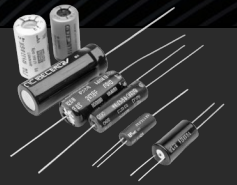


Creating Scalable Motor Technology with Data-Driven Approach

Peter Savagian
Head of Engineering
CONIFER

The World Knows How to Scale...



300B

Electrolytic Capacitors



150B

Silicon Chips

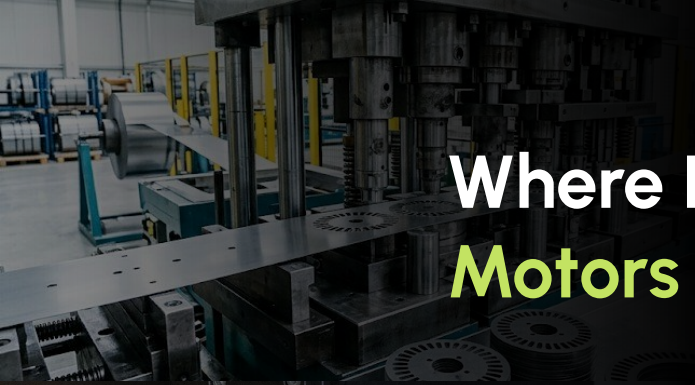


50B

Printed Circuit Boards

Annual global production of common electronic components

These industries scaled because they solved process cost and consistency — not because they had the best individual component.



Where Do Motors Stand?

~3B
Electric Motors Per Year

Mostly simple induction and brushed DC for fans, pumps, and appliances

~10s of M
High-Performance Motors

The motors you design in JMAG — traction, servo, precision actuators

But Motors today aren't built for the Future



- **Low CapEx ROI:**
  ~$20M - $50M per SKU per Line!
- **Wastes 60% steel**
- **Rare-earth Dependence**
- Hotspots → thermal limitations



- **~1 kg Rare-earths per Motor** (same as Model 3!)
- < 3yr life
- Very lossy → Low Range

The Demand We're Not Ready For









SMALL MOBILITY
(Consumer + Delivery)

+20% Range
No Rare-earths

CONTRACTS

AI DATA CENTERS
(Air/Liquid Cooling)

-50% Losses
No Rare-earths

CUSTOMER TESTED

ROBOTICS
(Joints & Wheels)

2X Torque/Mass
-50% Cost

PROTOTYPE

DEFENSE
(Air/Water Drones & Ground AWD)

2X Cont.
Power/Mass
-50% Cost

DESIGNED

POWERSYS

Designing for Capital Efficiency

The constraint that kills more motor programs than any design flaw...

Inventory Capital

Working Capital Lines

- Buying steel, copper, magnets
- Cash returns in ~90 days
- Risk: Tied to customer demand

= EASIER TO RAISE

Factory Capital

Manufacturing Infrastructure

- $50M+ for winding, stamping, varnish lines
- No guaranteed revenue
- Risk: Technology adoption

= HARDER TO RAISE

Capital looks small on the BOM after amortization.
The question isn't what % it is — **it's whether you can raise it at all.**

Lower Power, Higher Capital Stakes

150 kW
Traction Motor

- Selling Price: $500–1,500
- Factory capital spread across a high-value product
- Factory investment easier to absorb
- Capital burden per unit remains manageable

Capital % of BOM: Manageable

VS

500 W
Drone/Robot Motor

- Selling Price: $20–80
- Similar manufacturing infrastructure required
- Less revenue available to absorb factory costs
- Capital burden becomes a larger portion of product cost

Capital % of BOM: Significant

As motor power decreases, selling price drops –
but manufacturing capital doesn't drop proportionally.
Capital efficiency becomes **MORE** important, not less.

The Right Question

“ ~~*What is the best motor for this spec sheet?*~~ ”

“ ***For how many applications, and in what physical form, can this motor technology move the needle meaningfully?*** ”

If a technology only wins in one application, it's a **product**.
If it wins across a hundred applications, it's a **platform**.
Only platforms scale to billions.

Reimagined Design + Manufacturing + Software Solution

Higher Performance, Low BOM, Low CapEx

HIGH DENSITY STATOR

2X Magnetic Flux
95% less Steel. 20% less Copper
No Rare-earths required



"TOOL-LESS" LINE

$20M → $200K for Winding
All Products on Same Line

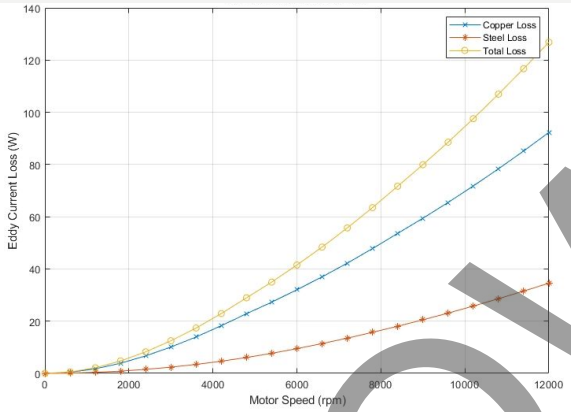
STACKABLE MOTORS

Modularity like Batteries
Drop-in replacements



Accurate Winding Loss Prediction Using 3D FEA

- Axial flux machines require 3D FEA
- Turn-by-turn coil models are needed for accurate representation of interleaved winding
- JMAG mesher enables high-fidelity meshes directly from CAD geometry
- "Multi-Purpose File Export" enables post-process of the mesh
- Analytical approach is used to estimate winding no-load loss on the windings across different operating speeds
- Understanding the loss vs number of axial splits has reduced the no-load losses significantly
- Model with ~3 million elements solves in 45 min (MPP64)



$$P = \frac{1}{24} \times d^3 \times l \times w \times \sigma \times (2\pi f B)^2$$

CAD coil models → Mesh and solve fields

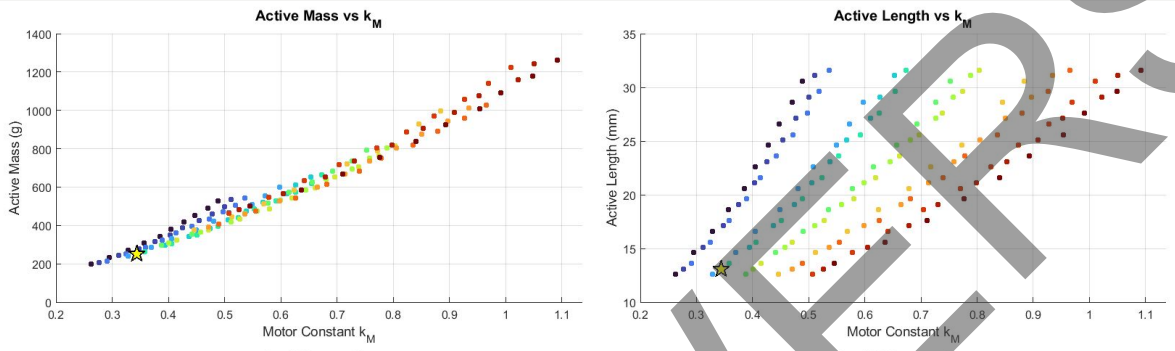
Export mesh and fields "Multi-purpose Export Tool"

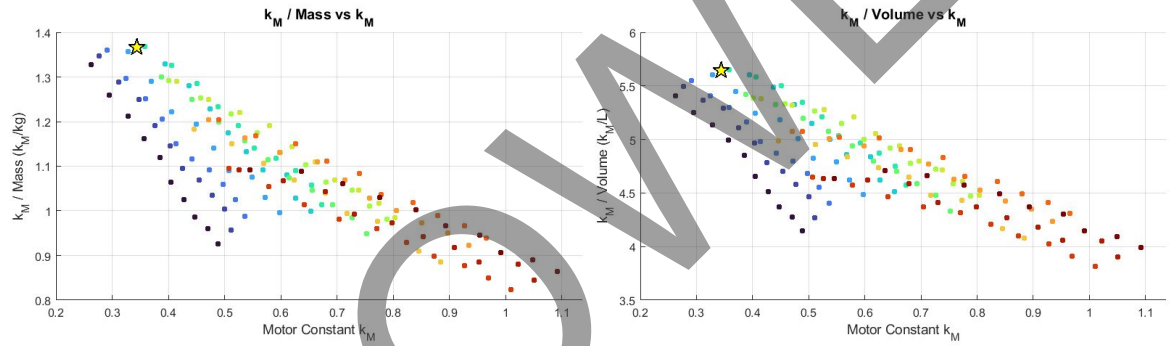
MATLAB scripts → Loss vs Speed Estimate

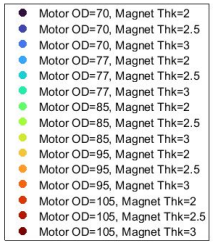
POWERSYS

Large-scale Optimization / Design Library

Each 3D model ~ 300k elements solves in less than 1 min (MPP64)





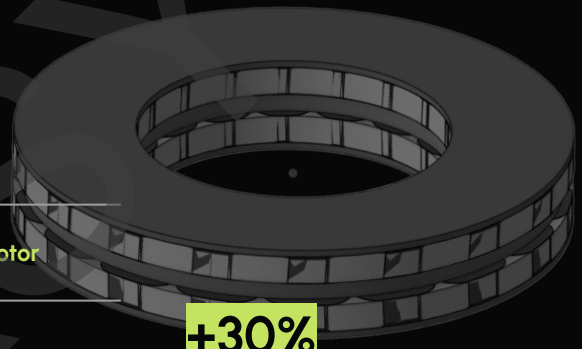


$$Motor\ Constant\ k_M = \frac{Torque}{\sqrt{Conduction\ Loss}} \left(\frac{Nm}{\sqrt{W}}\right)$$

POWERSYS

Robot Actuator Motor Comparison

Metric	Unit of Measurement	85x13 Competitor	Conifer Motor
Power P	[W]	404	404
Rated Torque	[Nm]	1.37	1.37
Peak torque T_{max} @ 20% linearity deviation	[Nm]	4.43	> 7.5
Active Weight m	[g]	356	252
Motor constant k_M @ 20°C	[Nm/√W]	0.34	0.34
Rotor inertia J	[kgcm²]	0.621	0.513
Outer diameter of motor	[mm]	85	77
Length of motor	[mm]	25.7	13.5



+30%
Motor Constant/Mass

-15%
Inertia/Mass

1.8X
Peak Torque

-50%
Axial Length

POWERSOLVE

SMALL MOBILITY

Electric Propulsion, that's better across Performance, Cost & Materials



IN-WHEEL PROPULSION FOR 2/3/4 WHEEL





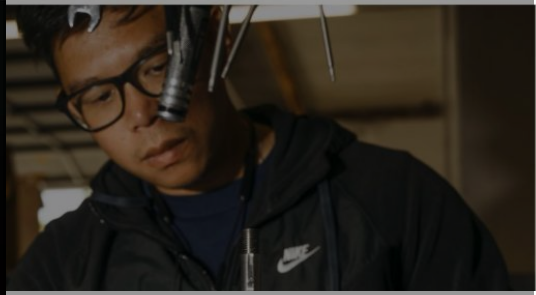
-50%
DRIVE CYCLE LOSSES

+20%
GRADABILITY & ACCELERATION

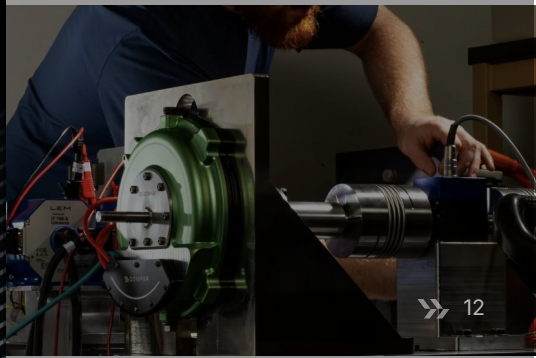
-40%
BOM COST

0%
RARE-EARTHS & CHINA DEPENDENCE









AI DATA CENTERS

Same Platform created the Ideal motor for Data Center HVAC / Industrial Automation



-50%
WEIGHT

-50%
LENGTH

-50%
LOSSES

0%
RARE-EARTHS &
CHINA DEPENDENCE

CDU
Liquid Cooling



Fan Wall
Air Cooling



Line
Automation



SOMERSET

Scaling to Billions Requires Co-Design

The industries that reached hundreds of billions of units didn't just design products.
They designed products and manufacturing systems together.

Motor development has historically treated manufacturing as an afterthought.

To power billions of motors, we must design both from day one.



CONIFER

Thank You

www.conifer.io