engineering laboratory

Integrating Data Visualization Software with Manufacturing Facility Databases: Reference Implementation and Lessons Learned

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National Institute of Standards and Technology
U.S. Department of Commerce

April 3, 2018

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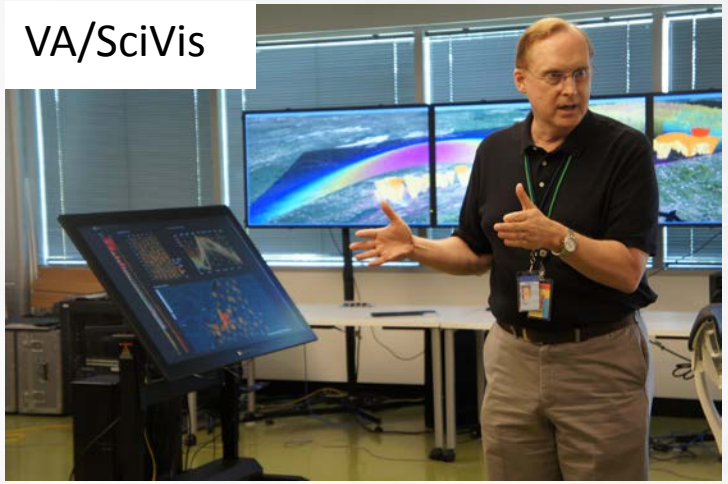
Why visualization for manufacturing?

AR

Rockwell Automation

VA/SciVis



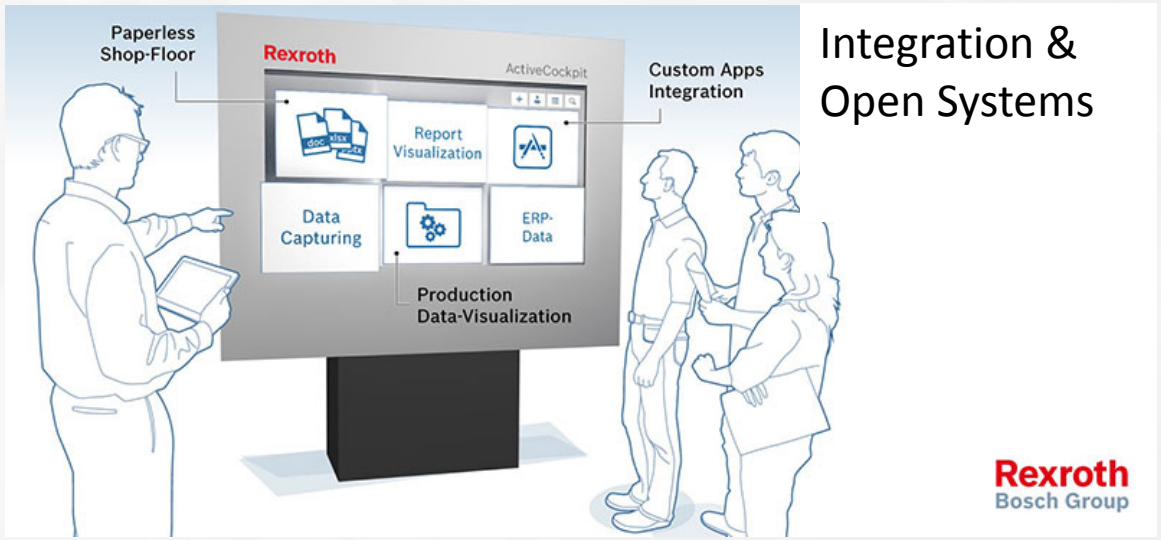
GE Digital

Power Walls

Proctor & Gamble

VR/CAVE

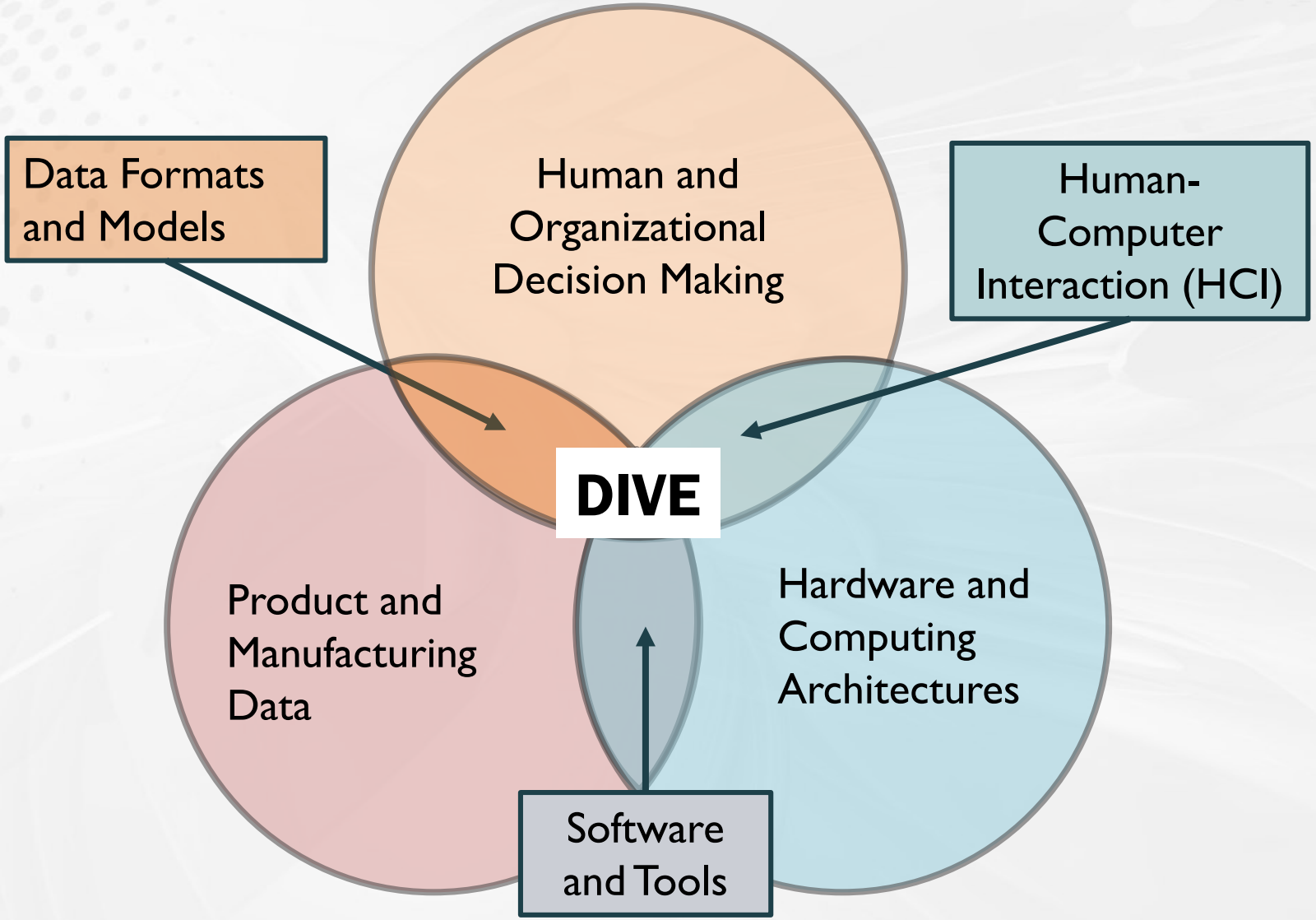
Ford Motor Company



Integration &
Open Systems

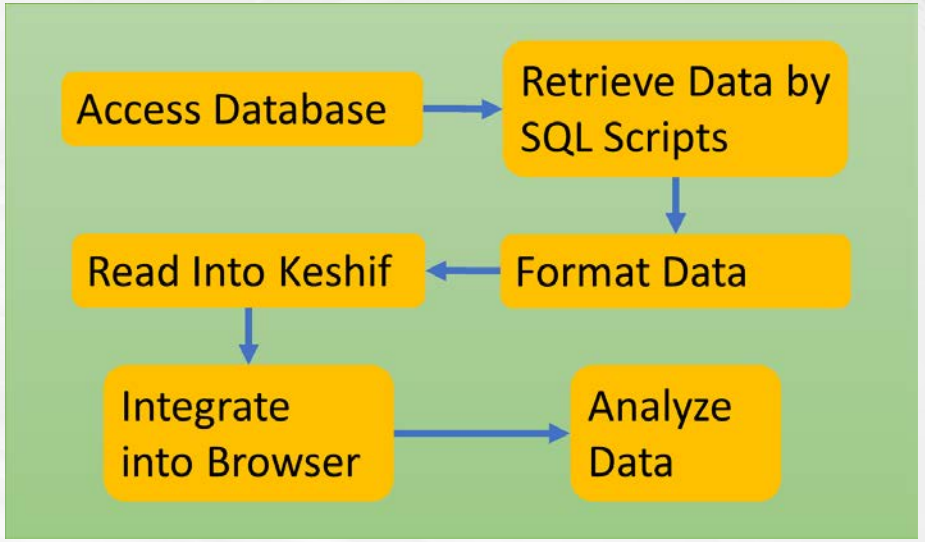
Bosch Research

Data and Information Visualization and Exploration (DIVE) Lab



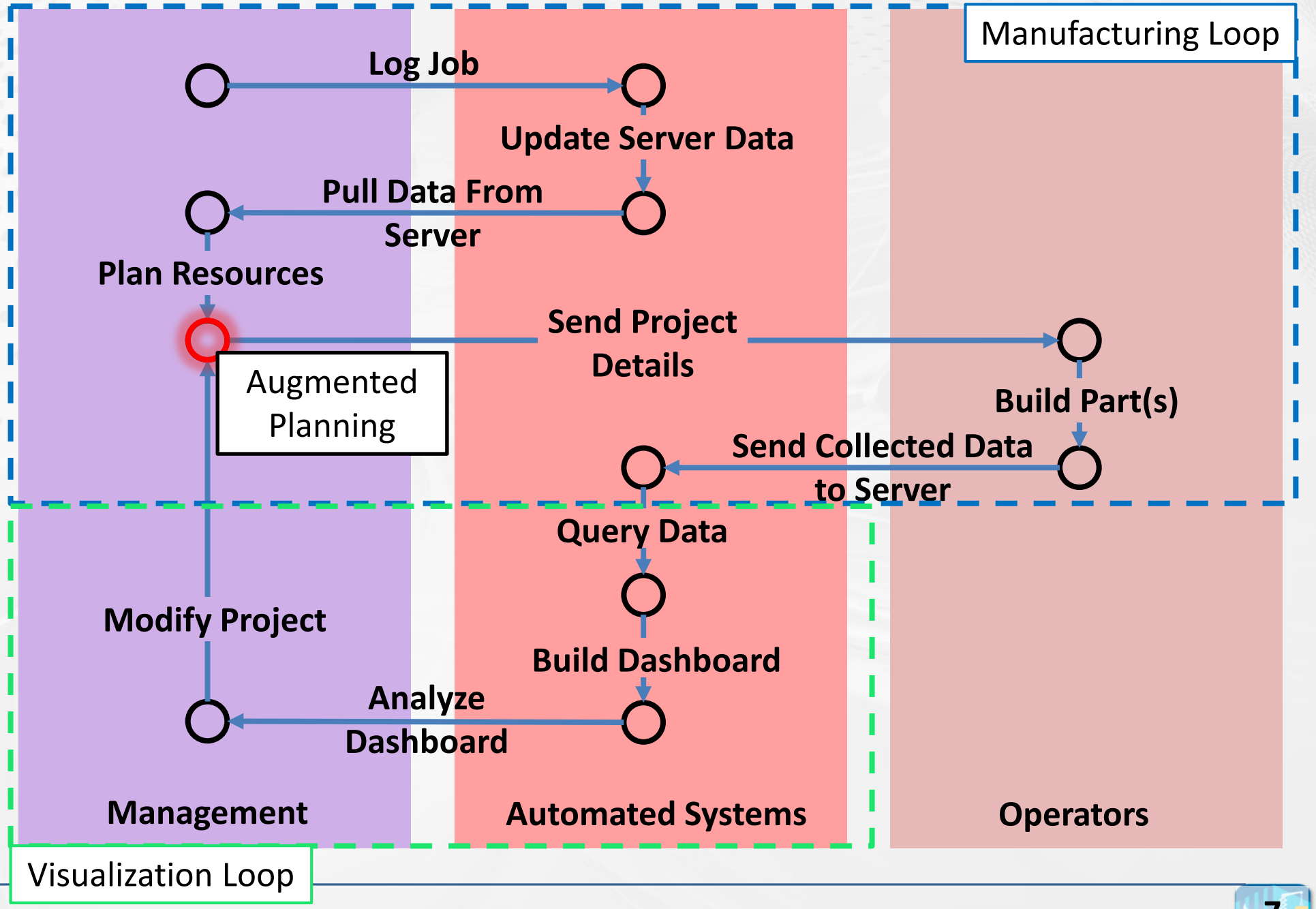
Goals of the project

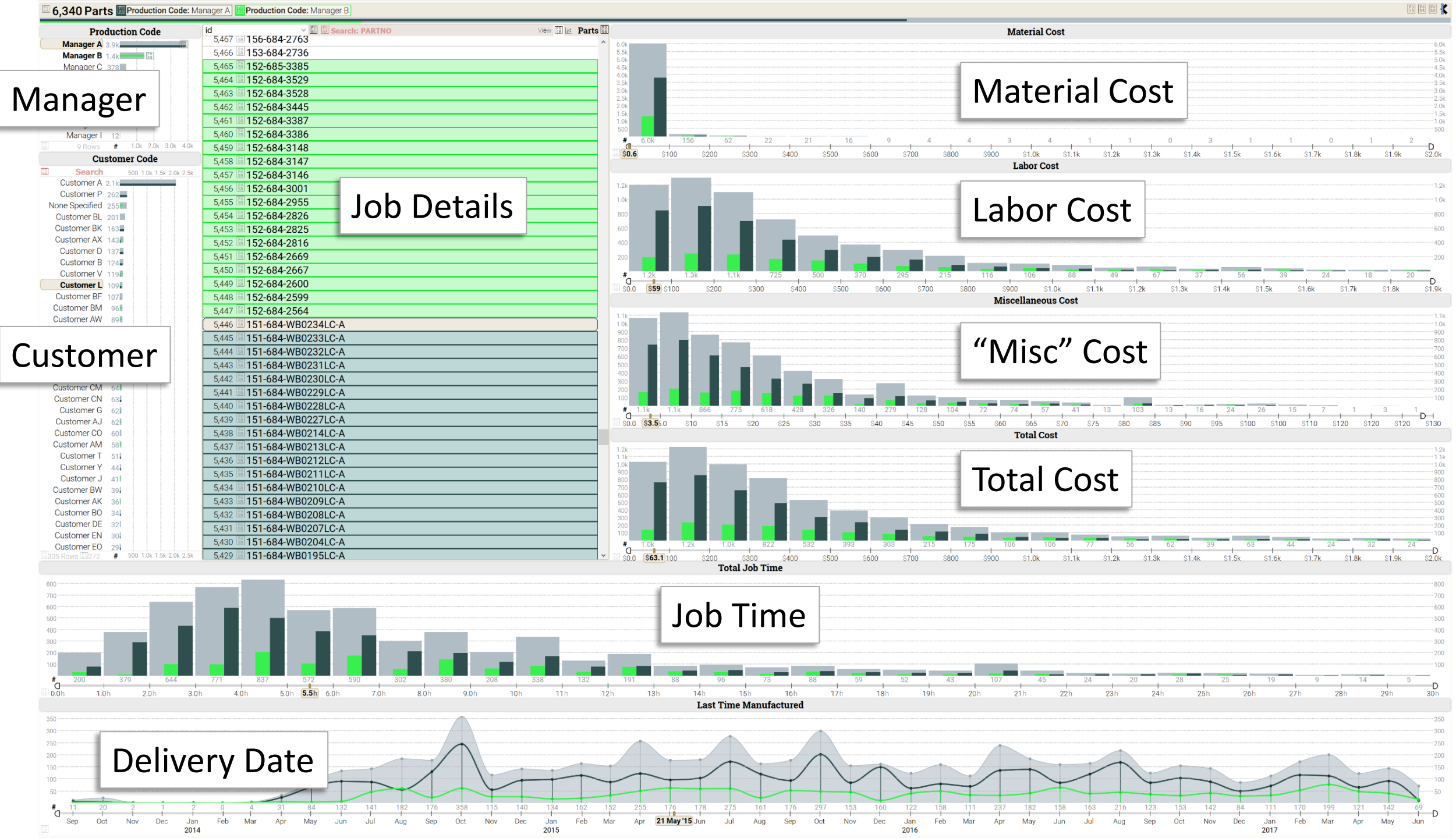
- Understand the requirements to integrate a visual exploration tool with a traditional machine shop database
- Enumerate capabilities and changes of such a task
- Demonstrate value for the NIST shops through a reference implementation



Keshif: A web-based tool for the visual exploration of tabular data

Job Shop Tracking Workflow




6,340 Parts
Production Code: Manager A
Production Code: Manager B
Production Code
Manager A 3.9k
Manager B 1.4k
Manager C 378
Manager I 12
9 Rows
Customer Code
Search
Customer A 2.1k
Customer P 262
None Specified 255
Customer BL 201
Customer BK 163
Customer AX 143
Customer D 137
Customer B 124
Customer V 119
Customer L 109
Customer BF 107
Customer BM 96
Customer AW 89
Customer CM 64
Customer CN 63
Customer G 62
Customer AJ 62
Customer CO 60
Customer AM 58
Customer T 51
Customer Y 44
Customer J 41
Customer BW 39
Customer AK 36
Customer BO 34
Customer DE 32
Customer EN 30
Customer EO 29
805 Rows
id
Search: PARTNO
View
Parts
5,467 156-684-2763
5,466 153-684-2736
5,465 152-685-3385
5,464 152-684-3529
5,463 152-684-3528
5,462 152-684-3445
5,461 152-684-3387
5,460 152-684-3386
5,459 152-684-3148
5,458 152-684-3147
5,457 152-684-3146
5,456 152-684-3001
5,455 152-684-2955
5,454 152-684-2826
5,453 152-684-2825
5,452 152-684-2816
5,451 152-684-2669
5,450 152-684-2667
5,449 152-684-2600
5,448 152-684-2599
5,447 152-684-2564
5,446 151-684-WB0234LC-A
5,445 151-684-WB0233LC-A
5,444 151-684-WB0232LC-A
5,443 151-684-WB0231LC-A
5,442 151-684-WB0230LC-A
5,441 151-684-WB0229LC-A
5,440 151-684-WB0228LC-A
5,439 151-684-WB0227LC-A
5,438 151-684-WB0214LC-A
5,437 151-684-WB0213LC-A
5,436 151-684-WB0212LC-A
5,435 151-684-WB0211LC-A
5,434 151-684-WB0210LC-A
5,433 151-684-WB0209LC-A
5,432 151-684-WB0208LC-A
5,431 151-684-WB0207LC-A
5,430 151-684-WB0204LC-A
5,429 151-684-WB0195LC-A
Material Cost
Labor Cost
Miscellaneous Cost
Total Cost
Total Job Time
Last Time Manufactured
21 May '15
2014
2015
2016
2017
Manager
Customer
Job Details
Material Cost
Labor Cost
“Misc” Cost
Total Cost
Job Time
Delivery Date

Challenges – mostly about the data

- Due to varying degrees of quality, the extracted data must be cleaned and consistently formatted.
  - Slang, jargon, and unexplained abbreviations present in the database pose a significant challenge.
  - 19,915 entries in the JobMaterials table:
    - 2338 entries described shipping activates with over 20 different terms for describing the same activity, many of which were simple typos.

```
1  select * from ShopSys.dbo.JobMaterials order by partno
```

Results | Messages

	OrderNo	JobNo	PartNo	Description	StepNo	MainPart	BinLoc1	QtyPosted1	BinLoc2	QtyPosted2	BinLoc3	QtyPosted3	BinLoc4	QtyPosted4	BinLoc5	QtyPosted5	PostedFromStock	Dat
1...	15-IS-974	15-IS-974-08	SHIPPING ORDER	Send parts to Omley - Lake	0	N	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	N	20
1...	15-RSV-599	15-RSV-599-08	SHIPPING ORDER	Return Resin Tanks for Refill	0	N		1	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	N	20
1...	15-RSV-599	15-RSV-599-08	SHIPPING ORDER	Send Circuit Boards to DynaPath for Repair	0	N	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	N	20
1...	15-RSV-599	15-RSV-599-08	SHIPPING ORDER	Return Resin Tanks for Refill	0	N	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	N	20
1...	15N6832016A	15N6832016A-20	SHIPPING ORDER	Ship material to Cabot Microelectronics - Addision, IL	0	N	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	N	20
1...	1751	1751-01	SHIPPING ORDER	Send parts to Ronal Tool Company - Raines	0	N		1	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	N	20
1...	17-IS-974	17-IS-974-08	SHIPPING ORDER	Return Board to VIC for Repair - Ronkonkoma, NY	0	N		1	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	N	20
1...	16N6864462A	16N6864462A-02	SHIPPING ORDER	Ship completed parts to Kris Bertness - Boulder, CO	0	N		1	NULL	NULL	NULL	[illegible]			.	NULL	N	20
1...	16N647W02...	16N647W024A...	SHIPPING ORDER	Ship completed parts to Tom Bruno - Boulder, CO	0	N		1	NULL	NULL	NULL				.	NULL	N	20
1...	16-IS-974	16-IS-974-10	SHIPPING ORDER	Sending parts to Gaithersburg from Boulder	0	N	NULL	NULL	NULL	NULL	NULL				.	NULL	N	20
1...	16-IS-974	16-IS-974-10	SHIPPING ORDER	Shipping HAAS VF8 from Boulder to Gaithersburg	0	N	NULL	NULL	NULL	NULL	NULL	NULL			.	NULL	N	20
1...	16-IS-974	16-IS-974-10	SHIPPING ORDER	Shipping misc equipment from Boulder to Gaithersburg (list in com...	0	N	NULL	NULL	NULL	NULL	NULL				.	NULL	N	20
1...	16-IS-974	16-IS-974-10	SHIPPING ORDER	Shipping Misc. items from Boulder to Gaithersburg Shop	0	N	NULL	NULL	NULL	NULL	NULL				.	NULL	N	20
1...	16-IS-974	16-IS-974-08	SHIPPING ORDER	Shipping HAAS VF8 from Boulder to Gaithersburg	0	N	NULL	NULL	NULL	NULL	NULL	[illegible]			.	NULL	N	20
1...	14N6845160A	14N6845160A-30	SHIPPING ORDER	Send payment to UNCC - McGlauflin	0	N		1	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	N	20
1...	13N6859064A	13N6859064A-17	SHIPPING ORDER	Send material to Grover Gundrilling for Lake	0	N		1	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	N	20
1...	NYSED-2017T	NYSED-2017T-...	SHIPPING ORDER	Ship Encasement Platform to Barbara Lilley @ NYSED - Albany, NY	0	N		1	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	N	20
1...	NYSED-2017T	NYSED-2017T-...	SHIPPING ORDER	Ship Glass to M. Culver @ NYSED - Albany, NY	0	N	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	N	20
1...	1268	1268-01	SHIPPING-1	shipping	0	N		1	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	N	20
1...	2025	2025-01	SHIPPING2	shipping	0	N		1	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	N	20
1...	2025	2025-01	SHIPPING2	Shipping	0	N		1	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	N	20
1...	2378	2378-01	SHIPPING4	shipping charges	0	N		1	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	N	20
1...	2367	2367-01	SHIPPING4	shipping charges	0	N		1	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	N	20
1...	2088	2088-01	SHIPPINGMC	shippingmcmaster	0	N		1	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	N	20
1...	15-IS-974	15-IS-974-09	SHOP	SHIP	0	N		1	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	N	20

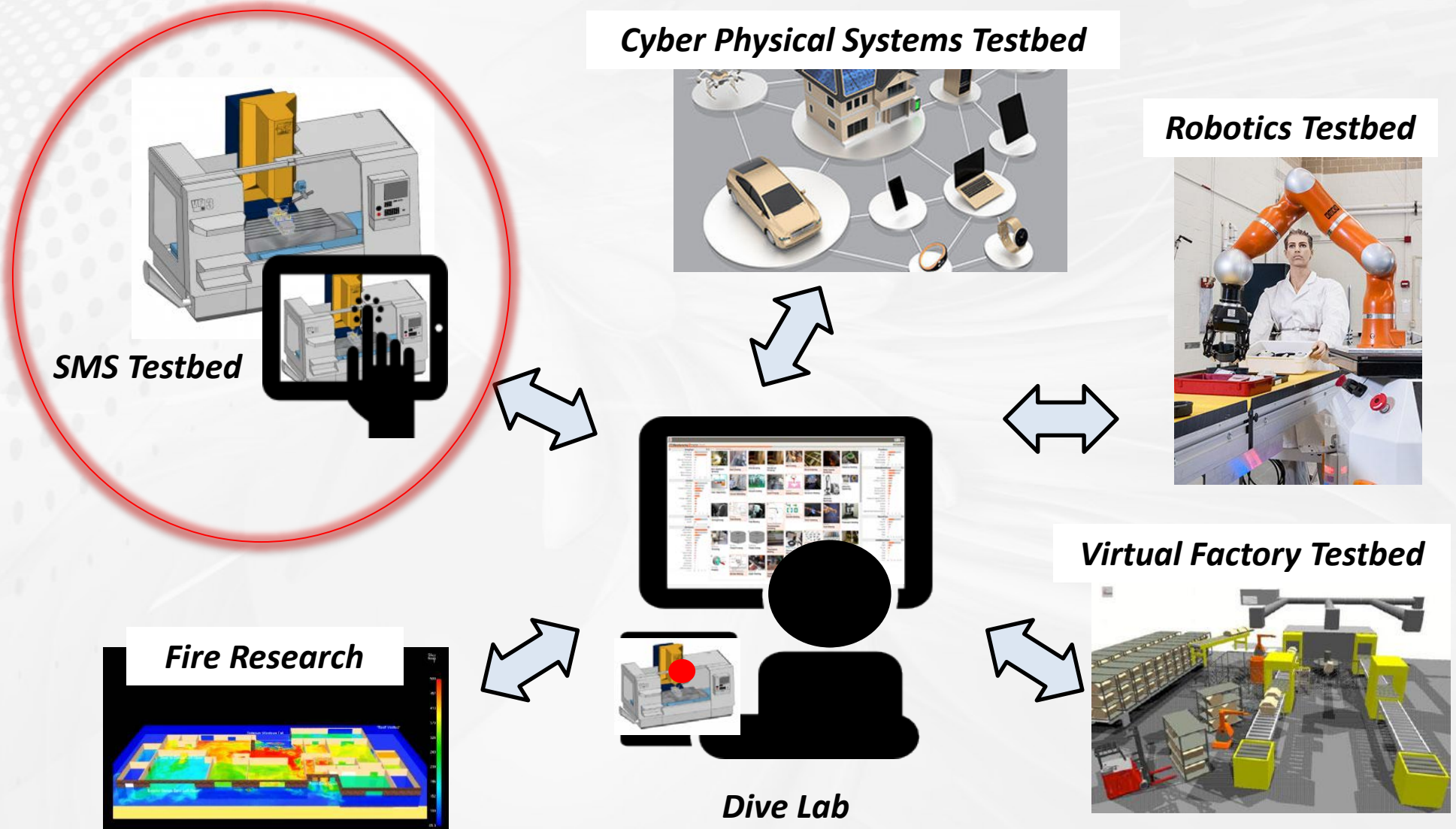
Future directions and opportunities

(1) Developing front-end tools that deal with ambiguous natural user input to the database

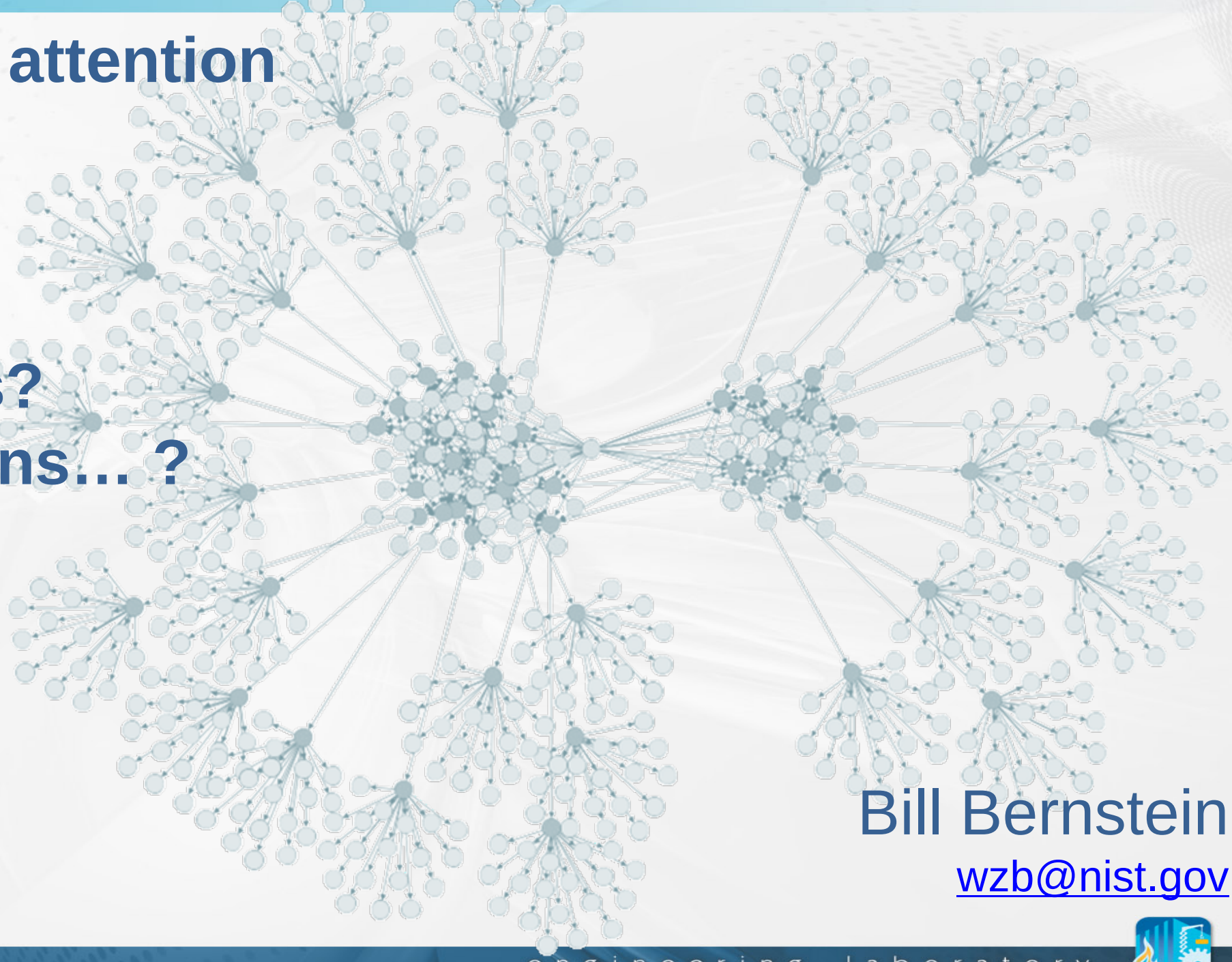
(2) Formalizing key performance indicators (KPIs) and metrics along with the data

(3) Improving data wrangling and querying without affecting the job shop database

Dive Lab to collaborate with other NIST Programs



Thanks for your attention



Questions?

Comments?

Objections… ?

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