

# **Strategic Modeling of the ITRS – 2013 Update**

Scotten W. Jones, President

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# ITRS Unmet Needs

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- The International Technology Roadmap of Semiconductors (ITRS) provides an industry consensus forecast of semiconductor technology requirements looking ahead 15 years.
- The ITRS provides half-pitch and some structural parameters for production and prototype products.
- The ITRS does not provide guidance on the Market for equipment, technology or materials required to meet the ITRS goals.
- The ITRS does not provide guidance on process complexity or cost resulting from the ITRS goals.

# Objective

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- Translates the ITRS into forecast fab configurations with equipment sets, material usage and wafer costs.
- Cover all half-pitches, years and product types defined in the 2012 ITRS.
- Produce a model with clearly defined assumption sets based on the best available industry knowledge at the time. Allow the user visibility into the assumption sets and the ability to change the assumptions.
- Provide forecasted equipment and material demand by type over the ITRS time frame.
- Provide calculated wafer and fab costs by half-pitch, year and product type.

# Model Foundation

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- IC Knowledge produces the most widely used commercial IC Cost and Price Model in the world. The model has been in the industry since 2000 and is really “the industry standard”.
- The commercial model has all of the necessary algorithms for the strategic model and the algorithms are already well vetted on current technologies.
- The key strategic modeling challenge is to define the long term assumption set.
  - Database trend analysis
  - Domain experts
  - Expose assumptions for user adjustment and feedback

# Strategic Product Offering

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- Strategic Cost Model (introduced in 2010) – the user defines a fab by selecting wafer size, country, year built with product and half pitch and up to four upgrades. The model produces detailed equipment sets, materials sets and cost projections. Available as an equipment version or materials version with expanded materials detail and customization.
- Strategic Industry Forecast Model (introduced in 2012) – a fully interactive model of the wafer fab equipment market driven from semiconductor revenue that is completely user adjustable.
- Strategic Forecast of the Semiconductor Industry (introduced in 2013) - utilizes the strategic models and research and analysis to provide conclusions in a report format.
- Materials Forecast Model – internal use only at our materials partner Linx Consulting.

# Strategic Cost Model

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# Product Support

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- Current products – ASIC, DRAM, MPU, NAND-2D, NAND-3D, NOR-CT, NOR-FG, RF
- Prototype products – FeRAM, MRAM, PCRAM
- Research – RRAM-2D, RRAM-3D
- All half-pitches defined in the 2012 ITRS
- Company specific pre-defined processes/fabs

# User Customization

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- Users can edit the process blocks and pitch ratios by product and by year.
- The user can edit the individual steps that make up each process block and even define completely custom blocks.
- The resulting process step summary is editable.
- The equipment used for each process step and equipment throughput, unit cost and footprint are all user editable.
- The materials used for each step are editable (materials edition only).



# Main Selection Sheet

**Fab definition**

Year and quarter to model

Node based predefined processes  Fab

**1/2-pitch based user defined** You must fill in this section

Wafer size

Country

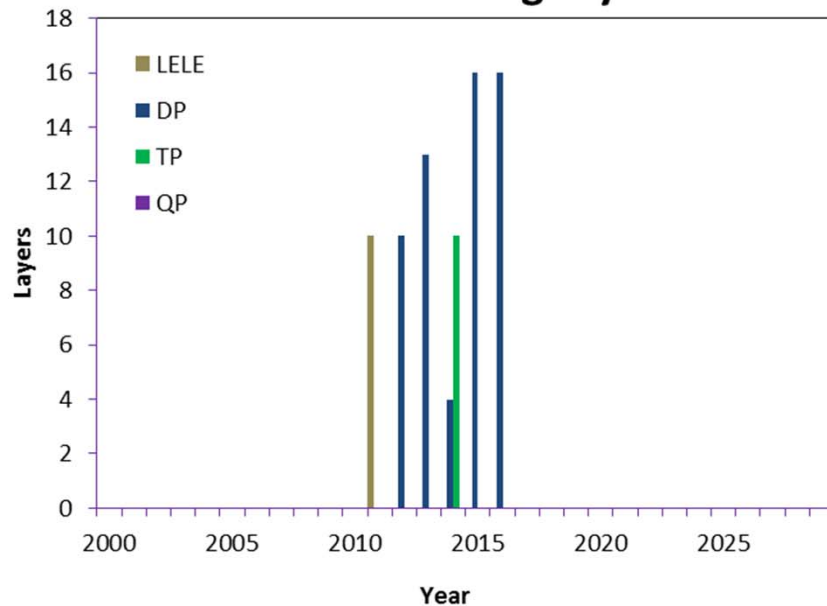
Fab configuration	Year	1/2 pitch - product	Capacity (wpm)	Error messages
Initial configuration	2011-Q1	45nm - ASIC	30,000	
Upgrade 1	NA	45nm - ASIC	NA	
Upgrade 2	NA	42nm - DRAM	NA	
Upgrade 3	NA	38nm - FRAM-2D	NA	
Upgrade 4	NA	38nm - PF	NA	
		38nm - PCRAM	NA	
		38nm - NOR-FG		
		38nm - NOR-CT		
		38nm - NAND-2D		

Utilization

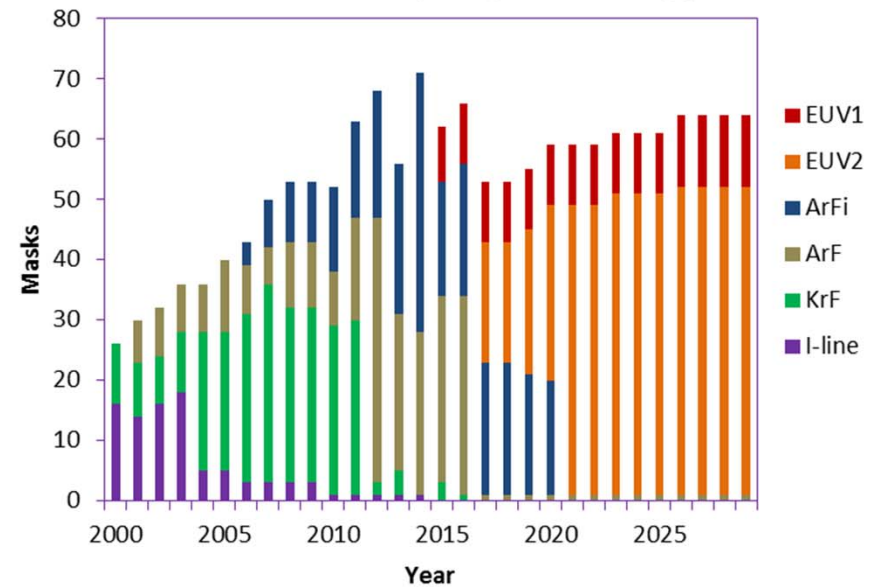
Wafer yield

# Mask Count Forecast

## Multi Patterning Layers

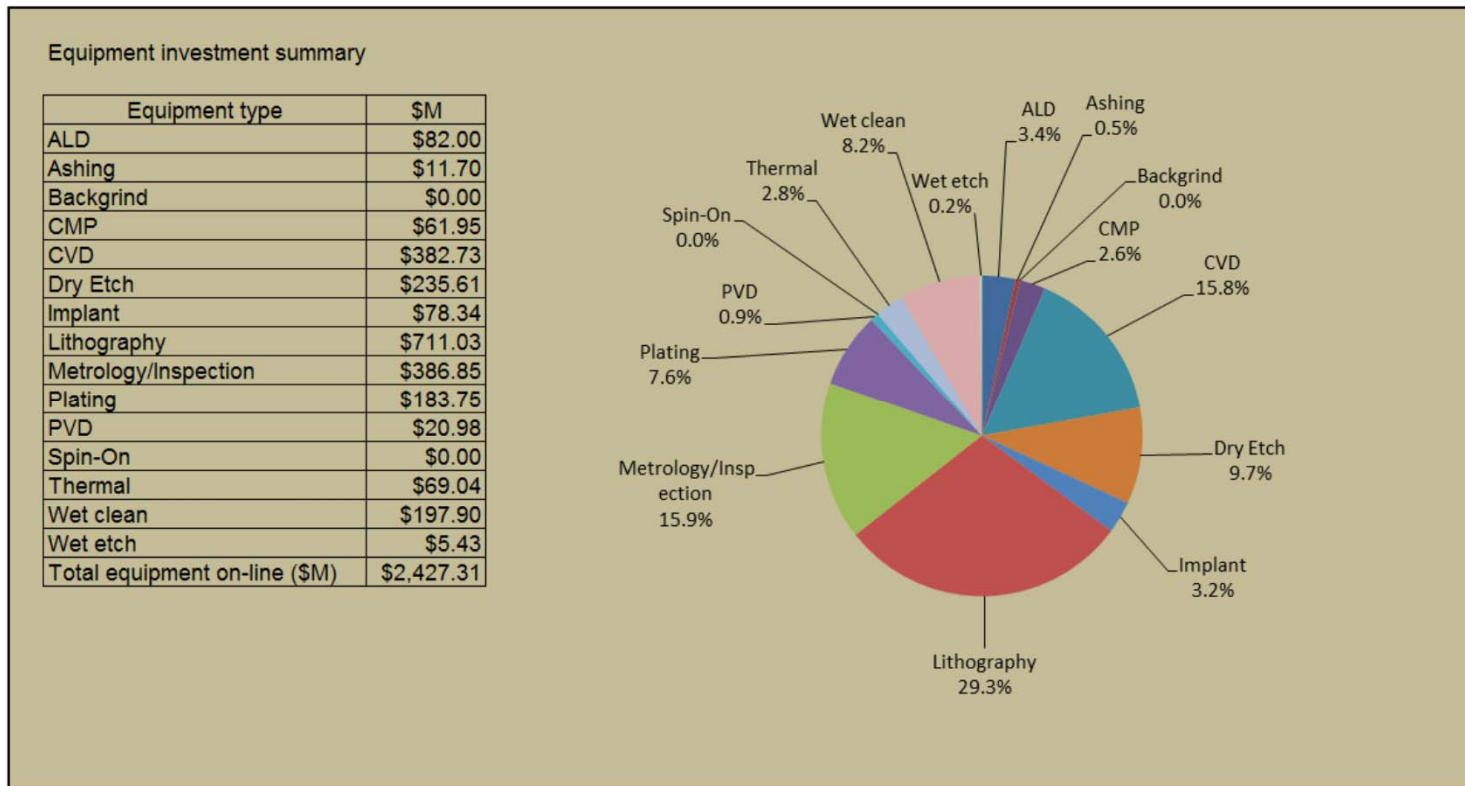


## Mask Count By Exposure Type



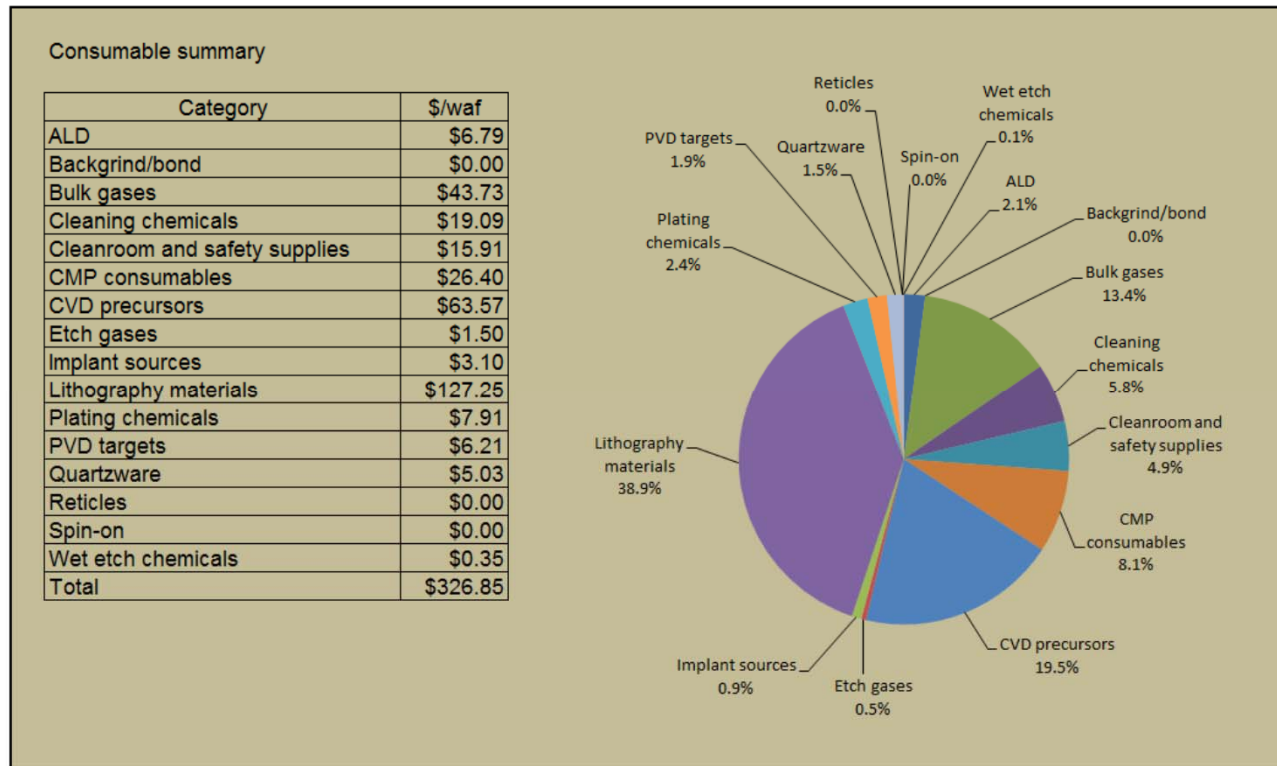
ASIC product type shown

# Equipment Investment



Summary sheet shown, details by tool are also available.

# Materials Summary

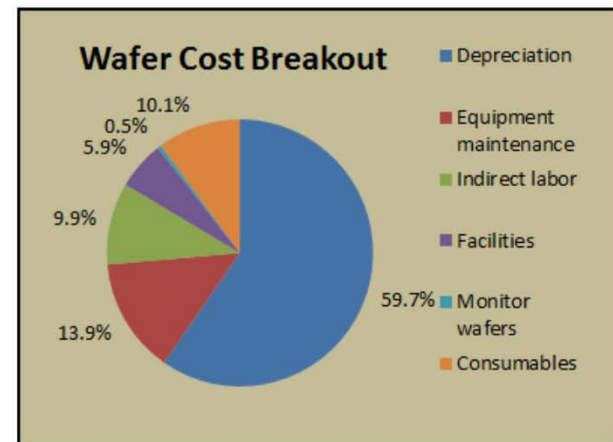


Summary sheet shown, details by process step are available in the materials edition of the model.

# Wafer Cost Summary

Wafer cost

Cost category	\$M/yr	\$/waf	\$/cm2
Starting wafer	\$40.50	\$125.00	\$0.177
Direct labor	\$47.93	\$147.93	\$0.209
Depreciation	\$624.07	\$1,926.13	\$2.725
Equipment maintenance	\$145.64	\$449.50	\$0.636
Indirect labor	\$103.80	\$320.38	\$0.453
Facilities	\$61.50	\$189.81	\$0.269
Monitor wafers	\$4.82	\$14.88	\$0.021
Consumables	\$105.90	\$326.85	\$0.462
Total unyielded wafer cost	\$1,045.73	\$3,500.47	\$4.57
Wafer yield		97.4%	97.4%
Yielded wafer cost		\$3,592.70	\$4.69



# Strategic Industry Forecast Model

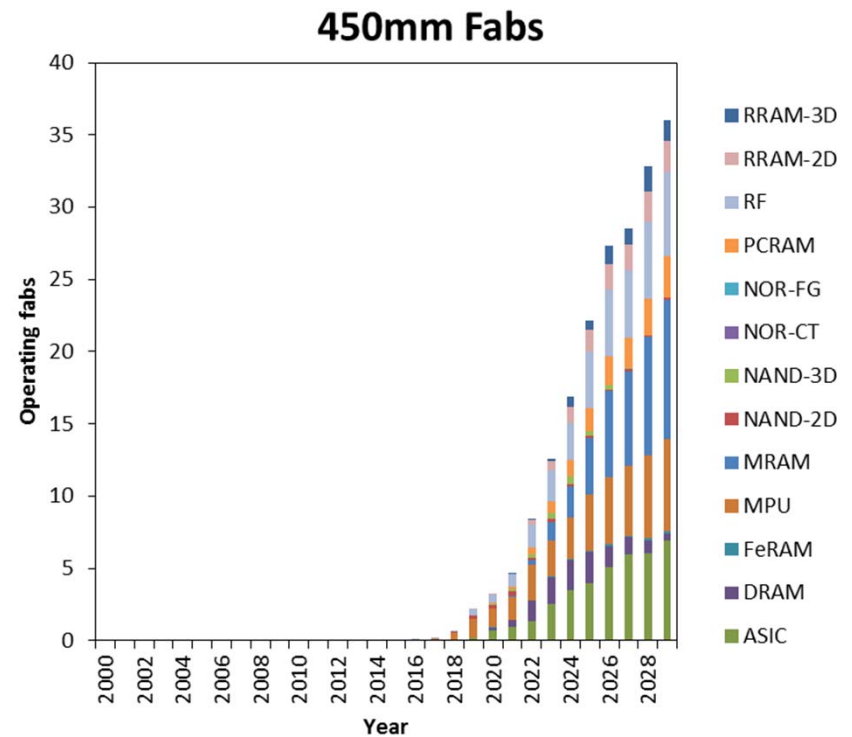
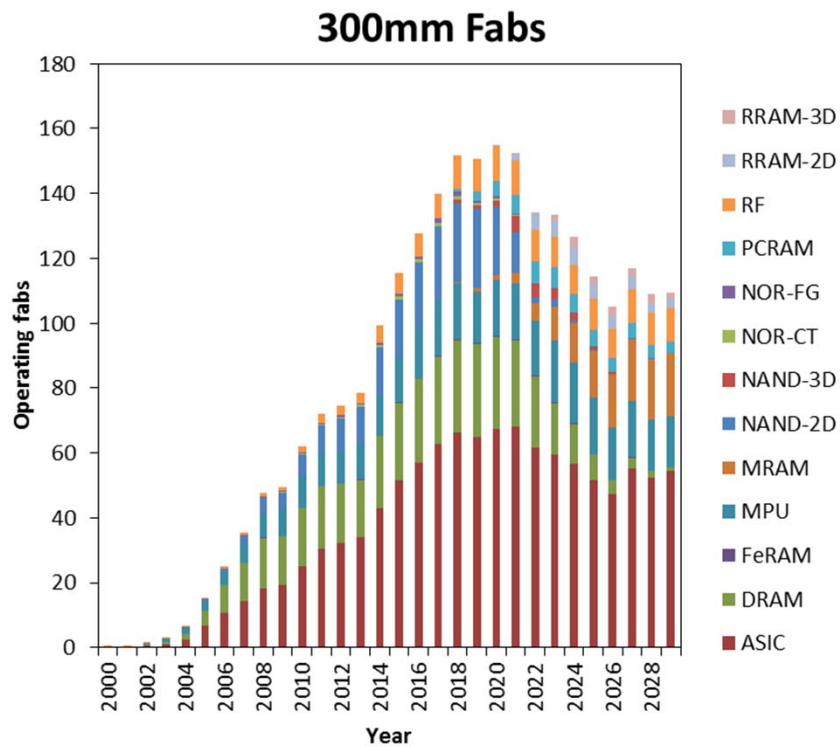
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# Industry Forecast Model

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- Begins with a user editable semiconductor forecast.
- Forecasts silicon MSI in total and by wafer size by year.
- Forecasts silicon required by product type by year for 300mm and 450mm wafers.
- Uses user editable process blocks to convert wafers by product to specific fabrication steps by product and year.
- Forecasts fabs required and half-pitch by product and year.
- Forecasts total industry sales of wafer fab equipment by product type, wafer size (300mm and 450mm) and year.

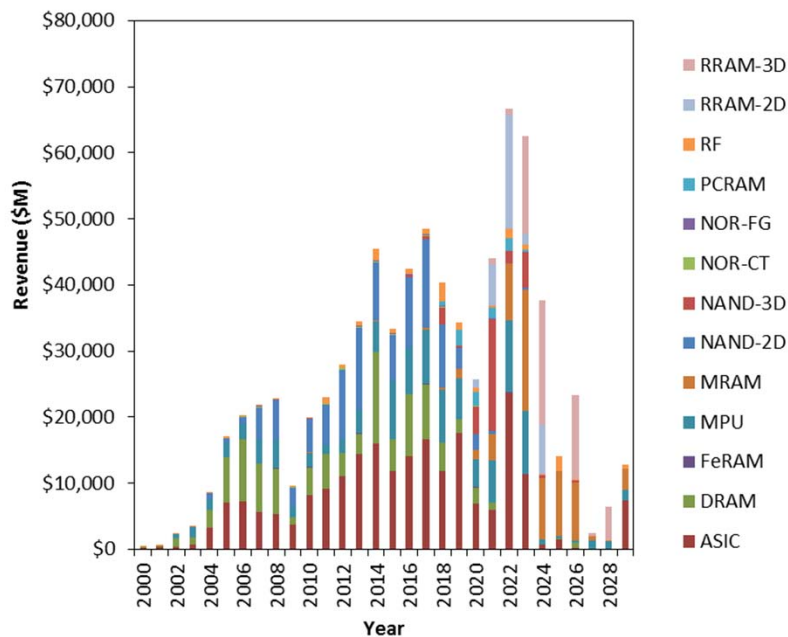
# Fab Forecast



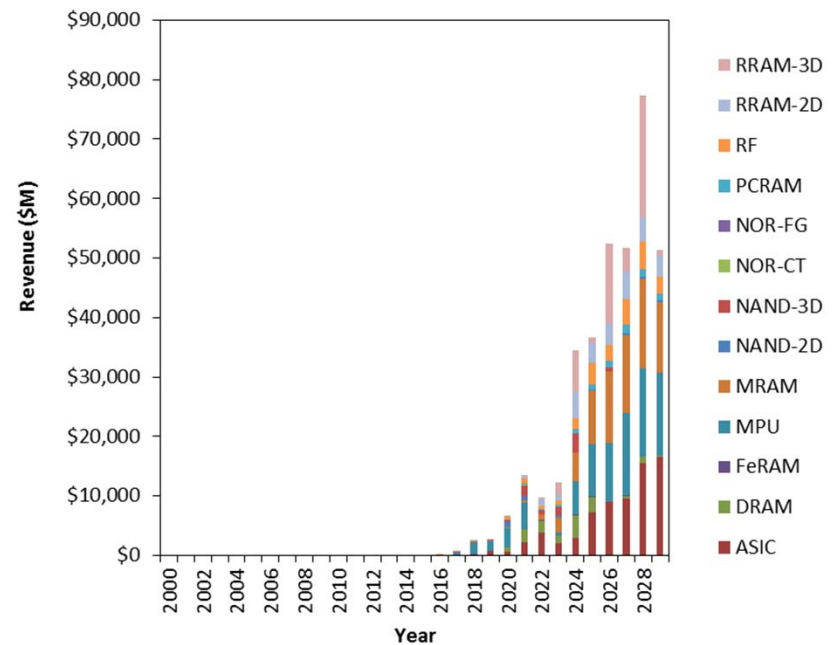


# Equipment Forecast

300mm Tool Spending by Product and Year



450mm Tool Spending by Product and Year



# Conclusion

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- A set of tools is available to forecast wafer cost and materials and equipment requirements based on the ITRS.
- The tools are commercially available, supported and in use out in the market place.
- Detailed forecasts of fab equipment and materials sets and the resulting wafer costs can be produced.
- Detailed forecasts of the entire wafer fab equipment and material markets can be produced.
- A summary report looking out at cost, economics and markets based on the modeling is in development.