BUILDING AN L4 AUTONOMOUS DRIVING R&D PLATFORM

“Drive-PX2 on Wheels”

Wolfgang Juchmann, Ph. D.
VP of Business Development

Supplier of components and services that enable autonomy
Building an L4 Autonomous Driving R&D Platform

- Step 0: Autonomous Applications
- Step 1: Vehicle & Compute Platforms
- Step 2: Perception/Positioning Sensors
- Step 3: Data-Fusion / DriveWorks
- Step 4: Automation Algorithms
Introduction: Wolfgang Juchmann
VP of Sales & Business Development

- Born in Germany
- Ph.D. in Physics ➔ Technical Sales
- In Silicon Valley since 2001
- Last 4 years at Velodyne LiDAR
- Since January 2016 with AutonomouStuff
- Live in Santa Cruz with my wife & 5 year old son
OUR GOAL: To enable the future of transportation by significantly reducing development time of autonomy, therefore rocketing our customers forward.

\[ \text{OUR GOAL} \quad + \quad \text{Y-O-U} \quad = \quad \text{Very Good} \]
Introduction: AutonomouStuff

- Founded in 2010
- ~ 2000 customers, world-wide sales
- Aggressive & continuous growth
- Headquarter in Peoria, Illinois
- Strong presence in Silicon Valley & Detroit
- Autonomy hardware & software experts
Pleasure of Driving
Danger of Driving
We need Autonomous Vehicles!
We want Autonomous Vehicles!

AutonomouStuff helps to get to Autonomy faster
Building an L4 Autonomous Driving R&D Platform

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Step 0: Autonomous Application

- **Shuttle Service**
  - AuroRobotics, VardenLabs, Navya, Zoox, Nutonomy, Uber

- **Passenger Vehicle**
  - OEM/Tier 1 (all major OEM’s/Tier1)
  - EV’s (Tesla, Faraday Future, Atieva, NextEV, BEV...)

- **Racing**
  - RoboRace, SelfDrivingCars.com

- **Truck**
  - Peleton, Otto

- **Special Purpose** (Mining, Agriculture, Construction, Military)
  - CAT, Komatsu, Liebherr, John Deere

- **Internet of Things (IoT)**
  - Google, Baidu, Alibaba, Tencent, Microsoft
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• **Step 4:** Automation Algorithms
Step 1: Vehicle Platforms

**AUTOMOTIVE**
- Lincoln MKZ
- Ford Fusion

**NEV**
- Polaris GEM

**OFFROAD**
- Polaris Ranger

Over 60 vehicles world-wide including USA, Canada, Germany, Austria, Israel, Korea

=> China: First Install last week <=

2015 2016 2016 2017
Step 1: Vehicle Platforms

- By-Wire capable vehicle
- Use existing actuators

- External actuators
- Universal controller

Lincoln MKZ / Ford Fusion

Neighborhood Electric Vehicle / Golf Cart
Step 1: Vehicle Platform

Showroom style
Step 1: Vehicle Platforms
Step 1: Vehicle Platforms
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DrivePX2 for L3/4

=> TODAY <=
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Step 2: Perception/Positioning/Computing/Storage Kits

Sensing:
- Radar
- LiDAR
- Camera
- Ultra-Sonic

Positioning:
- GPS/IMU/RTK

Computing:
- DrivePX2 / DriveWorks

Data Storage:
- Quantum Data Storage (80TB)
Step 2: Perception Kits

Camera
Point Grey / Sekonix
30°, 60°, 100°, 190°

ibeo LiDAR
6x Lux: 4 layers; vertical: 3°; range: 200m

Radar
4x SRR: Short Range: 0.5-80m/±75°
1x ESR: Mid Range: 60-100m/90°; Long Range: 174m/20°

Velodyne LiDAR
2x VLP-16: 16 layers; vertical: 30°; range: 120m

All Sensors
Vision, Radar, LiDAR
# Step 2: Positioning Kits

<table>
<thead>
<tr>
<th>GNSS GPS Solutions for Autonomous Vehicle R&amp;D</th>
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<td><strong>Good</strong></td>
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Step 2: Data-Storage Kits
Step 2: Perception Kits

“Drive PX2 on Wheels”

• **Hardware:**
  - DRIVE PX 2 professionally mounted in trunk
  - pre-wired for cameras, lidar and radar
  - drive-by-wire kit for Ford Fusion
  - Sensors options:
    - Custom configuration
    - NVIDIA configuration (or a subset)

• **Software:**
  - All the SW that comes with DRIVE PX2

*Pre-configured by AutonomouStuff*
Step 2: Perception Kits

“Drive PX2 on Wheels”

**Vision - 11 cameras**
- 2x front camera (Sekonix): 120 FOV medium + 60 FOV long range
- 1x 60 FOV rear long range
- 2x 120 FOV blind spot cameras
- 2x 120 FOV forward facing for Lane keeping (Training)
- 2x 60 FOV Long range Cross Traffic cameras
- 2x 120 FOV side facing for Turn

**Radar configuration:**
- 6x long range (Continental)

**Lidars configuration:**
- 1x Front bumper (Lux 4L)
- 2x Roof mounted (Velodyne VLP)

**Inertial navigation:**
- Novatel SPAN IGM-A1
- XSENS Mti-G710

Source: Nvidia

Pre-configured by AutonomouStuff
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Step 3: Data Fusion

DRIVEWORKS – SOFTWARE DEVELOPMENT KIT (SDK)

USE CASES
- Autonomous Driving
- Data
- Data Acquisition

APIs
 (> 450 AND GROWING)

DESIGN PHILOSOPHY
- Modular
- Scalable
- Optimized for GPU
- Rapid prototyping & production

source: nvidia
Step 3: Data Fusion

TOOLS - DATA ACQUISITION

Intuitive UI to enable simultaneous capture data from sensors

source: nvidia
Step 3: Data Fusion

PERCEPTION DNN SAMPLES
Deep Neural Networks

- DriveNet: Multi-class detection: Cars, Trucks, Pedestrian, Bicycles/Motorcycles, Traffic Signs*
- LaneNet: Lane Detection
- OpenRoadNet: Freespace Detection

source: nvidia
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Step 4: Automation Algorithms
Fast-Tracking Autonomous Driving