



From Fab Layout to Flow Intelligence

Simulation-driven design and optimization of
semiconductor material handling systems

Stratus Automation

K.Satiaseelan

Lohgaindran Harikrishnan





Agenda

- 01 About Us
 - 02 AMHS Products in the Virtual Fab
 - 03 The Transport Constraint
 - 04 Why AnyLogic ?
 - 05 Simulation Workflow
 - 06 KPIs and Engineering decisions
 - 07 Project snapshots and scenario review
 - 08 Future Plans
 - 09 Q & A
-

Stratus Automation

A turnkey cleanroom AMHS provider of both hardware and software

- Founded in 1998 in Silicon Valley; headquartered in Penang, Malaysia
- Hardware: Hybrid AMHS of conveyors, OHT, ORV, AMR and stockers (T-type, R-type, Zero Footprint), plus overhead buffer shelves
- Software: IntelliMove transport control and IntelliStock stoker control, with MCS/TCS integration and SEMI-compliant tracking
- Simulation evaluates each hardware-software solution against the customer's fab layout

Why Stratus

1

Conveyor & OHT: Hybrid AMHS Solutions Provider
Only provider of Hybrid AMHS in the world

2

Cost Efficient and High Reliability
Cost-efficient and high-reliability cleanroom AMHS provider in the world

3

Fully Automated
A turnkey solutions provider ranging from AMHS solutions, TCS and MCS

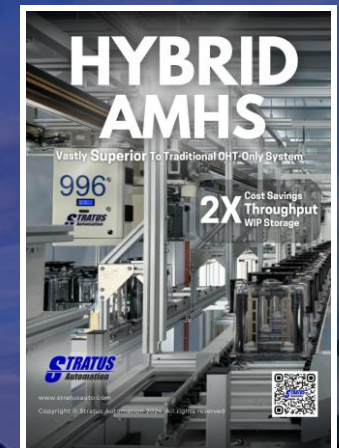
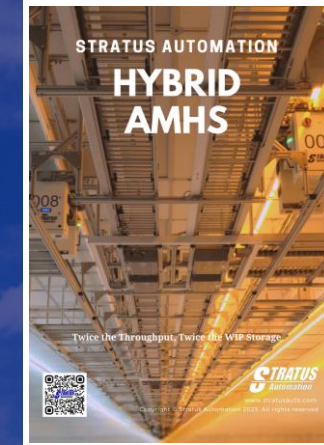
4

Higher Throughput per cost
Higher throughput at the fraction of the cost

5

Flexible
Able to cater multiple types of media and integrate with various existing systems like PRI and integrate with legacy tools

Industry recognition



Featured in Semiconductor Digest
2023 & 2024 Edition

Stratus Hybrid AMHS Modules



Capable for 200mm (8 inch) and 300mm (12 inch) wafers accommodating for Front-End, Mid-End and Back-End processes including other carriers. We also provide solutions for Panels

OHT Vehicle

- Bidirectional movement

Overhead Buffer Shelves

- Floorspace saving

Process Tool

- Direct load and unload



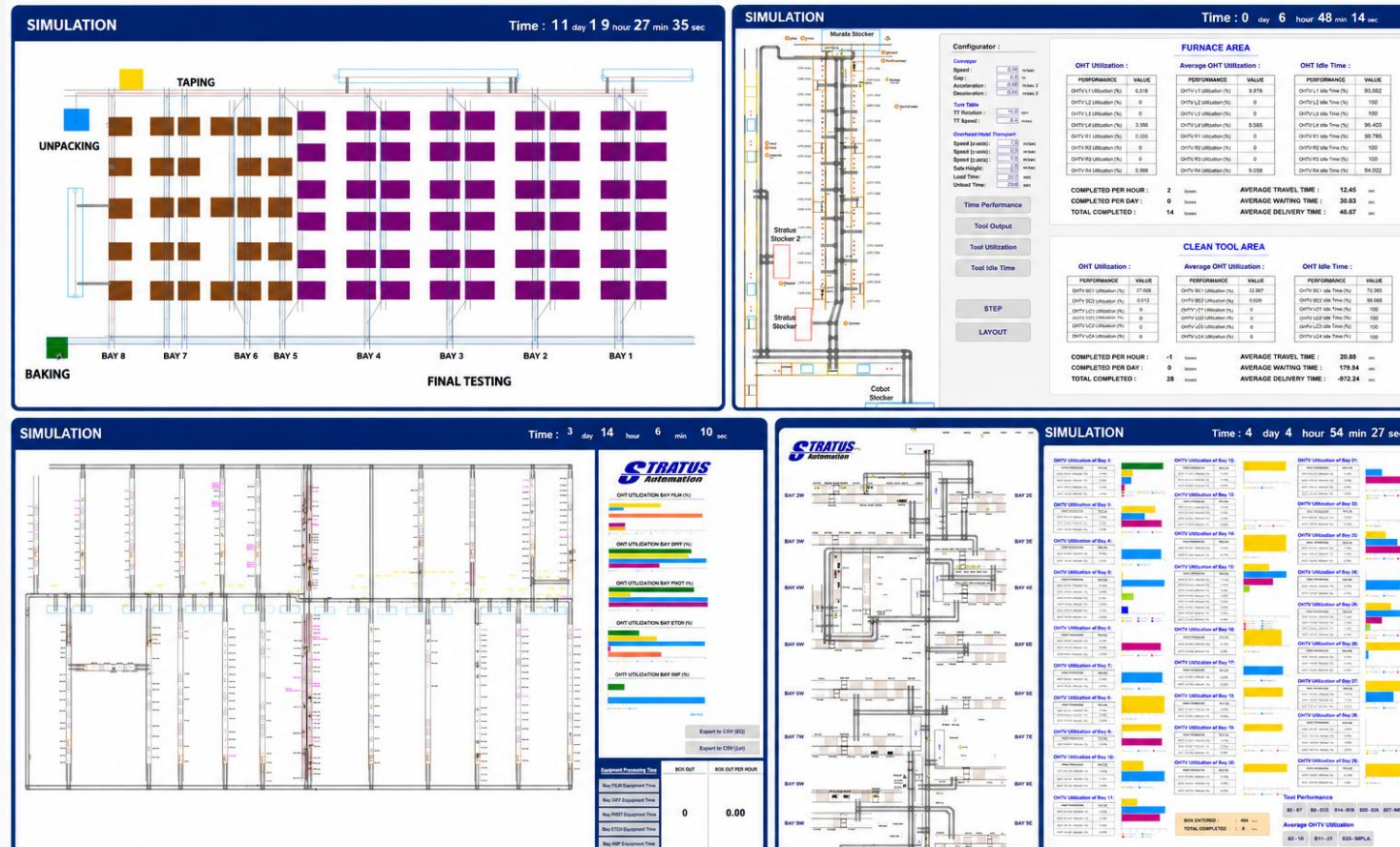
Intra-bay OHT Track

Turntable

I/O Conveyor

Conveyor

SIMULATION DASHBOARD COMPILATION

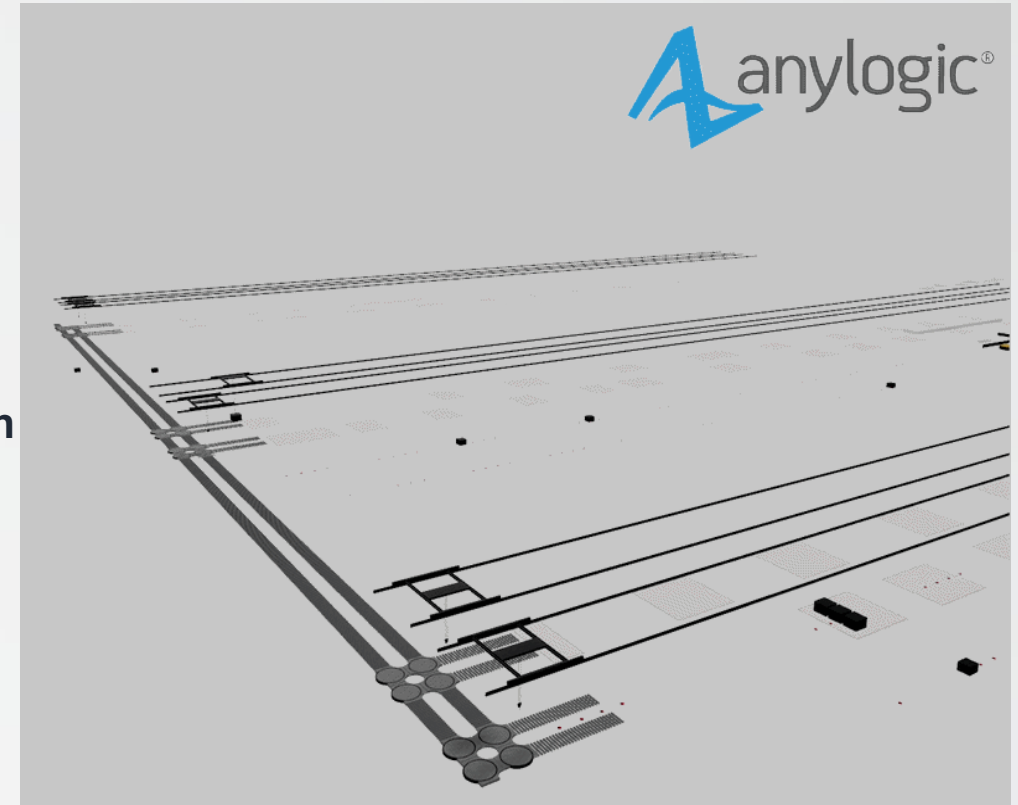


Hybrid AMHS, OHT, AMR and Manual solutions are compared on the same fab layout, product mix and demand profile, scored on delivery time, tool waiting, throughput and congestion so the trade-offs come from the transport concept rather than the assumptions.

Why Simulation ?

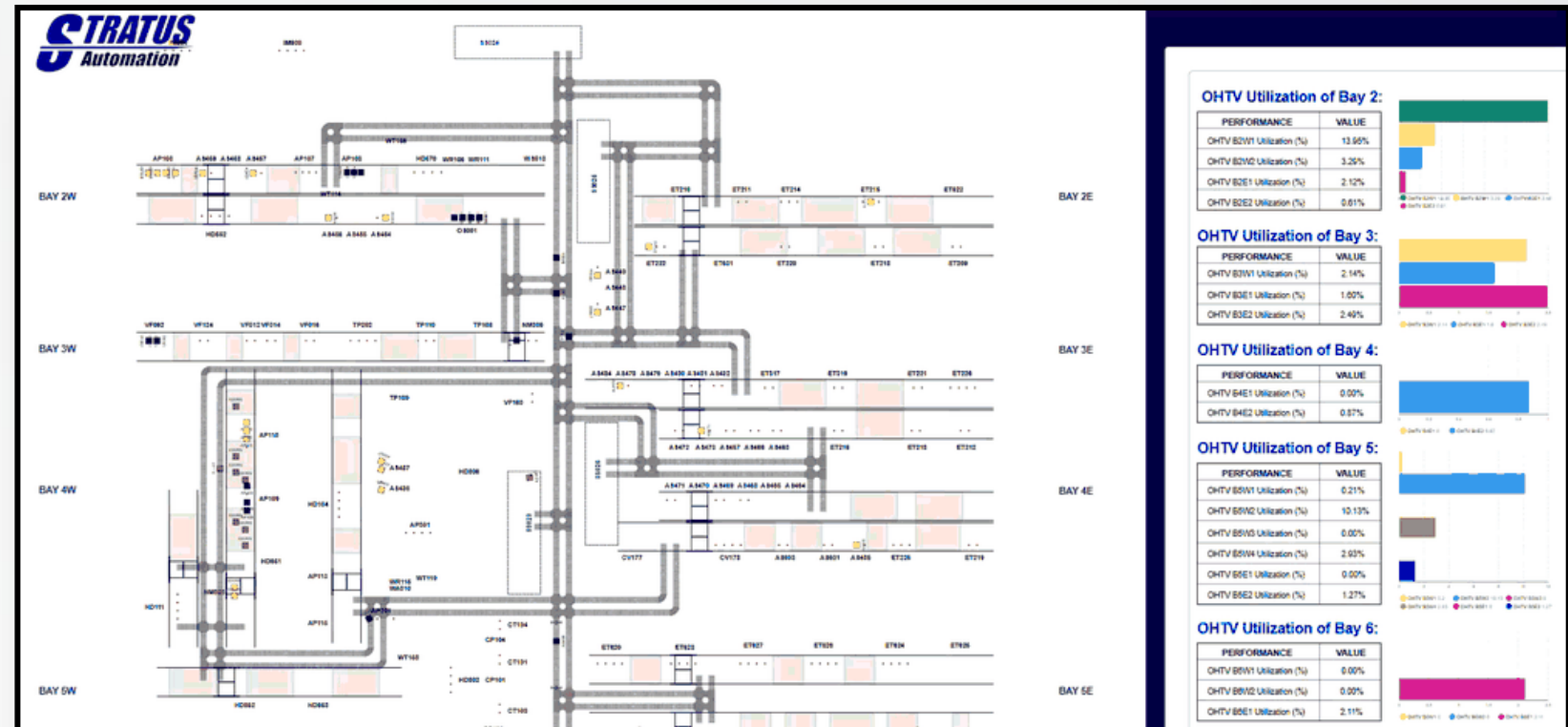
High AMHS utilization can increase waiting and disrupt tool supply

- Busy AMHS means longer waits and starved tools
- Lots compete for vehicles and routes
- Late delivery leaves tools idle
- Adding vehicles just moves the bottleneck
- Simulation shows where capacity helps and where layout must change.
- AnyLogic models lots, tools, transport and fab routing rules in one model, so scenarios compare on the same KPIs.
- Compare AMHS options with data, not assumptions
- Pick the right AMHS and back it with KPIs
- Prove it handles changing product mixes

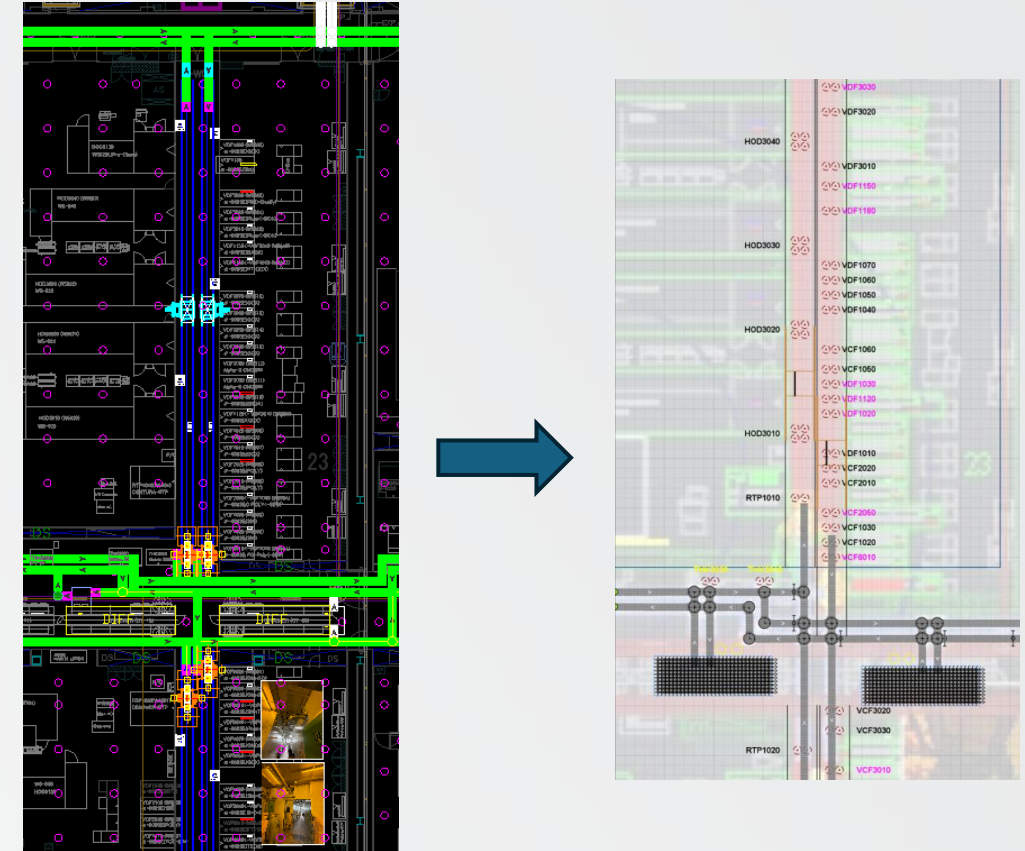


The model represents the equipment that moves and stores each lot

- **Conveyors carry lots between and within bays**
- **OHT transfers carriers to tools and overhead buffers**
- **Stackers and lifters provide storage and vertical transfer**
- **Routing and dispatch logic coordinate shared resources**
- **Customer layout and production demand define the model**



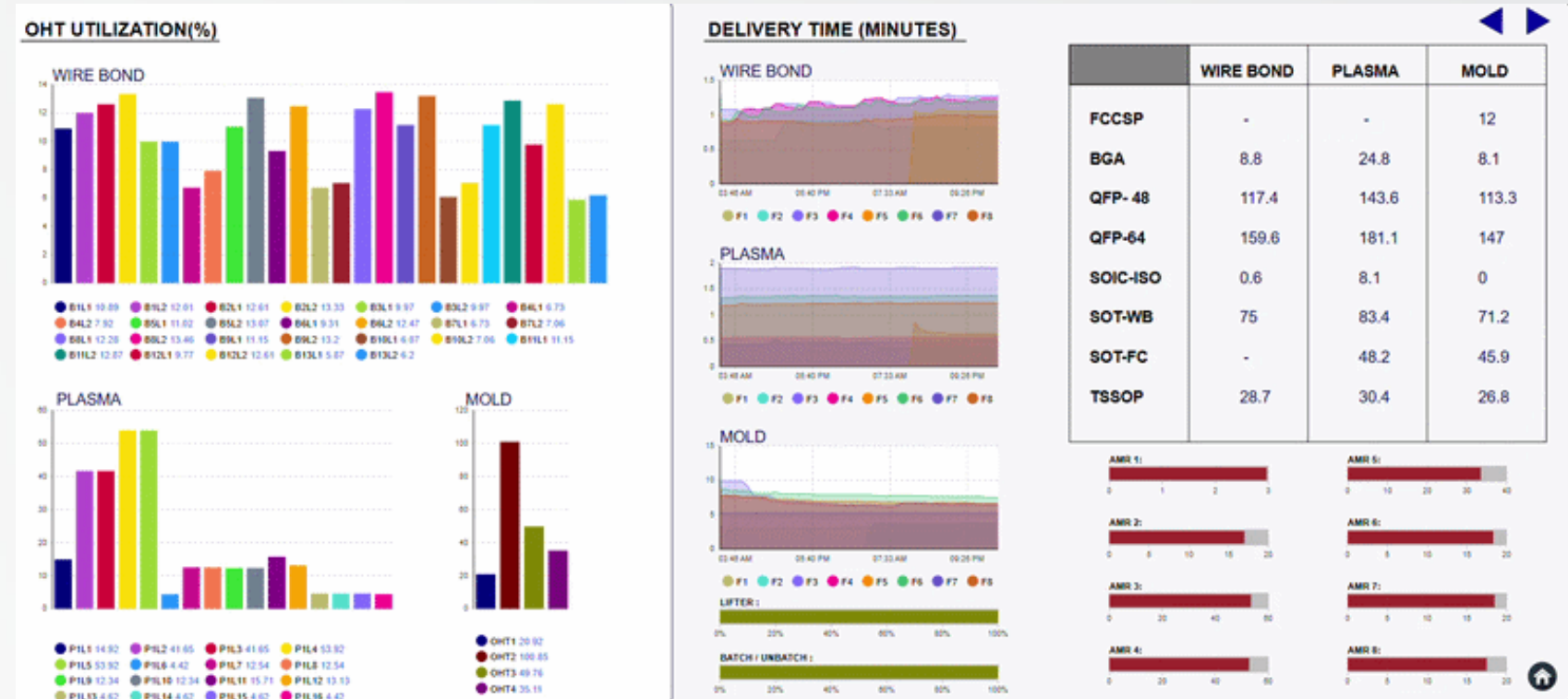
- **Pre-analysis on the data is done using AI assisted data analysis on the possible bottlenecks, shortage on storage and type of solution approach**
- **Import layout through CAD drawing, tool data, process routes and demand**
- **Validate connections, load ports and operating assumptions**
- **Model transport, tool selection, queues and batching**
- **Compare fleet, routing, buffers and production scenarios**
- **Review KPI trade-offs and recommend a design change**



KPIs That Explain Fab Performance

AMHS activity, tool readiness and lot timing must agree

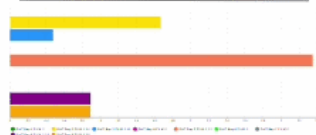
- **AMHS utilization**
busy time by vehicle or conveyor
- **Tool utilization**
processing time, with idle causes separated
- **Delivery time**
move request to destination handoff
- **Travel time**
time in motion within the delivery
- **Lot replacement time**
outgoing lot to next lot ready
- **Throughput, queues and congestion** explain the result



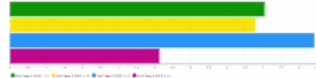
Simulation converts layout questions into quantified trade-offs: more vehicles, different routing, bigger buffers, modified dispatching, or targeted layout changes.

KPIs That Explain Fab Performance

OHT UTILIZATION BAY FILM (%)



OHT UTILIZATION BAY DIFF (%)



OHT UTILIZATION BAY PHOT (%)



OHT UTILIZATION BAY ETCH (%)



OHT UTILIZATION BAY IMP (%)



BOX PER HOUR : 10

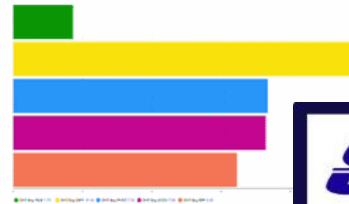
OHT Utilization

PERFORMANCE	VALUE (%)
OHTV BAY1 FILM Utilization	0.03%
OHTV BAY2 FILM Utilization	2.82%
OHTV BAY3 FILM Utilization	0.78%
OHTV BAY4 FILM Utilization	0.12%
OHTV BAY5 FILM Utilization	5.33%
OHTV BAY6 FILM Utilization	0.00%
OHTV BAY7 FILM Utilization	0.00%
OHTV BAY8 FILM Utilization	2.22%
OHTV BAY9 FILM Utilization	4.19%

PERFORMANCE	VALUE (%)
OHTV BAY1 ETCH Utilization	5.37%
OHTV BAY2 ETCH Utilization	8.03%
OHTV BAY3 ETCH Utilization	11.83%
OHTV BAY4 ETCH Utilization	0.92%
OHTV BAY5 ETCH Utilization	10.27%

Main Page

Average OHT Utilization



PERFORMANCE	VALUE (%)
OHTV BAY1 DIFF Utilization	11.33%
OHTV BAY2 DIFF Utilization	10.81%
OHTV BAY3 DIFF Utilization	11.41%
OHTV BAY4 DIFF Utilization	6.68%

PERFORMANCE	VALUE (%)
OHTV BAY1 IMP Utilization	2.56%
OHTV BAY2 IMP Utilization	0.83%
OHTV BAY3 IMP Utilization	15.96%

PERFORMANCE	VALUE (%)
OHTV BAY1 PHOT Utilization	7.56%
OHTV BAY2 PHOT Utilization	2.66%
OHTV BAY3 PHOT Utilization	10.49%
OHTV BAY4 PHOT Utilization	8.66%

EQUIPMENT : BAY 1 ETCH

Equipment ID	Utilization (%)	Delivery Time (min)	Lot Replace Time (min)	Travel Time (min)
ETC3070	0.24	16.29	0	13.65
ETC3090	23.82	0	122.22	1.16
ETC3050	31.96	14.36	113.32	1.12
ETC3060	42.85	15.45	109.37	0.91
ETC3030	56.47	14.47	156.61	1.03
ETC3020	19.27	10.44	74.22	2.17
ETC3010	37.55	10.6	80.44	1.3
ETC3220	0	0	0	0
ETC3080	16.03	13.72	250.39	3.02
ACP1020	46.69	8.59	3.58	0.24
ACP1010	12.95	8.99	51.14	3.57
ASH1050	7.74	14.15	20.13	0.17
ASH1040	17.21	13.4	11.16	0.13
ASH2070	0.22	14.53	18.158.29	14.28
ASH2090	49.6	7.52	0.03	0.15

EQUIPMENT : BAY 3 ETCH

Equipment ID	Utilization (%)	Delivery Time (min)	Lot Replace Time (min)	Travel Time (min)
SLP1040	16.08	5.35	14.91	0.39
ETC4010	52.21	13.93	1.9	1.88
ETC4020	45.46	13.95	1.98	1.96
ETC4030	35.8	13.98	1.75	1.73
ETC4040	19.21	14.15	4.12	4.09
ETC4050	6.1	14.55	2.19	2.16
ETC4060	0.95	14.51	3.213.6	13.78
ETC4070	0	0	0	0
ETC4080	0	0	0	0
ETC4090	0	0	0	0
ETC4100	0	0	0	0
ETC4110	0	0	0	0
ETC4120	0	0	0	0
SLP1030	29.1	5.69	6.28	0.18
SLP1080	0	0	0	0
ETC3240	0	0	0	0
SLP1070	0	0	0	0
ETC3150	30.72	14.47	3.57	3.56
ETC3160	17.56	15	3.67	3.65
ETC3170	3.49	14.92	81.62	13.93

EQUIPMENT : BAY 6 FILM

Equipment ID	Utilization (%)	Delivery Time (min)	Lot Replace Time (min)	Travel Time (min)
CVD2090	0.42	8.33	64,358.88	8.32
SLP4010	33.85	0	1.08	0

EQUIPMENT : BAY 7 FILM

Equipment ID	Utilization (%)	Delivery Time (min)	Lot Replace Time (min)	Travel Time (min)
SPT1070	9.36	10.64	91.3	4.41
SPT1080	1.33	11.04	1,641.32	8.46
SPT1090	0.1	11.29	0	11.29
CVD1270	35.67	9.11	265.6	8.75
CVD1280	20.12	9.1	828.01	8.59
CVD1290	16.41	11.97	282.42	11.37
CVD1300	4.45	12.21	84.81	11.76
CVD1310	2.79	0	133.59	3.6

EQUIPMENT : BAY 2 ETCH

Equipment ID	Utilization (%)	Delivery Time (min)	Lot Replace Time (min)	Travel Time (min)
ETC3190	3.35	11.94	270.73	4.91
ETC3180	6.99	11.11	96.91	4.79
ASH2030	64.8	8.22	0.03	0.06
ASH1030	28.31	8.04	0	0
ASH1020	42.67	10.38	2.9	0.89
ASH1010	45.4	10.4	2.9	0.98
ETC2070	58.79	25.75	302.6	1.2
ETC2060	50.52	17.78	124.47	1.05
ETC2040	53.99	14.92	96.47	0.86
ETC2030	69.36	17.7	116.75	0.92
ETC2020	74.08	15.79	113.94	0.98
ETC2010	74.83	14.86	88.94	1.05

EQUIPMENT : BAY 4 ETCH

Equipment ID	Utilization (%)	Delivery Time (min)	Lot Replace Time (min)	Travel Time (min)
ASH1060	0	15.73	9	15.73
ETC3100	0.14	14.6	0	14.59
ETC3110	0	0	0	0
ETC3120	0	0	0	0
SLP1050	2.27	10.92	52.97	3.42
SLP1060	0.45	14.51	835.06	3.77
ETC4130	0	0	0	0
SLP1010	47.93	10.73	5.44	2.26
SLP1020	38.64	10.64	6.75	2.69
ASH3010	0	0	0	0
SLP1090	0	0	0	0
ETC4140	0	0	0	0
ETC3090	4.32	14.41	172.92	3.84
ASH3020	0	0	0	0
ETC4160	0	0	0	0

CVD1320	0	0	0	0
CVD1330	0.17	9.67	0	9.67
CVD1340	0	0	0	0
CVD1160	1.6	0	2,733.74	0

EQUIPMENT : BAY 9 FILM

Equipment ID	Utilization (%)	Delivery Time (min)	Lot Replace Time (min)	Travel Time (min)
SCR1110	15.45	8.75	11.11	0.28
SCR2010	4.14	8.65	43.11	0.02
CVD1070	52.84	7.46	5.83	0.21
CVD1080	52.16	7.68	10.45	0.3
CVD1090	40.57	7.93	12.64	1.05
CVD1100	26.84	8.1	8.09	2.19
CVD1110	59.21	8.65	582.58	7.51
CVD1200	17.51	8.1	19.76	3.01
CVD1210	4.44	8.86	53.69	5.89
HOD3120	20.54	9.47	7.28	3.01
RTP1030	12.68	5.71	67.21	3.37

Main Page

Back Page

Project Snapshots and Scenario Review

One fab, one constraint, one controlled comparison

- **Baseline:**
Locate the queue and affected tools
- **Alternative:**
Change fleet, routing or buffer capacity
- **Compare delivery time, tool idle time and AMHS utilization**
- **Comparison is shown on OHT & AMR solution vs OHT/ORV solution**

SIMULATION

SOLUTION 2 : ORV

Time : 1 day 1 hour 45 min 19 sec

BAY : H11			BAY : H19		
EQUIPMENT IDs	UTILIZATION (%)	BUFFER USED	EQUIPMENT IDs	UTILIZATION (%)	BUFFER USED
ETCK21-01	93.66	3	CVDK01-01	92.96	5
ETCK21-02	93.31	3	CVDK02-01	72.44	5
ETCK21-03	92.76	4	CVDK05-01	92.54	1
ETCK21-04	91.42	3	CVDK06-01	79.3	0
ETCK18-01	89.24	8	CVDK12-02	95.87	6
ETCK18-02	83.58	2	FTCK18-02	92.77	13
ETCK22-01	89.24	4	SMHK40-03	79.87	0
ETCK22-03	77.23	5	CVDK12-03	96.7	6
ETCK70-01	86.89	8	CVDK15-02	96.43	2
ETCK50-01	86.68	8	ASHK01-01	94.41	3
			ASHK01-02	91.69	3
			FURK40-03	93.83	11
			ASHK14-01	93.54	10
			SPUK05-01	96.95	1
			SPUK05-02	95.65	2
			SPUK02-01	84.87	0
			SPUK02-02	82.68	1
			SPUK13-01	96.79	3
			SPUK13-02	96.92	2
			SMHK40-01	79.87	0
			WETK22-04	76.99	0
			WETK46-01	95.36	13
			SMHK13-01	87.29	6
			SMHK14-01	84.91	0

AMR, OHT - Performance

H11 ORV 1 : 32.91 %
H11 ORV 2 : 28.3 %
H11 ORV 3 : 21.65 %

H19 ORV 1 : 43.43 %
H19 ORV 2 : 39.22 %
H19 ORV 3 : 98.0 %

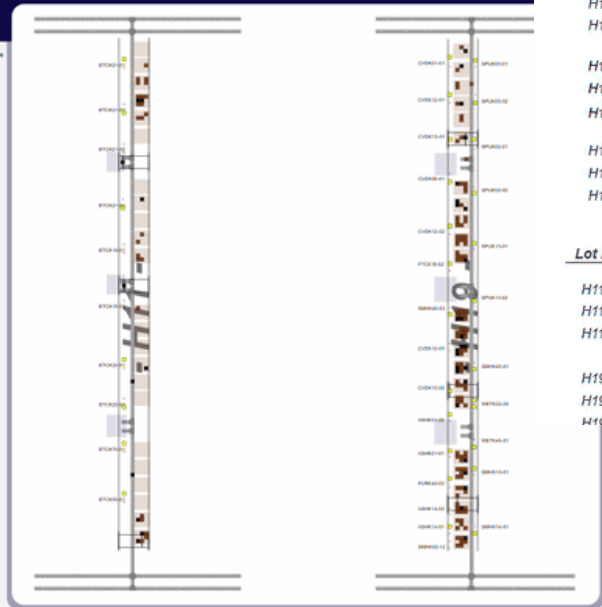
Lot Replace Time (in Minutes)

H11 Latch Area 1 : 22.02 % Time = 7.56
H11 Latch Area 2 : 23.97 % Time = 8.47
H11 Latch Area 3 : 22.02 % Time = 11.35

H19 Latch Area 1 : 43.64 % Time = 3.58
H19 Latch Area 2 : 49.99 % Time = 2.39
H19 Latch Area 3 : 46.12 % Time = 2.95

Throughput Per Hour :

H11 = 9
H19 = 25



BAY : H11

EQUIPMENT IDs	UTILIZATION (%)	BUFFER USED
ETCK21-01	84.79	2
ETCK21-02	75.2	3
ETCK21-03	74.74	2
ETCK21-04	70.38	2
ETCK18-01	79.73	1
ETCK18-02	42.98	5
ETCK22-01	63.42	1
ETCK22-03	60.2	0
ETCK70-01	74.95	1
ETCK50-01	90.27	3

AMR, OHT - Performance

H11 OHT1 : 33.31 %
H11 OHT2 : 34.81 %

H11 AMR 1 : 36.49 % Delivery Time = 91.14 s
H11 AMR 2 : 29.01 % Delivery Time = 78.42 s
H11 AMR 3 : 29.94 % Delivery Time = 94.02 s

H19 OHT1 : 59.51 %
H19 OHT2 : 73.92 %
H19 OHT3 : 61.38 %

H19 AMR 1 : 82.34 % Delivery Time = 96.48 s
H19 AMR 2 : 99.99 % Delivery Time = 101.93 s
H19 AMR 3 : 86.08 % Delivery Time = 105.78 s

Lot Replace Time (in Minutes)

H11 Latch Area 1 : 37.28 % Time = 8.42
H11 Latch Area 2 : 40.27 % Time = 9.98
H11 Latch Area 3 : 37.28 % Time = 12.05

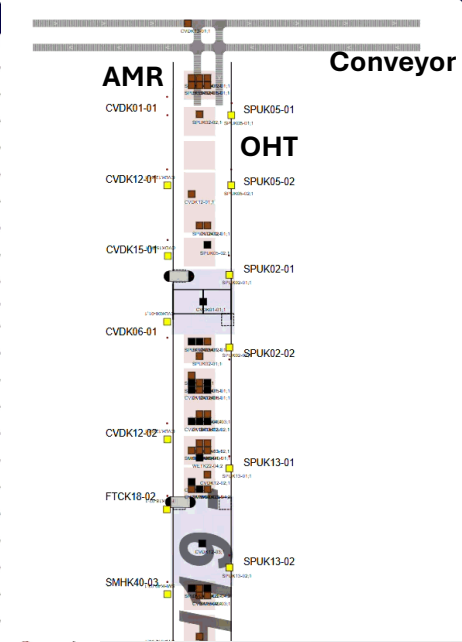
H19 Latch Area 1 : 45.14 % Time = 3.45
H19 Latch Area 2 : 53.28 % Time = 2.43
H19 Latch Area 3 : 47.72 % Time = 3.14

BAY : H19

EQUIPMENT IDs	UTILIZATION (%)
CVDK01-01	95.19
CVDK12-01	55.42
CVDK15-01	96.51
CVDK06-01	88.63
CVDK12-02	84.01
FTCK18-02	81.45
SMHK40-03	68
CVDK12-03	74.75
CVDK15-02	91.76
ASHK01-01	71.6
ASHK01-02	69.6
FURK40-03	68.88
ASHK14-01	85.41
SPUK05-01	76.54
SPUK05-02	62.98
SPUK02-01	93.55
SPUK02-02	88.28
SPUK13-01	71.39
SPUK13-02	65.06
SMHK40-01	68
WETK22-04	64.49
WETK46-01	78.5
SMHK13-01	86.04
SMHK14-01	65.68

Throughput Per Hour :

H11 = 5
H19 = 20



Same production demand and run conditions for a meaningful comparison

Future Plans

Configurable simulation environments and future digital twins

- Automated scenario reports with traceable inputs and results

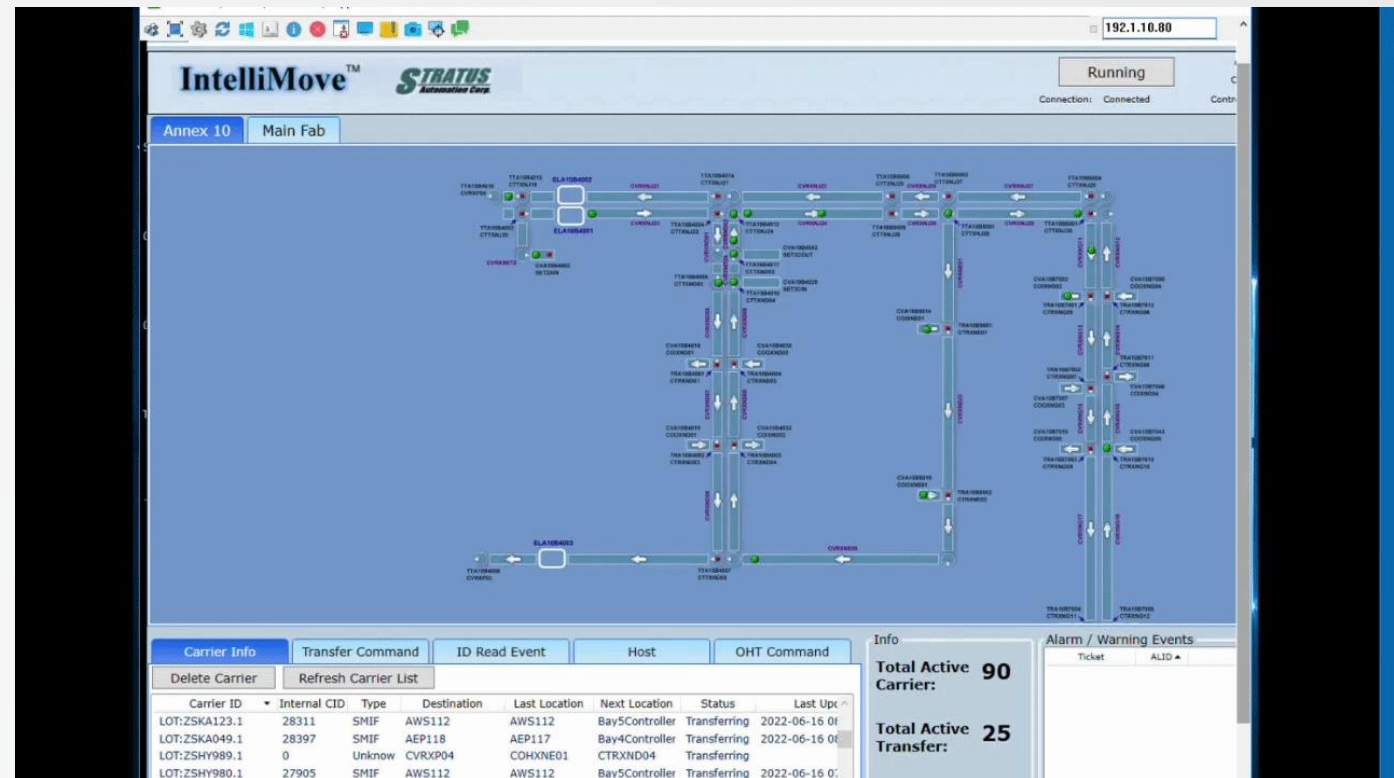
Simplifying analysis and decision making

- Future connection to live production data for ongoing decisions

From offline simulation to real-time digital twin

- Engineering validation remains essential at every stage

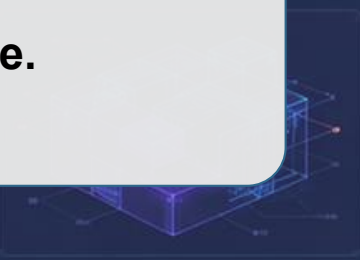
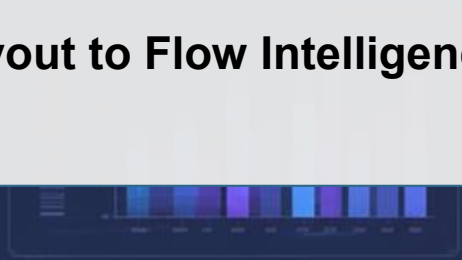
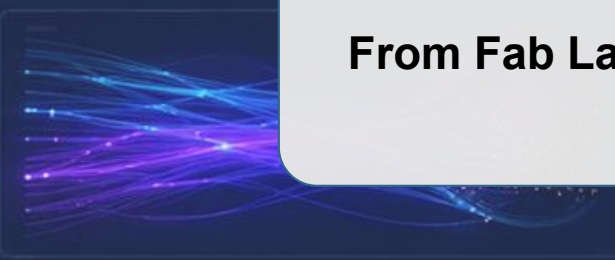
Human expertise ensures trusted and reliable outcomes



What Stratus brings to semiconductor material handling

-  **Translate** Fab layout into an executable material-flow simulation
-  **Quantify** AHMS and tool performance with decision-grade KPIs
-  **Compare** Transportation fleet, routing, buffer, dispatching and production scenarios
-  **Recommend** Targeted changes before physical implementation

From Fab Layout to Flow Intelligence.





Q & A





THANK YOU



Stratus Automation Sdn. Bhd. (1184353-T)
Plot 73-C, Lintang Bayan Lepas, Bayan
Lepas Industrial Park, Phase 4, 11900
Bayan Lepas, Penang, Malaysia.



sales@strsatusauto.com



+60 4-638 3131
+60 4-638 3232



+60 12-334 8131