Digitalization and AI
Technology that adapts to improve people’s lives

Henk van Houten
Chief Technology Officer
ESI Symposium, April 9th, 2019
Digitalization
The force behind the transformation of Philips
Philips became a Conglomerate through **Diversification**: Innovation in **Vacuum Electronics**, then **Digital Electronics**

<table>
<thead>
<tr>
<th>Vacuum Electronics</th>
<th>Digital Electronics</th>
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<tbody>
<tr>
<td>Lighting</td>
<td>Semiconductors</td>
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<tr>
<td>Radio</td>
<td>Displays</td>
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<tr>
<td>TV</td>
<td>Optical Storage</td>
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<tr>
<td>Cameras</td>
<td>Medical Systems</td>
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<tr>
<td>X-Ray</td>
<td>Data Systems</td>
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<tr>
<td>Passive Components</td>
<td>Mobile Phones</td>
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<tr>
<td>Magnetic Materials</td>
<td>Telecom</td>
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<tr>
<td>etc</td>
<td>LED and the IoT</td>
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Digitalization spawned Deverticalization

Philips radio in the late 1960’s

Philips Ambilight TV introduced 2004
Digitalization led to Deverticalization

Deconstructing the Conglomerate

From a diversified tech conglomerate....

- Displays (2001)
  - LG.Philips
- Semiconductors (2006)
  - NXP
- Television (2012)
  - TP Vision
- Medical systems
  - Health Systems
- Domestic Appliances
  - Personal Health
- Audio (2014)
  - Gibson Innovations
- Lighting (2016)
  - Signify

...to a focused company in HealthTech

Organic growth through innovation: e.g.
Genomics, Digital Pathology, Cardiology Informatics, Image Guided Interventions, Air,

Inorganic growth through acquisitions + innovation: e.g. Respironics, Volcano, Spectranetics, VitalHealth, TomTec,

Not exhaustive
Philips Today
A focused leader in health technology

EUR 1.8 billion
invested in R&D in 2018

65,000 patents

#1 ranking
for medical technology patents
filed at the European Patent Office in 2017

2018 Top 100 Global Innovator
for the sixth year in a row
according to Clarivate Analytics

~60%
of R&D personnel in software
and data science
The digital revolution: how photography evolved

Mechanization → Digitization → Integration

Internet → An ecosystem of digital propositions
The pathway of the digital revolution

Disrupting industries and society
Patient Monitoring start: analogue, single function

Sanborn – First portable ECG Machine, 1928

First Patient Monitor ‘Viso-Scope’, 1957

Cardiotachometer

Blood Pressure Monitor

Body Temp and Respiration Rate
Patient Monitoring in the ICU today

Digital monitoring platform: all basis measurements plug and play
Coming up: decision support and analytics in the cloud

CDS

- Acute respiratory distress syndrome
- Acute kidney injury
- Clinical information extraction
- Acute respiratory failure
- IntelliSpace console critical care
- Patient deterioration
- Multi-organ failure
- Hemodynamic instability
- Patient acuity
- Decision for non-invasive ventilation
- Decision for emergency care
- Critical care forecasting
- Patient deterioration at home

Healthy living | ER | OR | ICU | Ward | Telehealth | Home
Going forward, digital technologies will help transform healthcare in many different ways.

- Advanced Visualization
- Quantification
- IoMT and cloud
- Ubiquitous Patient Monitoring
- Smart Catheters
- Navigation Technologies
- AR/VR
- Digital Twin
- Adaptive Intelligence
Solutions and Outcomes
The way the world looks at health is changing

Value-based healthcare
Population health
Consumerization of healthcare

This requires a shift from product to solution and from transaction to relationship
Innovative value-added, integrated solutions
*Developed to better meet customer needs and capture greater value*

<table>
<thead>
<tr>
<th>Packaged suite of systems, smart devices, software and service</th>
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<tbody>
<tr>
<td><strong>Image-guided therapy solutions</strong></td>
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<tr>
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<tr>
<td>Early warning of patient deterioration</td>
</tr>
<tr>
<td>Total sleep management solutions</td>
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Hospitals are consolidating & Industrializing
Leading to shifting customer needs

North America:
~80% of IDN spend will be controlled by top 100 IDNs by 2023

Europe:
Hospitals have been consolidating across major markets

China:
Private hospital growth continues, while public hospitals are declining

North America:
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China:
Private hospital growth continues, while public hospitals are declining

Germany hospital count:
- 1991: 2,411
- 2012: 2,017

Belgium hospital count:
- 2000: 228
- 2004: 187

China:
Private hospital growth continues, while public hospitals are declining

Private hospital beds:
- 2012: 14%
- 2015: 19%
- 2017: 25%
C-Suite customers need new types of innovation
Partnering opportunities to cope with challenges

- **CEO**: Focusing on outcomes
  - New business models

- **CIO**: System interoperability
  - across care sites
  - Data and system security

- **Chief Nursing Officer**: Patient and caregiver satisfaction
  - Outcomes

- **CMO**: Linking hospital care with the home
  - Optimizing clinical operations and workflow

- **CFO**: Cost reduction
  - New financing models
  - Outsourcing, e.g. Radiology
Moving from products to solutions is transformative

Technology push: maximize
product opportunity

Solutions pull: maximize
customer opportunity

It is only a solution if it addresses the customer KPI’s: becoming an outcomes company
Becoming an Outcomes Company

Our new North Star: The Quadruple Aim

- Improved patient experience
- Better health outcomes
- Improved staff experience
- Lower cost of care
Guardian Early Warning connected care solution – addressing the Quadruple Aim

- **Health outcomes**
  - 86% reduction of Cardiopulmonary Arrests
  - 66% reduction in mortality of patients transferred to the ICU

- **Patient experience**
  - Patients feel safer in general care unit
  - Faster hospital discharge

- **Cost of care**
  - 24% reduction in ICU admission rate
  - Can reduce length of stay by 24%

- **Staff satisfaction**
  - 35% reduction of severe Adverse Events
  - 52% improvement in notifications to trigger interventions

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Solutions can be at department or enterprise level

**Department – Radiology**
- MR, PET/CT
- U/S, DXR
- Radiology IT
- Break/fix Services
- Added Value services

**Enterprise – Oncology**
- Radiology
- Pathology Genomics
- Radiation Therapy
- Oncology IT
- C-Suite

**Added Value services**
- Patient
- Department
- Patient
Cancer Care from Diagnosis to better Outcomes

Precision Diagnosis
- radiology
- image-guided biopsy
- histopathology
- molecular pathology

Therapy Selection
- intelligent information management
- patient engagement

Personalized Therapy Execution
- (targeted) chemotherapy
- radiation oncology
- minimal-invasive intervention
- active surveillance

Better Outcomes
- Patient outcomes
- Cost of care delivery
- learning from outcomes

Local & Global outcome data
Connected Oncology Demonstrator for Prostate
Presented at Astro 2018

Diagnostics

IntelliSpace portal

UroNav

IntelliSite digital pathology

Treatment selection & Follow-up

IntelliSpace Precision Medicine

IntelliSpace Pathways

Treatment planning & execution

IntelliSpace Radiation Oncology

Designed to enable same-day simulation to treatment

Prepared for 1-click planning

Prostate treatment plan creation within 25 minutes

Accuracy of AutoContouring ≥70%
Solutions need unlocking the power of Data

HealthSuite as “System of Engagement”
Customer needs related to Data

- **Consumers, patients and informal caregivers**: Access to, and control of, personal data sharing.

- **Health and wellness providers**: Actionable clinical insights where, how and when relevant.

- **Administrators**: Analytics to help manage patient populations and reduce financial risks.

- **Developers**: Open APIs, meets industry standards, compliant cloud infrastructure.

- **IT professionals**: Interoperability, privacy and security to ensure secure data exchange.

- **Researchers**: Analytics, machine learning and artificial intelligence.

Seamless, connected care that fits the workflow and daily routines of staff.
**HealthSuite** – a unique Platform evolving into a **System of Engagement** on top of the EMR*

### Quadruple aim
- Better health outcomes
- Improved patient experience
- Improved staff satisfaction
- Lower cost of care

### Clinical journeys
- In the home
- In the hospital
- Care management
- Precision diagnosis

### Solutions
- **Products, SW, Systems**
- **Services**
- **Ecosystems**

### HealthSuite
- **Workflow**
- **Intelligence**
- **Engagement**

### EMR
- **System of Record**: Patient History, Medication lists, Clinical Documents, Notes, Protocols, Guidelines

*and other Hospital IT systems for billing, lab mgt etc
Enabling Virtual care
Making scarce resources available 24/7
Optimization of resources and better quality of care, by virtual consults, networked care and remote monitoring
SleepCare
Empowering consumers to manage chronic disease

Direct Consumer Engagement
>3 million consumer visits annually to our websites

Diagnostics
Leader in lab and home sleep tests
#1 in the United States

People-centric Therapy
Award-winning Dream Family fuels market growth

Connected Proposition
~5 million devices connected
>575K registered DreamMapper users

Care Management Services
>325k patients managed
Expanding across US, UK, France and India

Insights from 2.3 billion nights of cloud-based data enables improving care pathways and services
The next wave: Adaptive Intelligence
Everyone is talking about Artificial Intelligence
The opportunity of AI in Healthcare

- AI applications can potentially create $150B in annual savings for US healthcare by 2026.

- Growth in the AI health market is expected to reach $6.6 billion by 2021— a CAGR of 40%.

- In just the next five years, the health AI market will grow more than 10x.

- Opportunities are in clinical, operational, and financial domains.

<table>
<thead>
<tr>
<th>Application</th>
<th>Value*</th>
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<tbody>
<tr>
<td>Robot-Assisted Surgery</td>
<td>$40B</td>
</tr>
<tr>
<td>Virtual Nursing Assistants</td>
<td>$20B</td>
</tr>
<tr>
<td>Administrative Workflow Assistance</td>
<td>$18B</td>
</tr>
<tr>
<td>Fraud Detection</td>
<td>$17B</td>
</tr>
<tr>
<td>Dosage Error Reduction</td>
<td>$16B</td>
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<tr>
<td>Connected Machines</td>
<td>$14B</td>
</tr>
<tr>
<td>Clinical Trial Participant Identifier</td>
<td>$13B</td>
</tr>
<tr>
<td>Preliminary Diagnosis</td>
<td>$5B</td>
</tr>
<tr>
<td>Automated Image Diagnosis</td>
<td>$3B</td>
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<tr>
<td>Cybersecurity</td>
<td>$2B</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>~$150B</td>
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* Frost and Sullivan, by 2026
AI is starting in the cloud, but will become embedded as well

- AI software providers are tailoring their AI models and algorithms for deployment on machines and devices outside the data center
- Chip manufacturers are increasingly embedding support for AI directly into devices
- AI chips are being developed that can perform complex computations but consume minute amounts of power
- Machines with embedded AI are beginning to appear in many industries, including health care
- Annual shipments of devices with embedded AI are projected to increase from 79 million last year to 1.2 billion in 2023

Dealing with AI responsibly will be key to success

Appropriate validation on well curated, annotated, and representative test data is key (avoiding bias)

We must be mindful about customer/patient concerns related to their personal data

Trustworthy companies become preferred data partners

Ethical dimension is very important. AI must not harm or adversely affect citizens

When it comes to legal requirements, transparency, choice and access are fundamental principles
Philips positioning is **Adaptive Intelligence**

Using AI to help turn large amounts of data into actionable insights to support and empower people

- Enhances the people who use it
- Adapts to the context
- Is embedded into people’s workflows or daily environment

**Adaptive intelligence** combines the power of AI and other technologies with clinical and operational domain knowledge
Adaptive Intelligence Attributes

**Dynamic:** changes dynamically, in response to you

**Unobtrusive:** integrates into the environment

**Context-aware:** devices recognize you & your context

**Natural:** interact and converse in an intuitive way

**Precise:** multi-modality perspective for precision

**Personalized:** configured to your needs

**Predictive:** anticipate your condition & needs

**Pro-active:** preventative, enabling early intervention
AI in radiology will enable **precision diagnosis and efficiency**

- Integration of vast amounts of diagnostic data for earlier and more definitive diagnosis
- Right study, at the right time, leading to the right therapeutic interventions
- Precise therapies guided by imaging
- Optimal operational performance to ensure equal quality of care across hub-and-spoke health systems
- Simplified and automated workflow to reduce staff workload and variability

Using AI to **augment** healthcare providers
A solutions approach for AI in Radiology
Illumeo with adaptive intelligence
Launched at RSNA 2018
Data analytics and insight gathering using Performance Bridge

Phoenix Children’s Hospital, USA

- Reduced waste
  - 60 Unnecessary exam cards eliminated
  - 7% Repeat scans reduction

- 20+ minutes of time savings in changeover time

- Improved patient and staff experience

Results from case studies are not predictive of results in other cases. Results in other cases may vary.
Philips AI Translational Solution for Radiology

From Clinical Research to Clinical Routine

Philips Marketplace

Research Apps

Validated Clinical Apps

Research

Translation

Clinical Routine
Creating an Adaptive Intelligence Ecosystem

**AI Engine on HealthSuite Platform**

**Ecosystem**
- Standard APIs
- Curation tools
- Streamlined licensing
- Developer ecosystem

**Enabled solutions**
- Workflow analysis
- Imaging
- Clinical text

**Application domains**
- Digital pathology
- Radiology
- Cardiology
- Genomics

**AI Engine**
- DL / ML / analytics
- Data repository / data lake
- Cloud / on-prem
- Standardized data connectivity
- De-identification

**3rd party**
- Philips

**Marketplace**
In 2018, 19 AI start-ups were selected from 800 across 11 countries.

Ecosystem Innovation
HealthWorks, Market Place, Connected Care Ecosystem
It all comes together in a Connected Care ecosystem

AI will enable deep insight in a person’s health, disease drivers and state. AI supports a more precise diagnosis, better therapy fit and improved adherence.

- **Sleep & Respiratory Care**
- **e-ICU**
- **Elderly Care**
- **Precision Diagnosis**
  
  Coaching & therapy compliance
  
  Real-time monitoring and Intervention
  
  Behavioral pattern recognition
  
  At the point of care
Your digital twin
Putting data and AI into a personalized clinical context
Five ways in which healthcare innovation is changing

• From product features to solutions for value-based care

• Designing solutions aligned with customer KPI’s is critical

• This requires ecosystem innovation on open digital platforms

• To unlock the power of data we need a System of Engagement with Adaptive Intelligence to translate EMR and device data into actionable insights embedded into the workflow

• Research is moving out of the lab to the frontline of innovation – co-creation with customers and ecosystem partners

https://www.linkedin.com/pulse/five-ways-which-healthcare-innovation-has-changed-over-van-houten/
From “the Lab is your World” – to “the World is your Lab”