leg length cm	3116	36.8	31.9	36.9	41.4

The female field is not defined as a scalar reduction of TV-M. Some dimensions show different ratios, distributions, and overlap. Tool studies reinforce why direct interface dimensions matter: Lee et al. found grip-span preferences depended on hand size in a male sample, and a 2026 orthopaedic power-tool study reported that hand anthropometrics, grip strength, and sex were relevant to how surgeons used a one-size-fits-all tool (Lee et al.; Morgan et al.). These studies do not justify a universal female handle; they justify adjustable, tested interfaces and the collection of the actual variables that drive use.

TV-F RECORD

SEX STRATUM: female as reported by source | POPULATION: U.S. civilian noninstitutionalized adults age 20+ | SURVEY: NHANES Aug. 2021-Aug. 2023 | VERSION: TV-F 1.0 | USE: reference context, not identity or destiny

09

Percentiles, Accommodation, and the Myth of Composite Bodies

A percentile is one coordinate in one distribution, not a whole person.

No One Is the Ninety-Fifth Body

The tall shoulder may meet a short arm.
The wide hand may live with a narrow hip.
Percentiles do not assemble themselves
into a single obedient statue.

Count people, not ghosts made of endpoints.

A recurring ergonomic shortcut is to imagine a '5th percentile female' and a '95th percentile male' as complete bodies. That is statistically unsafe when multiple dimensions are involved. Percentile rank in one dimension does not guarantee the same percentile rank in another, and correlations vary. The anthropometry literature therefore emphasizes fitting criteria, multivariate methods, sampling, and prototype evaluation rather than reliance on a single average or endpoint (Dianat, Molenbroek, and Castellucci).

True V records percentiles by variable and calculates accommodation against actual multivariate records whenever possible. It treats adjustability as a first-class design strategy because one fixed geometry frequently produces unequal exclusion. De Vries and Parkinson's work makes that inequality explicit as disproportionate disaccommodation.

```
A(u,D,T,E) = 1 if user u can perform task T with design D in environment E under declared criteria; otherwise 0
```

EQUATION CLASS: PROJECT

Binary accommodation bookkeeping for a declared test, not a physiological probability.

```
A_P(D,T,E) = (1/N) SUM_j A(u_j,D,T,E)
```

EQUATION CLASS: PROJECT

Population accommodation estimate over an actual or validated simulated sample.

REQUIRED DISCLOSURE

NEVER SAY "ACCOMMODATES 5TH-95TH PERCENTILE" WITHOUT NAMING THE DIMENSION(S), POPULATION, DATA SOURCE, TASK, TEST METHOD, AND WHETHER VARIABLES WERE MODELED JOINTLY.

10

Joint Topology and Kinematics

The static figure becomes a system of transformations through time.

Joints Are Agreements

A joint is where one certainty ends
and another is negotiated.
Rotation borrows space;
flexion borrows clearance.

Design the agreement before the shell,
or the shell will become a prison.

The Raven Valley Play System states a transferable principle: a joint is an agreement among parts, clearances, motion, load, and assembly. True V applies the same reasoning to the human-object system. Static dimensions are necessary but insufficient because reach and access depend on coordinated movement. Sengupta and Das measured maximum dynamic reach envelopes for seated and standing male and female participants; Holman, Davis, and Maghsoodloo found that trunk and shoulder movement entered seated reach earlier than simple static-arc assumptions implied, while noting their study's limited sample and need for further investigation (Sengupta and Das; Holman, Davis, and Maghsoodloo).

```
T_chain(t) = T_1(t) T_2(t) ... T_n(t)
```

EQUATION CLASS: MATH / PROJECT APPLICATION

A standard homogeneous-transform concept applied to an articulated body or body-object chain; actual joint models and limits require validated biomechanical data.

True V therefore records both anatomical range and task-authorized range. A maximum reach is not automatically a comfortable or sustainable reach; a joint can be kinematically capable yet ergonomically inappropriate under load, repetition, speed, instability, clothing, pain, or hazard. The standard distinguishes reachability from suitability.

11

Five-Fingered Whole Graphic Being

The hand as terminal body geometry and beginning of the tool chain.

Five Small Levers

Five small levers open the century:
thread, key, brush, scalpel, switch.
The fingertip is the last point of the body
and the first point of the machine.

A millimeter at the control
may move a world beyond the hand.

'Five-Fingered Whole Graphic Being' is not only a title. It identifies the hand as the most densely consequential bridge between body coordinate systems and constructed systems. The chain BODY -> SHOULDER -> ELBOW -> WRIST -> PALM -> FIVE DIGITS -> OBJECT -> MACHINE -> ENVIRONMENTAL CHANGE makes agency geometrically explicit.

```
p_finger(t) = T_shoulder T_elbow T_wrist T_hand T_digit p_0
```

EQUATION CLASS: PROJECT / MATH

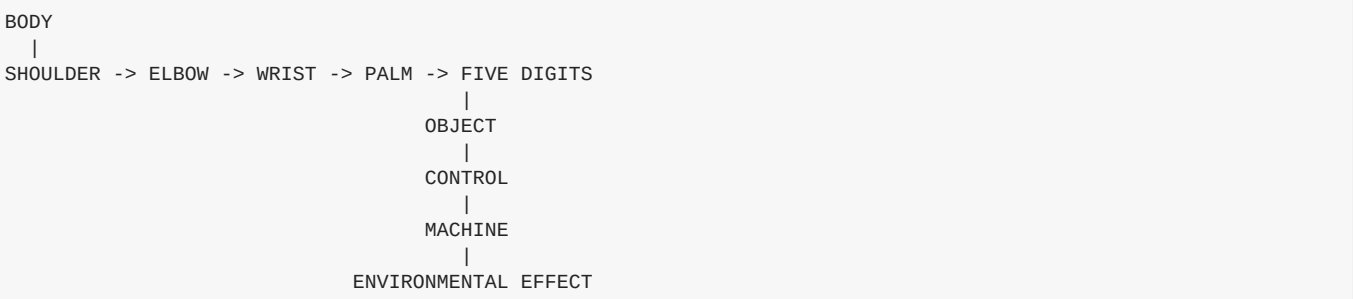
Kinematic chain notation for a fingertip endpoint.

```
p_effect(t) = T_machine[p_finger(t)]
```

EQUATION CLASS: PROJECT

The user's small action is mapped through an object or machine into a larger external effect.

Handle geometry should therefore be tied to measured hand variables, required force, duration, glove state, wrist posture, control precision, and consequence. In Lee et al.'s 46-male study, grip span interacted with hand-size group; in Morgan et al.'s 2026 surgeon study, one-size-fits-all orthopaedic power-tool handles were implicated in compensatory use patterns. Neither study is a universal sizing table. Together they support the True V rule that hand interfaces should be adjustable or offered in validated variants when a target population is diverse.



Audio description: A causal chain runs from the body through the upper limb to the five digits, then through an object and control into a machine and an environmental effect.

12

Reach Fields: The Circle as Action Envelope

From the Vitruvian circle to layered comfortable, extended, emergency, and hazard fields.

The Circle Learns Distance

The old circle touched fingertips.
The new circle asks why they reached.
Comfort has one radius,
emergency another, danger another still.

A reachable thing is not yet a usable thing.

The Vitruvian circle becomes, in True V, a family of action envelopes rather than a single radius. Reach changes with posture, trunk movement, footwear, support, carried load, vision, speed, fatigue, and environmental conditions. Dynamic reach research supports modeling reach as a task-dependent volume rather than a fixed arc (Sengupta and Das; Holman, Davis, and Maghsoodloo).

```
V(t) = union_i R[p_hat_i(t), theta_i(t)]
```

EQUATION CLASS: PROJECT

A time-varying articulated reach envelope assembled from normalized landmarks and joint states.

- R_p - primary comfortable reach: repeated or precision interaction zone.
- R_s - secondary reach: less frequent or moderate-extension interaction zone.
- R_e - emergency reach: safety-critical access assessed separately from comfort.
- R_h - hazard/exclusion field: region the body must not enter during specified machine states.

Legal accessibility reach ranges are a separate layer, not synonymous with ergonomic comfort. For covered U.S. accessibility applications, the Access Board's ADA Standards specify unobstructed adult forward and side operable-part ranges from 15 in (380 mm) minimum to 48 in (1220 mm) maximum; obstructions alter high-reach limits (U.S. Access Board). True V stores those constraints as regulatory interface rules with jurisdiction and edition metadata.

13

Constraint Fields: The Square as Habitation Envelope

The square becomes clearance, support, boundary, and recovery space.

Four Walls Are Not a Room

A square can hold a body
and still refuse a life.
Clearance is not emptiness;
it is possibility kept open.

The room begins where movement can finish safely.

If the circle is action, the True V square is constraint: floor, wall, ceiling, edge, obstruction, support, opening, and available maneuvering volume. In this interpretation the square is not a symbol of bodily perfection but a record of the conditions within which a body can enter, turn, see, reach, work, rest, recover, and leave.

Constraint fields are task-specific. A doorway needs body plus clothing, carried object, mobility device, hand clearance, and emergency egress assumptions. A storage opening must account for the hand and object together. A maintenance hatch must include tool swing and visibility. The Play System already uses an analogous rule at figure scale: a door must fit the actual figure and accessories, while ladders and platforms must be tested against real hand, foot, and articulation geometry (Conrad and OpenAI, Raven Valley Play System).

```
C_habitat = {boundary, clearance, support, passage, visibility, recovery, exclusion}
```

EQUATION CLASS: PROJECT

A checklist set, not a scalar equation.

14

Furniture and Support Surfaces

Furniture is geometry derived from actions, contact, variation, and time.

The Chair Borrows a Body

A chair borrows the geometry of rest,
then returns it changed.
Seat, edge, back, arm, floor:
a quiet machine made of contact.

Do not fit the body to the chair.
Let the chair learn who arrives.

A chair is not fundamentally four legs and a seat. For True V it is an interface among popliteal height, buttock-knee length, hip breadth/circumference, elbow height, joint angles, reach, pressure/contact distribution, duration, task, and ability to enter and exit. The equation below is therefore an input registry rather than a prescriptive chair formula.

```
F_chair = f(H_popliteal, L_buttock-knee, W_hip, H_elbow, theta_hip, theta_knee, R_reach,
                                    P_contact, t)
```

EQUATION CLASS: PROJECT

Design relationship only. Safe dimensions require appropriate standards, population data, and physical evaluation.

The 2025 NHANES report is a useful caution: current national tables contain stature, upper-arm and upper-leg lengths, and several circumferences, but not all classic seated-furniture dimensions. Its historical appendix shows that older U.S. surveys reported sitting height, knee height, elbow-rest height, popliteal height, thigh clearance, and buttock-knee length, but those are not current measurements in the 2021-2023 table set (Fryar et al. 16-17). True V therefore forbids pretending current stature can safely regenerate missing seated dimensions.

Evidence from school-furniture research supports the broader principle that compatibility between furniture dimensions and users' anthropometry affects physical responses, while the evidence base is heterogeneous and context-specific (Castellucci et al.). Adjustable furniture is therefore often preferable to a single sex-labeled geometry.

15

Machines, Tools, Controls, and Hazard Envelopes

Machines amplify small human motions into consequential external actions.

The Lever Remembers the Finger

A finger moves five millimeters.
Steel moves ten meters.
Between them lives the duty of design.

Make error visible before power makes it large.

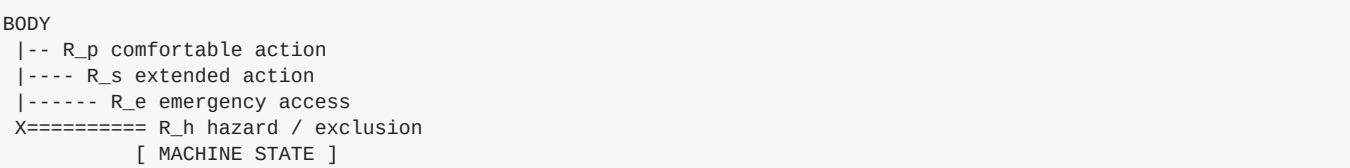
Machines add causal amplification. True V therefore does not stop at whether a control can be touched. It asks whether it can be perceived, identified, reached, gripped, actuated with the required force, operated repeatedly, released, interrupted, and accessed during abnormal conditions without entering a hazard field.

$$M_I = f(R, V, G, F, T, C, H)$$

EQUATION CLASS: PROJECT

R reach; V visibility; G grip/manipulation; F force; T duration/repetition; C cognitive/control mapping; H hazard consequence.

Manual material handling demonstrates why task geometry must be explicit. The Revised NIOSH Lifting Equation manual evaluates lifting-task factors rather than treating worker stature alone as a risk descriptor (Waters, Putz-Anderson, and Garg). NASA-STD-3001 Volume 2 similarly integrates human performance, habitability, environment, hardware, software, and operations in a high-reliability context (NASA). True V adopts the systems lesson while deferring to domain-specific safety methods.



Audio description: Concentric or nested action zones extend from the body, ending at an explicitly separated machine hazard/exclusion field.

16

Living Spaces as Choreography

Rooms are temporal sequences of posture, reach, carrying, perception, and recovery.

The Room Is a Verb

A kitchen is not counters.
It is turn, carry, wash, see, wait, reach.
A bedroom is not a bed.
It is rise in darkness and find the floor.

Draw the verbs, and the walls will know where to stand.

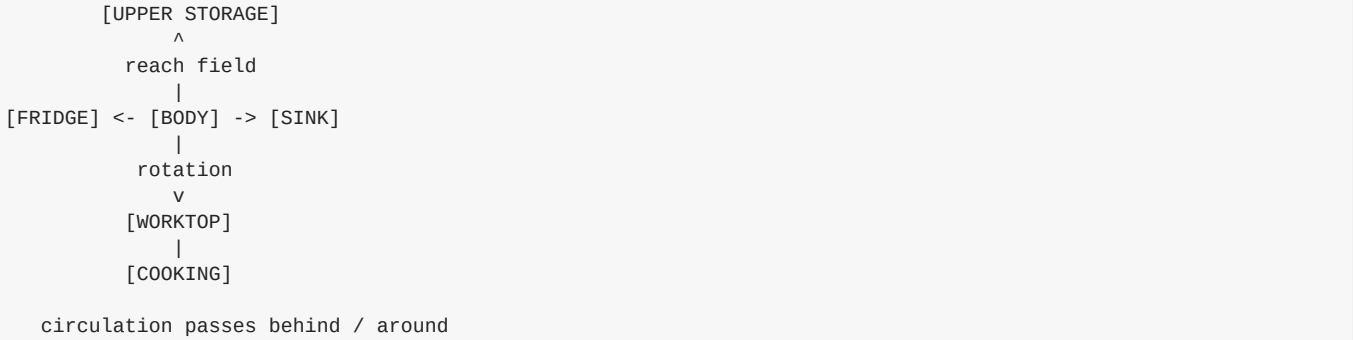
True V defines a room as Geometry + Occupancy + Movement + Reach + Sight + Sound + Light + Air + Task + Time. The terms are deliberately additive in the notation because the equation is a project checklist rather than physics. A room that fits a static body but obstructs the task sequence is not functionally fitted.

```
ROOM = Geometry + Occupancy + Movement + Reach + Sight + Sound + Light + Air + Task + Time
```

EQUATION CLASS: PROJECT

Room-design decomposition used to force explicit task and environmental variables.

Kitchen analysis, for example, should follow actual sequences: stand, approach, open, lift, carry, turn, place, cut, wash, cook, monitor, clean, store, and recover. Each step changes hand occupancy, visual attention, reach envelope, collision risk, heat exposure, and circulation. Similar choreography applies to bathrooms, bedrooms, studios, shops, laboratories, transit cabins, and maintenance spaces.



Audio description: A kitchen task map places the body between refrigerator and sink, with upper storage above, worktop and cooking below in the task chain, and circulation passing around the user.

17

Mobility, Accessibility, and Non-Standing Bodies

Variation belongs inside the primary model, not in a remedial appendix.

The Figure Sits Down

At last the figure sits,
kneels, leans, rolls, rests,
reaches from another height.
The old diagram does not break;
it becomes more truthful.

Access is not a special edition of the world.

The classical Vitruvian image privileges an upright ambulatory adult. True V explicitly includes standing, seated, reclined, lying, kneeling, crouched, reaching, turning, and walking postures, plus wheelchairs, walkers, canes, crutches, prostheses, assistants, and carried loads where relevant. This is not a claim that one model covers every disability; it is a rule that no single posture is treated as the unmarked human default.

WHO's ICF provides the strongest external conceptual precedent: functioning and disability occur in context, and environmental factors can be recorded as part of that context (WHO). The Raven Valley Book of Conduct similarly states that participation should not depend on one body, language, sense, or cognitive style (Conrad and OpenAI, Raven Valley Book of Conduct). True V converts those principles into interface records.

- P = {standing, seated, reclined, lying, kneeling, crouched, reaching, turning, walking}.
- P+ = {wheelchair, walker, cane, crutch, prosthesis, assistant, carried load}.
- Accessibility requirements are minimum legal/standard constraints where applicable; ergonomic comfort and task performance require separate evaluation.
- Assistive devices are part of the active body-object envelope and must be represented in clearances, reach, storage, charging, transfer, and recovery scenarios.

18

Environmental Physics and the Second Body

Light, heat, humidity, air, sound, vibration, surface, weather, and clothing change the functional human field.

The Second Body

The hand does not end at its final bone.
It continues through the cup it lifts,
through the lever, room, and opened gate.

The foot remembers every floor.
The eye enlarges into windows and horizons.
A chair borrows the geometry of rest;
a machine borrows the geometry of intention.

Measure the person, then measure the meeting.
For neither body nor world is whole alone.

Environmental anthropometry begins when dimensions are treated as state-dependent interfaces. A person in darkness has the same stature but not the same usable visual field. A wet or gloved hand can have different friction, tactility, and effective clearance. Clothing changes occupied volume. Heat, cold, air movement, humidity, vibration, noise, surface condition, and weather can alter comfort, task duration, communication, stability, and error likelihood.

$$E(t) = [L, Temp, Hum, Air, Noise, Vib, GravLoad, Surface, Weather]$$

EQUATION CLASS: PROJECT

Environmental state vector: illumination, temperature, humidity, airflow, noise, vibration, gravitational/postural loading, surface/terrain, and weather/exposure.

$$B'(t) = f[B(t), E(t), Task(t)]$$

EQUATION CLASS: PROJECT

Functional body state depends on measured body, environmental state, and task; no physiological prediction is implied.

ASHRAE Standard 55 supplies a strong domain precedent for coupled variables: thermal acceptability depends on combinations of environmental factors such as temperature, thermal radiation, humidity, and air speed together with personal factors such as activity and clothing (ASHRAE). True V generalizes the methodological lesson - declare coupled state variables - but does not substitute its vector for thermal-comfort calculations.

```
[V0] SKIN / BODY
       |
[V1] PERSONAL ENVELOPE - clothing, footwear, carried items
       |
[V2] HAND / OBJECT - handles, switches, tools, controls
       |
[V3] FURNITURE - chair, bed, desk, counter, storage
       |
[V4] ROOM - floor, wall, door, window, circulation, light, sound
       |
[V5] BUILDING / MACHINE - workplace, vehicle, transit, equipment
       |
[V6] ECOLOGICAL - sun, air, heat, humidity, terrain, plants, water, weather
```

Audio description: Seven nested scales run from the skin/body outward through personal items, hand/object interfaces, furniture, room, building/machine environments, and finally ecological conditions.

19

Perception and Observer-System Coupling

The human occupies what can be reconstructed, not only what can be touched.

The Eye Builds a Door

A threshold first exists as light.
Then edge, contrast, depth, expectation,
then footfall.

To be traversable, a stair must be seen
before it can be stepped upon.

True V extends the body field into perception because interaction depends on detecting and interpreting affordances, boundaries, controls, hazards, and routes. Gestalt research provides a mature empirical basis for grouping and figure-ground organization, while predictive-processing theories provide models in which perception depends on inference and prior expectations (Wagemans et al.; Friston). These literatures do not validate the project's 'holographic' metaphors, but they support the narrower claim that usable environments are observer-dependent information systems.

```
P_H = V_visual union A_auditory union T_tactile
```

EQUATION CLASS: PROJECT

Minimal perceptual envelope; can be extended to vestibular, thermal, olfactory, proprioceptive, and interoceptive channels as the task requires.

```
R = f(O, S)
```

EQUATION CLASS: ADAPTED

Visual Equations shorthand: readout R depends on observer O and system state S. It is a design analogy, not a canonical law of perception.

This changes evaluation. A stair is not adequately designed because tread and riser dimensions exist; it must also be differentiated, anticipated, approached, traversed, and recovered from under expected lighting, visual conditions, attention demands, and environmental noise. A control is not accessible merely because it lies inside a reach rectangle; it must be identifiable and operable in context.

20

Human-Environment Feedback and Time

Environment acts back: furniture changes posture, light changes perception, tasks change fatigue, and users change spaces.

The Room Answers

You sit, and the chair edits you.
You speak, and the room edits speech.
You walk, and the path learns wear.

Every interface is a conversation
with a delay measured in consequence.

True V is dynamic because the body-environment relationship is reciprocal. A workstation changes posture; a screen changes gaze; a doorway funnels circulation; acoustic conditions change speech; stairs change gait; sunlight changes visual adaptation and thermal load; repeated tool use changes fatigue. Conversely, the human moves furniture, opens doors, alters controls, wears surfaces, and changes environmental state.

```
Human_t -> Environment_t -> Human_(t+1)
```

EQUATION CLASS: PROJECT

A causal feedback diagram for design analysis.

```
B_(t+1) = B_t + alpha(E_t - B_t)
```

EQUATION CLASS: ADAPTED

Adaptation analogy only. This update-rule form must not be presented as a physiological equation.

Time also changes anthropometric reference itself. Population dimensions can shift across decades, and product lifetimes can outlast the datasets that informed them. True V therefore treats source date and revision review as mandatory metadata. A standards paper that does not know when its people were measured will eventually design for a population that no longer exists as described.

21

Visual Holography Equation Registry

A disciplined translation from optical and mathematical forms into design heuristics.

Do Not Call the Metaphor Physics

A wave may teach rhythm
without becoming the wall.
A hologram may teach distributed memory
without making a poster a hologram.

The analogy grows stronger
when its border is named.

The project's Visual Equations paper already established the required epistemic discipline: some supplied equations are canonical mathematical forms, some are adapted analogies, some are project heuristics, and the final combinations are synthetic governance summaries. That taxonomy is carried directly into True V (Conrad and OpenAI, Visual Equations 2-3). Gabor's 1948 holography paper is retained as the historical optical anchor; it does not establish a literal holographic theory of human design (Gabor).

Equation	Class	True V reading
H(x)=SUM_i h_i(x)	ADAPTED	Local landmarks/interfaces carry partial information about whole-system organization.
R=f(O,S)	ADAPTED	Readout depends on observer and system state/context.
P(x)=SUM_n a_n phi_n(x)	PROJECT	Recursive/layered representation with bounded coefficients.
Psi(x,t)=A sin(kx-omega t)	MATH borrowed	Waveform used to reason about phase/rhythm, not body physiology.
f(lambda x)=lambda^k f(x)	MATH borrowed	Scale-recurrence test for patterns across body/object/building levels.
S_(t+1)=S_t+alpha(O-S_t)	ADAPTED	Iterative correction toward an observed/desired state.
U=H*P*R*E	SYNTHETIC	Dashboard for distribution, recursion, observer coupling, environment; no physical units.
TRUE V=B*M*P*O*E*T	SYNTHETIC	Governance reminder that body, motion, perception, object, environment, time must be jointly declared.

The multiplication signs in synthetic expressions signal coupling, not calibrated dimensional multiplication. If any factor is undefined, the design record is incomplete; if a safety-critical factor is unacceptable, a high score elsewhere cannot cancel it. The equations function as prompts and schemas rather than predictive laws.

$$TRUE\ V = B * M * P * O * E * T$$

EQUATION CLASS: SYNTHETIC

Subject to Variation intersection Accessibility intersection Safety intersection Task intersection Consent intersection Evidence.

22

Recursive Architecture: From Body to Building and Image

The measured body becomes a seed for clothing, furniture, machines, rooms, architecture, and visual composition.

A Ratio Leaves the Hand

A knuckle repeats as a hinge.
A reach repeats as a bay.
A seam becomes a joint in a wall.
A rhythm of steps becomes a rhythm of light.

Scale the relation, not the flesh.

True V's recursive claim is not that buildings should be body-shaped. It is that design relationships can remain legible across scales. The body supplies a primary coordinate seed; clothing adds service and manufacturing envelopes; furniture transforms contact and posture; machines transform action into consequence; rooms organize repeated tasks; buildings assemble rooms into civic systems; images and interfaces communicate these states back to the observer.

```
f(lambda x) = lambda^k f(x)
```

EQUATION CLASS: MATH / PROJECT APPLICATION

A canonical scaling form borrowed as a test for whether a structural relation persists under scale change; not a claim that human-built forms are exact power laws.

This connects directly to ARCH-3 and the Veil's nested-envelope logic: outer and inner shells, corresponding vertices, controlled offsets, seams as agreements, and functional filigree can be anchored to human interfaces rather than decorative resemblance. A hand-scale grip motif can become a cabinet pull, a service-access geometry, or a facade maintenance module if the operational relation survives the change in scale. The rule is recurrence of function and interface, not repetition for its own sake.

Dimensional Aesthetics contributes a complementary perceptual boundary: light, depth, contrast, and observer position are part of the interface by which a built relation becomes legible (Conrad and OpenAI, Dimensional Aesthetics). The Opus II biomechanical/biodiversity and uncertainty studies add two outer constraints: buildings participate in shared habitats, and modular interfaces should expose what must remain verifiable when systems change (Conrad and OpenAI, Biomechanical Systems; Conrad and OpenAI, Weaving Understanding). In True V, a repeated geometry that cannot be perceived, reached, maintained, safely traversed, or reconciled with its environmental context has not successfully recurred merely because its silhouette resembles the seed. Recursive architecture therefore preserves operational relationships across body, object, room, building, image, and ecology.

```
BODY LANDMARK
   -> GARMENT SEAM / CLEARANCE
      -> TOOL / FURNITURE INTERFACE
         -> ROOM BAY / SERVICE ZONE
            -> BUILDING MODULE
               -> URBAN / ECOLOGICAL INTERFACE

At every arrow: preserve provenance + task + tolerance + test.
```

Audio description: A recursive chain begins with a body landmark and expands through garment, tool or furniture, room, building, and ecological scales. Each translation carries provenance, task, tolerance, and validation information.

23

AI Representation, Training, Privacy, and No-Drift Governance

A True V record must be machine-readable without becoming a machine-made stereotype.

The Model Must Remember Its Source

Teach the model the measure,
then teach it the margin around the measure.
Teach it the person may refuse the label.
Teach it that a missing field is missing,
not permission to invent.

Provenance is memory with responsibility.

For AI training and design automation, True V should be represented as structured records with explicit provenance and nullability. Missing hand width must remain missing; it must not be silently inferred from sex or stature unless a validated model is deliberately invoked, named, versioned, and uncertainty-labeled. Sensitive identity fields should be minimized and separated from fit variables. National Academies guidance emphasizes privacy/confidentiality for sex and gender data, and NIST's AI RMF provides a general framework for managing AI risks across design, deployment, use, and evaluation (National Academies 38; Tabassi).

The 2024 NIST Generative AI Profile reinforces lifecycle risk management for generative systems. In True V, this becomes no-drift governance: an AI may propose, compare, simulate, and flag; it may not upgrade a project heuristic into an established standard, fabricate a missing anthropometric measurement, claim regulatory compliance without the governing test, or infer identity from geometry (Autio et al.).

```
{
  "standard": "TRUE_V",
  "version": "1.0",
  "subject_model": "TV-I | TV-M | TV-F | TV-P",
  "measure": {"name": "...", "value": null, "unit": "mm"},
  "source_population": "...",
  "protocol": "...",
  "posture": "...",
  "task": "...",
  "environment": "TV-E/...",
  "evidence_class": "E|S|P|X",
  "equation_class": "MATH|ADAPTED|PROJECT|SYNTHETIC",
  "validation": {"method": "...", "result": "..."}
}
```

Audio description: A compact machine-readable True V schema stores version, body/reference model, measurement and unit, source population, protocol, posture, task, environment, evidence class, equation class, and validation record. Missing values remain explicitly null.

AI RELEASE GATE

NO SOURCE -> NO NUMBER. NO TEST -> NO SAFETY CLAIM. NO CONSENT -> NO IDENTITY INFERENCE. NO VERSION -> NO STANDARD CLAIM.

24

Validation Program and Conformance Levels

From descriptive record to simulation, prototype test, and domain verification.

Proof Lives in Contact

The equation is quiet on paper.
The hinge speaks when loaded.
The chair speaks after an hour.
The doorway speaks when two people meet.

A standard earns its name
by surviving the world it describes.

True V cannot become credible through elegant equations alone. The validation program proceeds from measurement provenance to simulation, prototype testing, and, where relevant, formal safety/regulatory verification. Dianat, Molenbroek, and Castellucci emphasize prototype evaluation and testing as recurring methodological needs in anthropometry-based design. True V therefore defines conformance as a traceable process rather than an aesthetic resemblance to the Vitruvian figure.

Level	Meaning	Minimum evidence
TV-A DESCRIPTIVE	Data/provenance complete	Declared population, protocol, units, posture, task, environment, equation/evidence classes.
TV-B SIMULATED	Digital accommodation assessed	Versioned digital human/model, assumptions, collision/reach/visibility results, uncertainty.
TV-C PROTOTYPE	Representative physical use tested	Target-user or valid surrogate testing, task protocol, failures and revisions recorded.
TV-D DOMAIN VERIFIED	Applicable formal requirements verified	Qualified review/testing to governing safety, accessibility, regulatory or engineering requirements.

The conformance label is project governance, not certification. TV-D does not grant legal approval; it records that applicable external requirements were identified and verified by appropriate parties. For a public building that may include accessibility law and building code; for a manual-lifting task, an occupational ergonomics method; for a thermal environment, an applicable thermal-comfort standard; for a spacecraft, NASA-specific requirements; for medical or industrial machines, their own regulatory and safety regimes.

RELEASE GATE

A True V design is not released as "validated" until its target population, task, environment, failure modes, test method, results, exclusions, and external governing requirements are versioned in the record.

25

Conclusion: The Measure That Returns to the Person

A standard becomes humane when reference data lead back to individual reality.

The True V

Five fingers open the figure.
Two feet return it to the ground.
The circle becomes what may be done;
the square becomes what must allow it.

Body, motion, perception, object, world, time:
not six kingdoms, but one meeting.

Measure the person.
Measure the meeting.
Then let the design remember both.

The True V preserves the deepest useful idea in the Vitruvian tradition - relations matter - while reversing its most dangerous modern simplification. The human is not a canonical figure to which environments are scaled. The human is a changing, measurable participant in a field of interfaces. Male and female reference standards are retained because sex-stratified data can reveal relevant distributions and exclusions, but they are demoted from archetypes to context. The directly measured individual and declared target population remain primary.

The circle becomes reach, action, and perception. The square becomes constraint, habitation, and clearance. The skeleton becomes topology. The joints become transformations. The skin becomes an interface rather than the final functional boundary. Five fingers make the body-object-machine chain explicit. Movement adds time; environment acts back; perception reconstructs what geometry alone cannot guarantee.

The result is a common human-coordinate grammar for clothing, furniture, tools, machines, vehicles, interiors, buildings, public space, visual systems, and ecological environments. Its scientific strength will depend not on the poetry of its equations but on the discipline with which every variable is sourced, every analogy is labeled, every missing value remains missing, every population is named, and every consequential design is tested.

```
TV_individual = TV_reference + Delta_individual + Delta_state + Delta_task + Delta_environment
```

EQUATION CLASS: SYNTHETIC

A project summary: the individual record is never reducible to the reference field alone.

Appendix A. True V Measurement Dictionary

Field	Definition	Required metadata
STATURE	Standing vertical body height under defined protocol.	Source, protocol, unit, posture, date, statistic.
LANDMARK p_i	Anatomical/surface point in declared coordinate frame.	Landmark definition, frame, confidence, time.
REACH R	Task-specific reachable/actionable region.	Posture, permitted trunk motion, hand state, task, duration.
CLEARANCE	Space needed for body + clothing/device/object + tolerance.	State, load, motion path, allowance, validation.
GRIP	Hand-object geometry and force interface.	Hand dimensions, span/diameter, glove, wrist posture, force, duration.
PERCEPTION	Task-relevant detectable information field.	Sense/channel, lighting/noise, viewing/listening condition, acuity assumptions.
ENVIRONMENT E	Physical environmental state vector.	Sensor/source, units, location, time, task.
MANUFACTURING B_M	Built dimension derived from body/interface plus allowances.	Underlying measure, allowance, tolerance, material/process.

Appendix B. Baseline TV-M / TV-F Reference Table

Baseline values below are NCHS/NHANES U.S. adults age 20+ for August 2021-August 2023 and are included only for measures available in the current report. They are reference distributions, not universal design dimensions. Sample sizes and exclusions differ by measure; consult the source tables before deployment (Fryar et al.).

Measure	TV-M P5	TV-M P50	TV-M P95	TV-F P5	TV-F P50	TV-F P95
Stature cm	162.2	175.2	187.2	149.6	161.2	172.5
Weight kg	60.9	86.6	131.8	50.7	73.5	119.2
Waist circ. cm	79.3	100.9	133.2	73.8	95.7	129.2
Hip circ. cm	89.5	103.6	129.1	89.7	106.8	138.4
Mid-upper arm circ. cm	27.7	34.4	42.9	25.1	32.1	43.6
Upper arm length cm	35.8	39.5	43.5	32.4	36.1	39.8
Upper leg length cm	35.8	41.0	45.9	31.9	36.9	41.4

Appendix C. Equation Register

ID	Expression	Class	Use boundary
C1	p_i(t)=(x_i,y_i,z_i)	MATH	Coordinate notation; landmark definition is empirical.
P1	p_hat_i=[p_i-p_0]/H	PROJECT/MATH	Normalization; H must be declared.
P2	V(t)=union R(p_hat_i,theta_i)	PROJECT	Reach-envelope abstraction; validate task model.
A1	H(x)=SUM h_i(x)	ADAPTED	Distributed-whole analogy from Visual Equations.
A2	R=f(O,S)	ADAPTED	Observer/system-context analogy.
P3	P(x)=SUM a_n phi_n(x)	PROJECT	Recursive/layered representation.
C2	Psi=A sin(kx-omega t)	MATH	Canonical waveform; design-rhythm borrowing only.
C3	f(lambda x)=lambda^k f(x)	MATH	Canonical scaling law; recurrence analogy in design.
A3	S_(t+1)=S_t+alpha(O-S_t)	ADAPTED	Generic iterative correction.
S1	U=H*P*R*E	SYNTHETIC	Design dashboard; no physical units.
P4	T_V=B union R union P union O union S	PROJECT	Environmental/body field union.
P5	M_I=f(R,V,G,F,T,C,H)	PROJECT	Machine-interface variable registry.
S2	TRUE V=B*M*P*O*E*T	SYNTHETIC	Governance completeness reminder.

Appendix D. Environmental Design Interface Matrix

Scale	Examples	Primary True V questions
V0 Skin/body	body surface, joints, sensation	Which landmarks, contact zones, motion limits, sensitivities, and state changes matter?
V1 Personal	clothing, footwear, carried items	How do volume, insulation, grip, mass, and mobility change?
V2 Hand/object	handles, switches, tools, phones	Can it be seen, reached, grasped, actuated, released, and distinguished?
V3 Furniture	chair, bed, desk, counter	Does geometry support posture, task, entry/exit, duration, and variation?
V4 Room	doors, windows, circulation, storage	Can users approach, turn, carry, see, hear, recover, and egress?
V5 Building/machine	vehicles, factories, transit, equipment	What causal amplification, hazards, maintenance, accessibility, and failure states exist?
V6 Ecological	sun, heat, humidity, rain, terrain, plants	How do weather, surfaces, biodiversity, exposure, and season change use?

Appendix E. Text-Only Diagram and Audiobook Convention

All diagrams in this paper are encoded as monospaced text followed by an explicit audio description. In derivative audiobook or text-to-speech editions, the diagram block may be skipped if the audio description is retained. Equations should be read with their equation-class label and verbal gloss so listeners can distinguish a canonical mathematical form from a project heuristic.

```
[DIAGRAM TITLE]
 node A -> node B -> node C
    |                  |
  state              result
```

Audio description: Example convention: a simple process moves from node A to node B to node C; node A has a state branch and node C has a result branch.

Appendix F. AI Data Schema

Minimum machine-readable fields for a True V object:

```
TRUE_V_RECORD
- standard_version
- record_id
- reference_field: TV-M | TV-F | TV-I | TV-P
- source_population
- source_document / dataset / date
- measurement_protocol
- body_measurements[] {name,value,unit,statistic,landmark,confidence}
- posture / task / duration
- motion_model / reach_fields
- object_interface[]
- environment_state: TV-E
- accessibility_constraints[]
- hazard_fields[]
- evidence_class: E|S|P|X
- equation_class: MATH|ADAPTED|PROJECT|SYNTHETIC
- validation[] {method,participants,result,failures}
- consent_and_privacy_flags
- revision_history[]
```

Audio description: The record is a versioned hierarchy covering source population, measurement protocol, body measurements, posture/task, motion and reach, objects, environment, accessibility, hazards, evidence and equation status, validation, privacy, and revision history.

Appendix G. Version and Source Manifest

Component	Version / date	Status
True V project standard	1.0 / 9 Aug. 2026	Project-defined; requires validation per use case.
TV-M / TV-F U.S. baseline	NHANES Aug. 2021-Aug. 2023; NCHS report June 2025	Current national U.S. reference used in this paper.
ISO 7250-1	2017, confirmed 2023	Current at citation audit date.
ISO 15535	2023	Current at citation audit date.
ISO 20685-1	2018, confirmed 2024	Current at citation audit date.
NASA-STD-3001 Vol. 2	Rev. E / 1 May 2025	Active at citation audit date.
ANSI/ASHRAE 55	2023	Current edition listed by ASHRAE at audit date.
NIST AI RMF	1.0 / 2023	Voluntary framework; NIST ecosystem continues to evolve.
NIST GenAI Profile	AI 600-1 / 2024; page updated 2026	Companion profile.

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