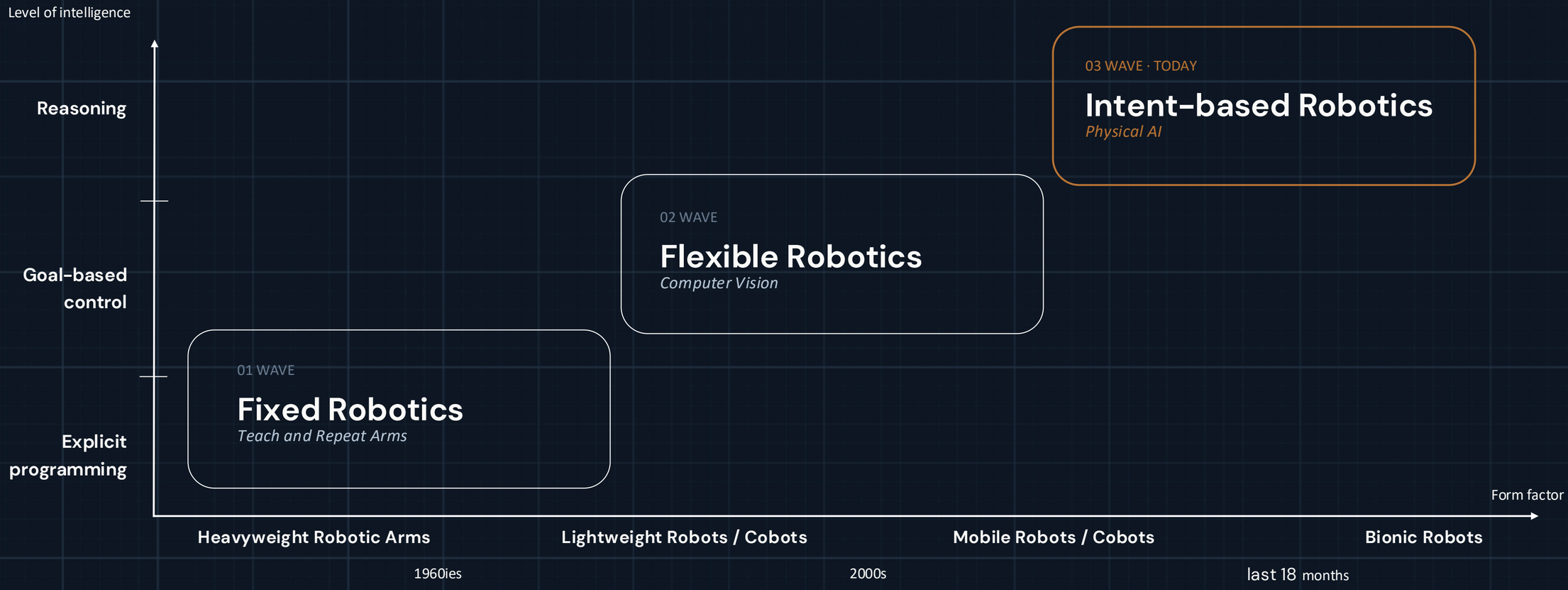
Why Physical AI means a step change to wire harness automation

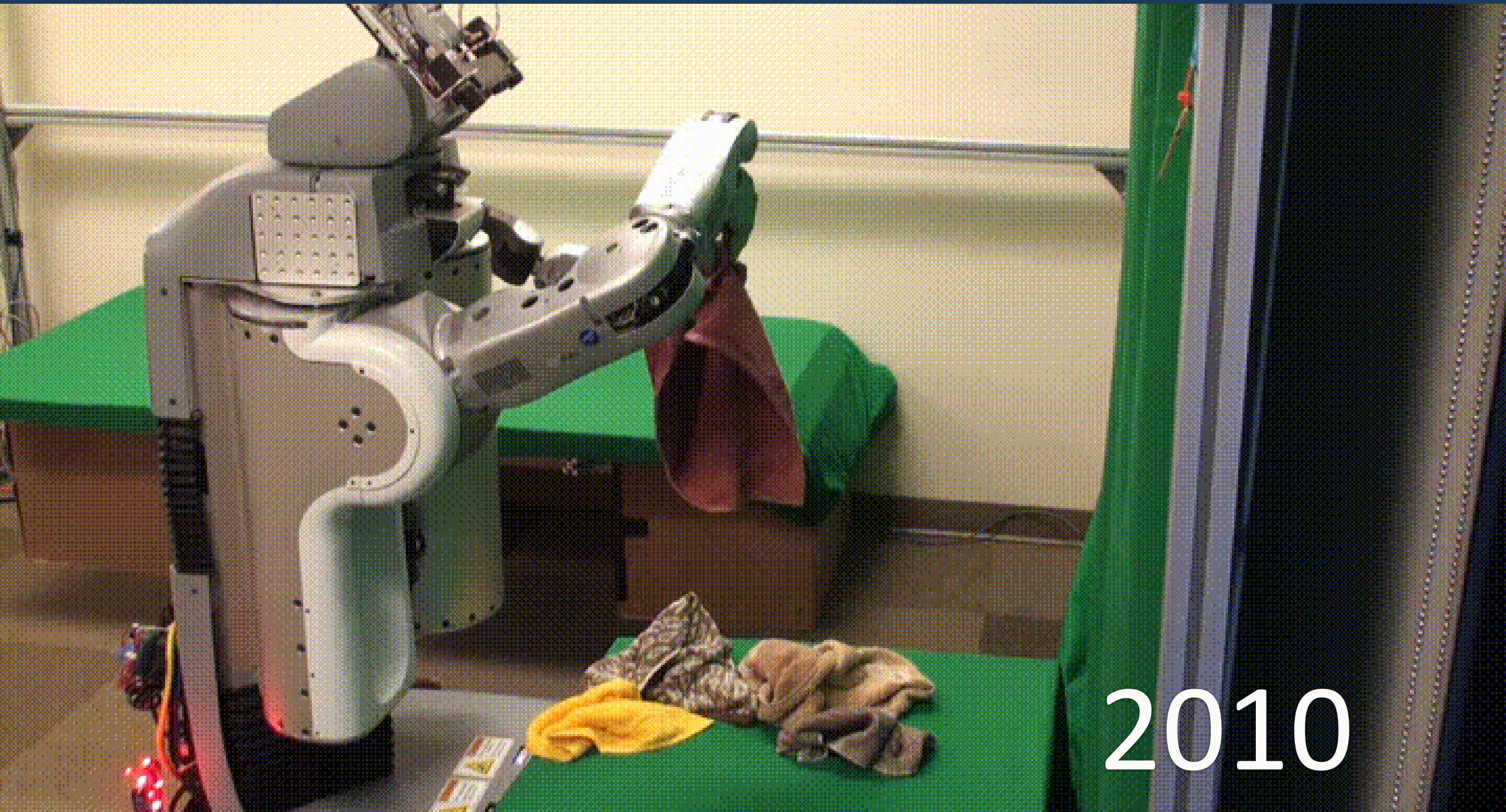
“Wire Harness Assembly cannot be automated by a Robot”

Or can it?

WHY NOW?

Right now, Robotics is having a *"Foundation-Model"* – Moment




2010

F.02
2025

WHY NOW?

Manual tasks that have resisted automation are *automatable* for the first time

Too variable. Too unstructured. Too low-volume — until now.

2023

WHY IT FAILED · 01

Task variability

Every part looked different. Rigid automation couldn't absorb the variation.

WHY IT FAILED · 02

Integration cost

Programming and integrating a cell cost more than the labour it replaced.

WHY IT FAILED · 03

Volume economics

High-mix, low-volume lines never justified a dedicated machine.

2026

Robot Foundation models

General physical understanding, transferable across tasks and parts.

Imitation learning

Show the task once; the robot learns the policy — no reprogramming.

Robotics-as-a-Service

No upfront capex. Pay per robot, per shift — the risk shifts to us.

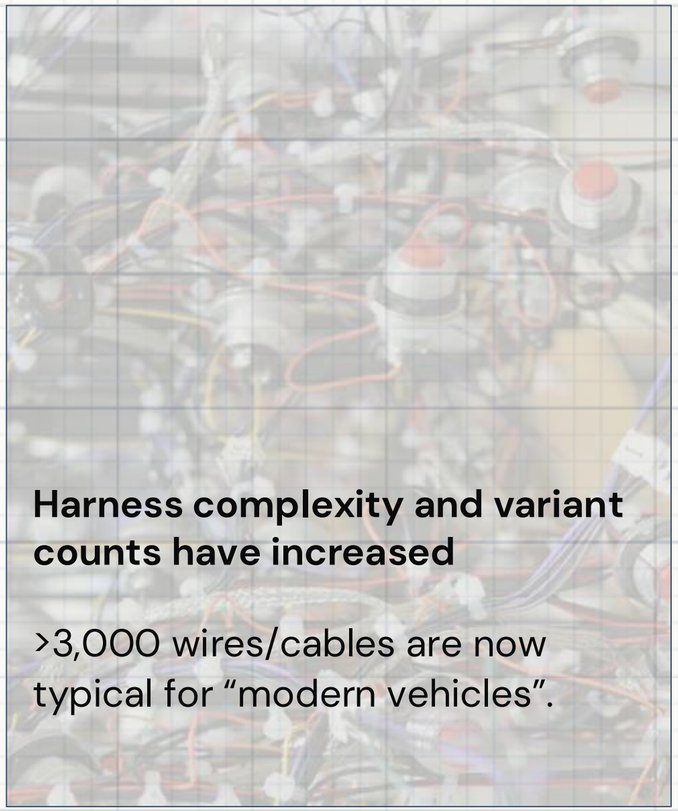
We want to find the right task for Mercedes.

WHY NOW?

Wire harnessing could be one of the most valuable applications of foundation models

Labor dependency is becoming a structural risk

14% increase in hourly labor costs in Eastern Europe in 2024 (Source: Eurostat)



Harness complexity and variant counts have increased

>3,000 wires/cables are now typical for “modern vehicles”.

Supply chain resilience needs to be urgently addressed

$6.2 billion in import value (2024) for HS 854430.

We believe that wire harnessing automation is entering a step-change with Physical AI

From Design to Action: Enabling End-to-End Robotic Wire Harness Assembly

Lukas Knak[1], Jan Olsson[2], Tom Heitmann[3], Markus Rentschler[4], and Robert Suess-Wolf[5]

[1] Eisbach Robotics, München, Germany
[2] Eisbach Robotics, München, Germany
[3] Neura Robotics GmbH, Metzingen, Germany
[4] ARENA2036 e.V., Stuttgart, Germany
[5] ARENA2036 e.V., Stuttgart, Germany

Abstract. Automated wire harness production is severely limited by fragmented and heterogeneous engineering data — including KBL, VEC, STP files, and PDFs — which describe product geometry and Bill of Materials but fail to provide a machine-readable manufacturing blueprint. Consequently, process engineering remains largely manual, variant-specific, and heavily dependent on expert knowledge, creating a major bottleneck for scalable automation. Existing solutions address isolated aspects of this complexity, but fall short of delivering true end-to-end integration. This paper presents a novel data-driven framework that directly infers manufacturing intent from diverse design artifacts using a Product-Process-Resource (PPR) and Capability–Skill–Service (CSS) methodology. The proposed end-to-end pipeline employs multimodal extraction, combining vision-language models with structured Asset Administration shell (AAS) templates to aggregate and harmonize engineering data from customer inputs towards an automatically generated a Bill of Process,

INDUSTRY BOTTLENECKS

What is end-to-end automation?

1

Agentic AI: instant engineering

Reduces engineering effort — every quote uses live production & warehouse data.

2

Physical AI: assembly

Enables automated manufacturing — robots that learn the task from demonstration.

The two halves close the loop — quote to part, with no manual handoff in between.

THE NEW MANUFACTURING OS

Eisbach OS: training an agent to replace cumbersome extraction with fast results

TODAY

OEM
Circuit diagram (Stromlaufplan)

eCAD Design
Engineer interprets KBL file

⚠ Iterative process
Weeks of back-and-forth between parties

2–6 weeks

Final drawing (Zeichnung)
Correct technical drawing

Manual production
Human assembles wire harness

Weeks

EISBACH OS

OEM
Uploads circuit diagram

Eisbach OS — Agent Interface
- ✓ Understands KBL & circuit diagrams
- ✓ Iterates to correct final drawing instantly
- ✓ Generates quote in real time

Final drawing + instant quote
Minutes, not weeks

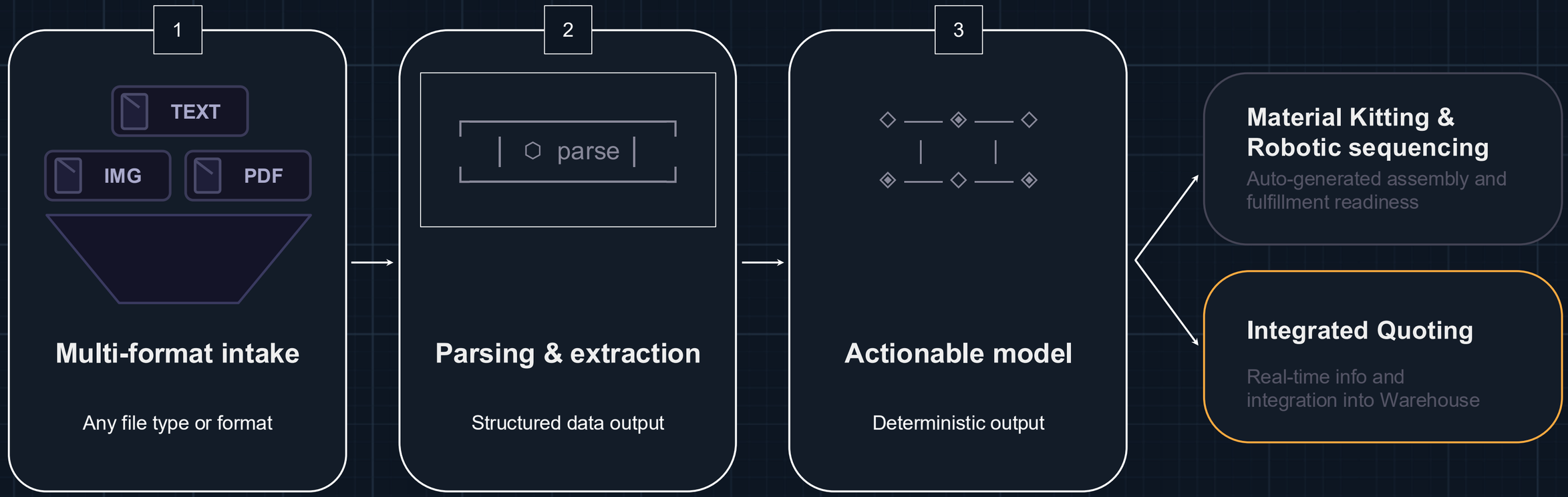
✓

Robot or human production
Eisbach OS agent generates robot instructions

Hours

THE NEW MANUFACTURING OS

Agentic AI starts with understanding inputs



Eisbach OS

Enter your files (CSV, TEXT, PDF drawings, images, ...)
and get from wire harness design to manufacturing in seconds.

FACTORY OF THE FUTURE

End-to-end factories require central intelligence and no more manual interventions

Eisbach OS
A central Factory Intelligence Unit orchestrates every process

Supplier agent

IF Incoming parts insufficient?

THEN Automatically follows up with supplier

Maintenance agent

IF Machine fault detected?

THEN Alerts factory, reroutes production plan

Quoting agent

IF New quote requested?

THEN Uses live production & warehouse data instantly

Physical assembly agent

IF Conflicting priorities?

THEN Negotiates between subagents to resolve

SELF-CORRECTION LOOP

Human-in-the-loop at start → full autonomy over time

THE METAPHOR

Brain ↔ Muscles

The intelligence layer monitors, decides and acts – machines are the muscles.

AUTOMATION STRATEGY

From design data to robotic execution

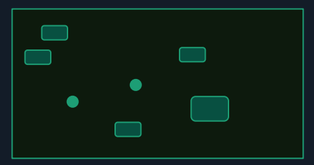
re-plan on error

Design data

KBL VEC PDF

Any variant (modularized)

Board layout



Variable positioning

Motion planning

Flexible sequences

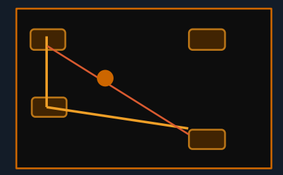
Sensor feedback

Visual

Force

Vision / Force re-planning

Assembled harness



Routing & insertion

DATA STRATEGY

Teleoperation Centers are emerging around the world to generate high-value data

DATA STRATEGY

Cameras and smart glasses are being deployed in factories worldwide at scale

DATA STRATEGY

We are building a strong data pipeline for *learning from the real world*

quality

01

Robot Data

Through deployment or teleoperation

02

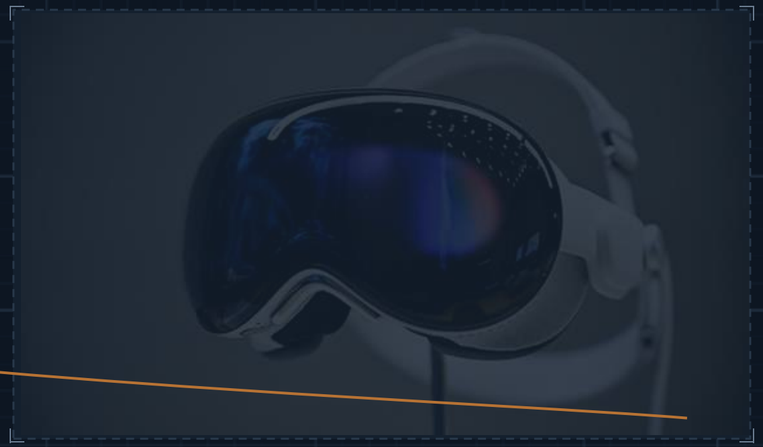
Data from handheld grippers

Universal Manipulation Interface, Data-Gloves

03

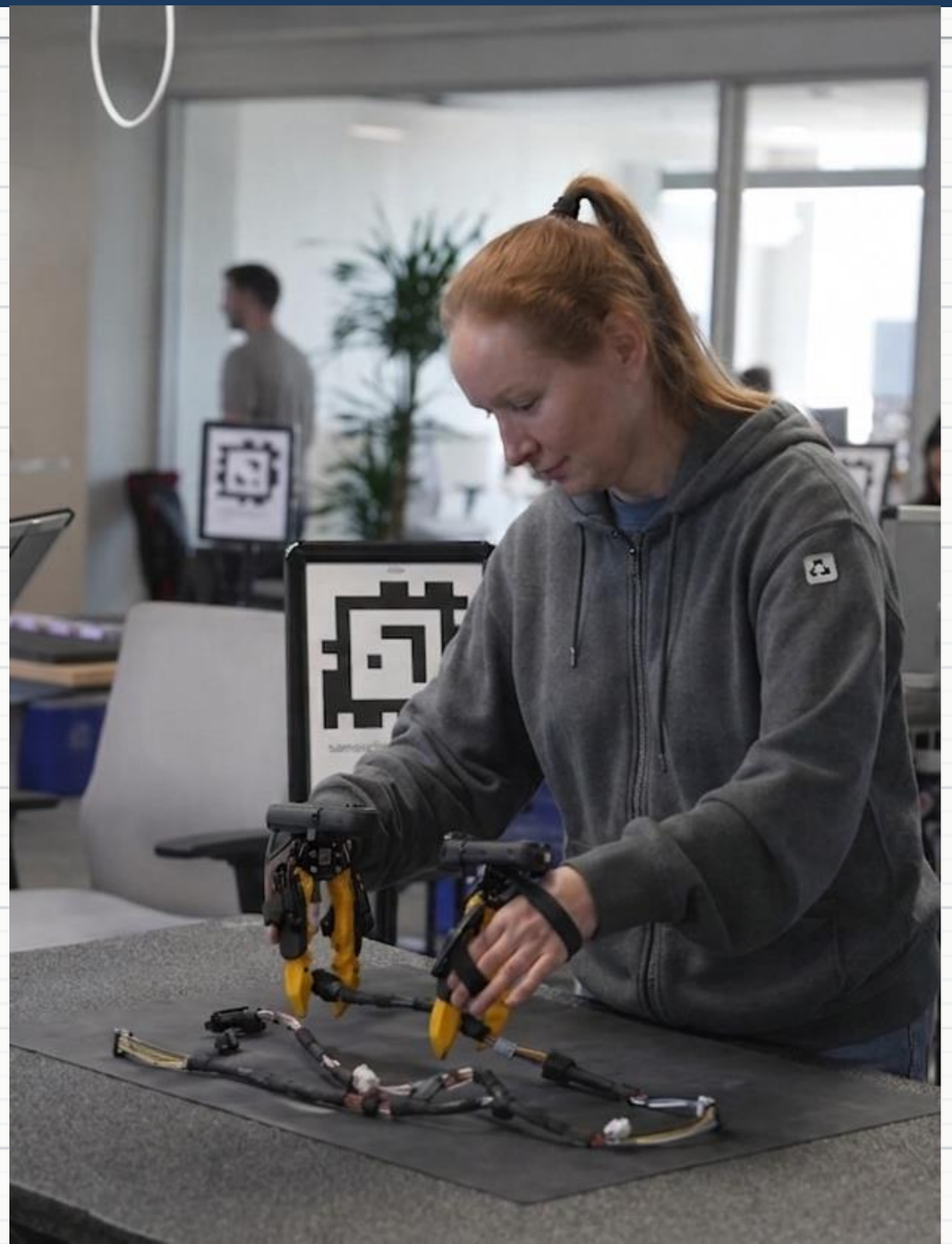
Human Ego

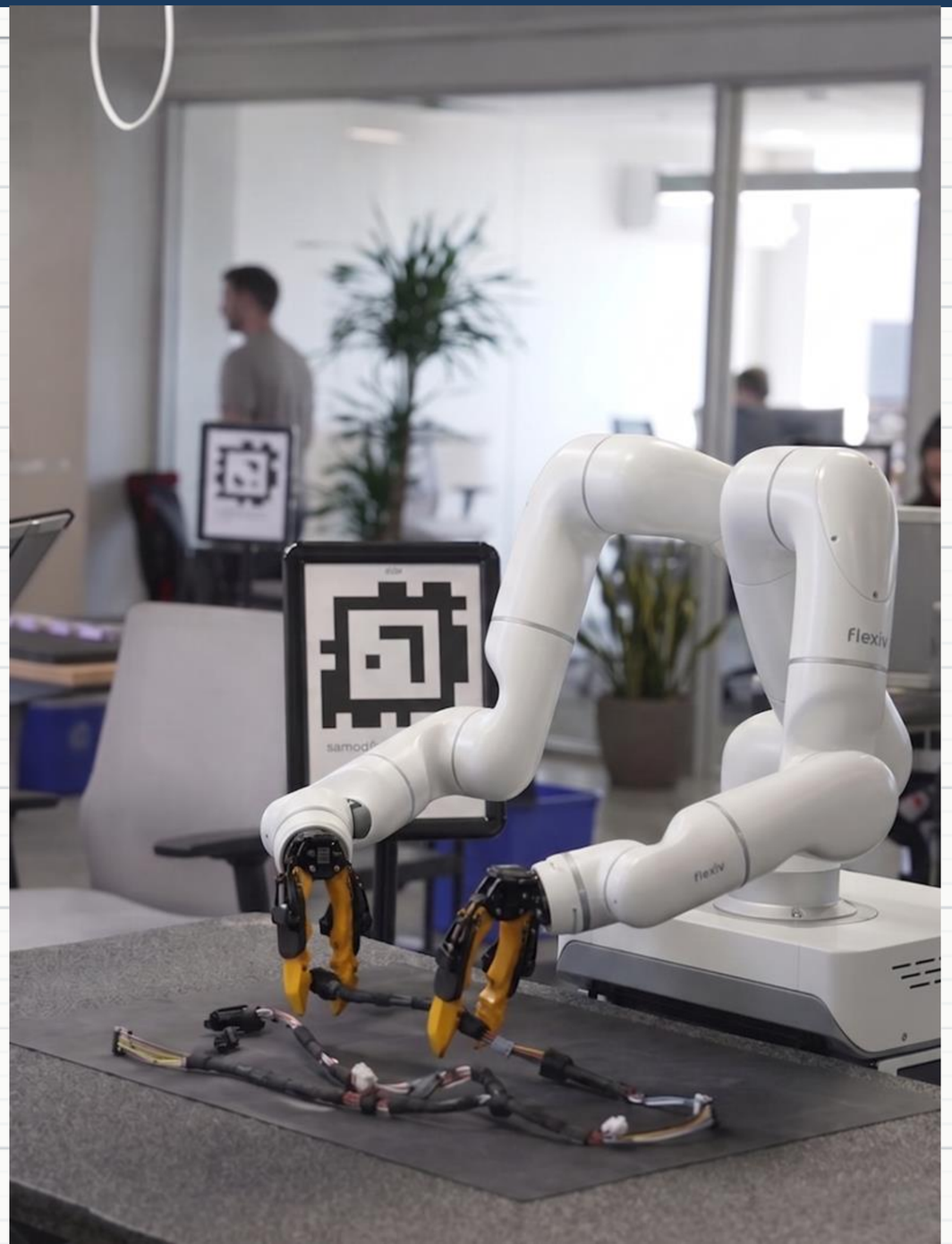
VR Glasses, Smart Glasses, Mounted Cameras



scalability

Scope of Eisbach Robotics




Flexiv
Flexiv

1x speed, fully autonomous
Generalist

FIG · 01
STANDING WAVE
EB-MARK-A

EISBACH ROBOTICS

We teach robots to make things

Robotic Challenge 2026

FIG · 01
STANDING WAVE
EB-MARK-A

We teach robots to make things

Visit us at eisbachrobotics.com