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CADalytic

Motius GmbH

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CADalytic

Manufacturing & Heavy Machinery | Generative AI | CAD Engineering

For a heavy machinery manufacturer transitioning from freeform CAD to parametric CAD systems, Motius developed CADalytic, an AI-powered tool that automates the conversion of thousands of CAD parts while preserving the complete feature tree and engineering history. This breakthrough eliminates months of manual remodeling work and lays the foundation for more automated CAD engineering workflows.

- [x] Automates migration of CAD parts from legacy systems to modern parametric CAD with full feature history
- [x] Leverages cutting-edge LLM technologies like CAD-Llama and multimodal vision models
- [x] Reduces manual remodeling effort for thousands of parts, each containing complex sheet metal operations
- [x] Three-stage AI pipeline: Decoding geometry, generating modeling sequences, and translating to CAD API commands

The Challenge

Migrating from one CAD system to another is one of the most time-consuming challenges in mechanical engineering. While simple geometry conversion using STEP files is possible, this loses all parametric information, feature history, and design intent.

Typical Migration Challenges

- Thousands of parts need to be converted, each requiring manual remodeling
- Standard CAD formats like STEP only preserve geometry, not the feature tree or modeling history
- Manual remodeling is error-prone and takes significant engineering time
- Different CAD systems use different modeling approaches and feature sets
- Sheet metal parts require specialized handling for bends, flanges, and other operations
- No commercial tools exist that can handle full feature tree migration

For manufacturers with large product portfolios and extensive part libraries, this migration becomes a multi-year bottleneck that delays modernization and prevents adoption of more advanced CAD capabilities.

Our Approach

Motius developed CADalytic based on extensive research into academic AI-for-CAD solutions and emerging technologies. The system uses a three-stage AI pipeline that mimics how human CAD engineers approach remodeling tasks.

❶ Decoding

The first stage analyzes the input CAD file to understand both geometry and design intent:

Technology	Purpose	Benefits
Automated Extraction	Script-based extraction of vertices, edges, faces, and B-rep topology from STEP files	Provides precise measurements and geometric relationships
LLM Analysis	Multimodal AI models analyze geometry, technical drawings, and projections	Infers modeling strategy and feature operations from part data
Point Cloud Generation	Optional 3D sampling for validation and visualization	Enables additional verification and quality checks

The system can process multiple input formats including STEP files, technical drawings, and isometric views to build a comprehensive understanding of the part.

❷ Generation

The generation stage creates a step-by-step modeling plan that can recreate the part:

CAD-Llama Integration

Leveraging state-of-the-art research in LLM-based CAD generation, specifically trained to model parametric CAD parts from spatial understanding

{..} Intermediate Representation

Structured description language capturing sketches, extrusions, bends, cuts, and other operations with precise dimensions and constraints

Precision Enhancement

Manual extraction data can be injected to improve dimensional accuracy and ensure faithful reproduction of critical features

Iterative Refinement

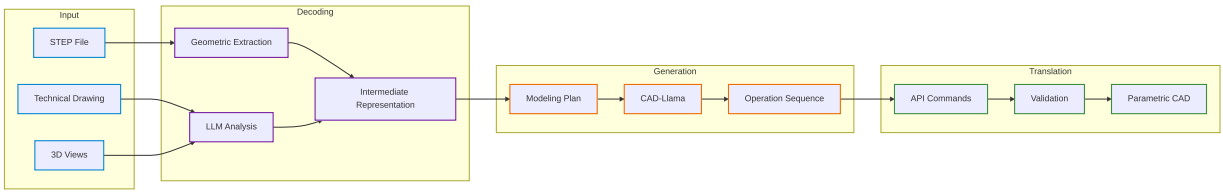
The system can perform improvements based on feedback, handling complex parts through multiple generation cycles

Alternative approaches being evaluated include Text-to-CadQuery and custom LLM solutions fine-tuned for the specific customer requirements.

❸ Translation

The final stage converts the modeling plan into executable commands:

- **API Command Generation**: Translates high-level operations into Creo Toolkit API calls (or other CAD system APIs)
- **LLM Translation**: Uses language models to handle complex conversions with built-in CAD documentation
- **Deterministic Translation**: For simpler cases, direct 1-to-1 mapping ensures reliability
- **Validation Loop**: Automated verification compares generated geometry with original part



Technologies

The solution combines cutting-edge AI research with established CAD automation:

- **CAD-Llama**: Specialized LLM trained for parametric CAD generation
- **Text-to-CadQuery**: Open-source model for converting descriptions to CadQuery code
- **Vision Language Models**: For analyzing technical drawings and 3D views
- **Creo Toolkit API**: Programmatic control of CAD operations
- **STEP File Processing**: Extracting B-rep topology and geometric primitives

Application at Koenig & Bauer

CADalytic's AI-powered approach can dramatically accelerate 

Koenig & Bauer's CAD modernization efforts:

- [ ] Automate conversion of existing part libraries to modern parametric CAD systems
- [ ] Preserve critical engineering knowledge encoded in feature trees and modeling history
- [ ] Reduce time-to-market for CAD system migrations from years to months
- [ ] Enable more advanced CAD automation workflows built on AI-powered modeling
- [ ] Extensible architecture can adapt to Koenig & Bauer's specific CAD systems and modeling standards