

Dimensions of  
Functionality  
Axes

Early Examples

Rivet Glasses  
Countess of Lovelace  
Roulette

“Recent”  
Examples

Computing on the Wrist  
Environmental Sensing  
Human Sensing

More Examples

Fashion  
Communication  
Mobility  
Implantables

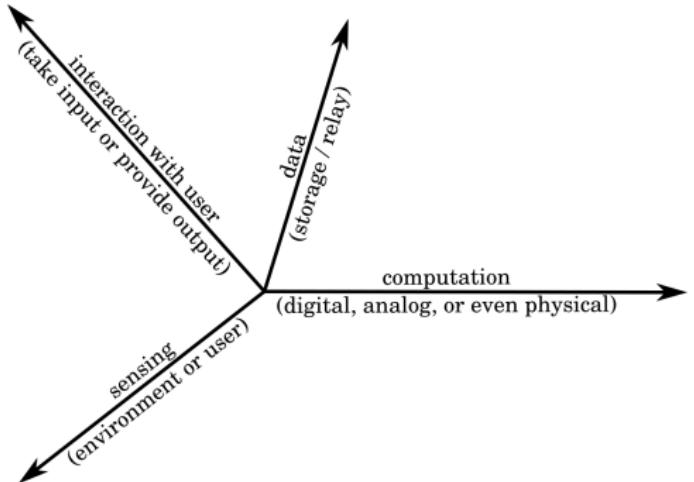
Dimensioning  
Examples

# Wearable Technologies and Applications (Wearable Informatics)

Winfree

Lecture 2

# Axes as a Framework



- ▶ Four dimensions of functionality.
- ▶ Each axis is not necessarily orthogonal to any other.

Dimensions of Functionality

## Axes

## Early Examples

Rivet Glasses

Countess of Lovelace

Roulette

## "Recent" Examples

Computing on the Wrist

Environmental Sensing

Human Sensing

## More Examples

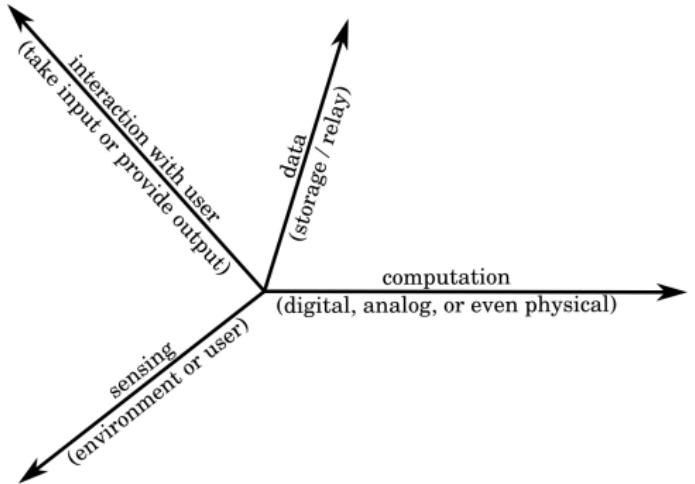
Fashion

Communication

Mobility

Implantables

## Dimensioning Examples



- ▶ Environmental
  - ▶ Temperature (not skin)
  - ▶ Location
  - ▶ Air quality
- ▶ Wearer (user)
  - ▶ Temperature (eg skin)
  - ▶ Heart Rate
  - ▶ Physical Activity Level

Dimensions of Functionality

#### Axes

#### Early Examples

Rivet Glasses  
Countess of Lovelace  
Roulette

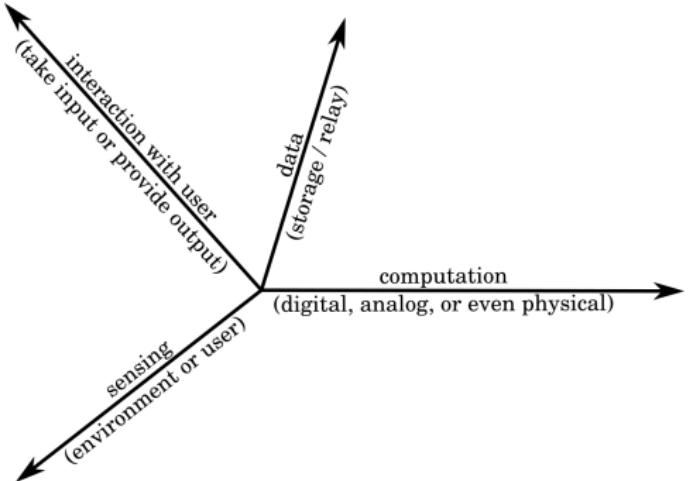
#### "Recent" Examples

Computing on the Wrist  
Environmental Sensing  
Human Sensing

#### More Examples

Fashion  
Communication  
Mobility  
Implantables

#### Dimensioning Examples



## ► Storage

- Local
- No storage - process and throw away

## ► Relay

- Physical storage - SD card
- Wired on command
- Wireless
- Continuous or Staged

Dimensions of Functionality

Axes

Early Examples

Rivet Glasses

Countess of Lovelace

Roulette

"Recent" Examples

Computing on the Wrist

Environmental Sensing

Human Sensing

More Examples

Fashion

Communication

Mobility

Implantables

Dimensioning Examples

Dimensions of  
Functionality**Axes****Early Examples**

Rivet Glasses

Countess of Lovelace

Roulette

**"Recent"  
Examples**

Computing on the Wrist

Environmental Sensing

Human Sensing

**More Examples**

Fashion

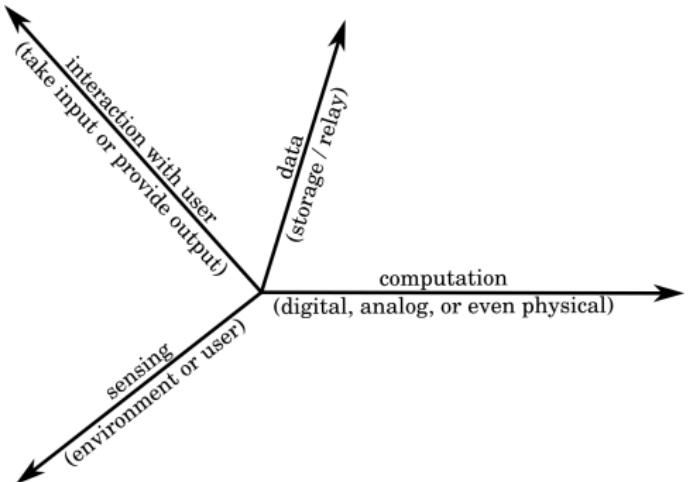
Communication

Mobility

Implantables

**Dimensioning  
Examples**

# Interaction with the Wearer (Human Comp. Interaction - HCI)

**Input**

- ▶ Direct entry
- ▶ Motion
- ▶ Voice
- ▶ Command

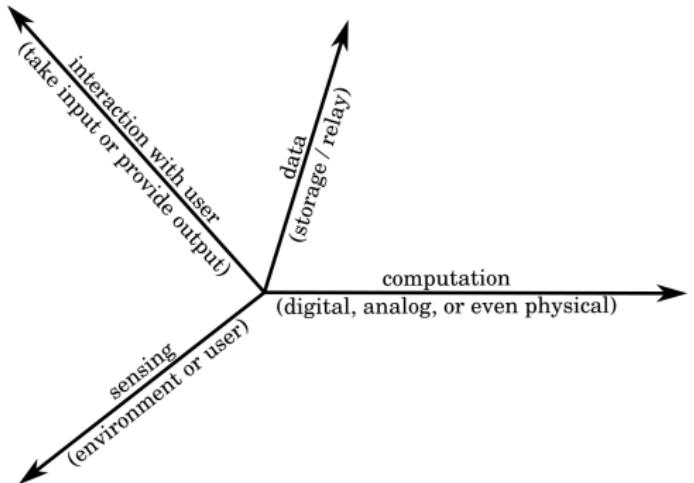
**Output**

- ▶ Audio
- ▶ Haptic
- ▶ Visual

# Computation

INF632  
(EE499/EE599)

Winfree



- ▶ Mechanical
- ▶ Analog
- ▶ Digital

Dimensions of Functionality

Axes

Early Examples

Rivet Glasses  
Countess of Lovelace  
Roulette

"Recent" Examples

Computing on the Wrist  
Environmental Sensing  
Human Sensing

More Examples

Fashion  
Communication  
Mobility  
Implantables

Dimensioning Examples

- ▶ First clear exemplar of wearable technology.
- ▶ Corrective glasses (with a convex lens) - 13th century in Italy. Two lenses held together by a rivet; no arms to rest on the ears.
- ▶ Function - Modify information (images) through a mechanical process (the lens) for the wearer (user) - mechanical computing.<sup>a</sup>

---

<sup>a</sup><https://en.wikipedia.org/wiki/Glasses>,  
<https://www.medievalchronicles.com/medieval-history/medieval-inventions-list/eyeglasses/>



Dimensions of  
Functionality  
Axes

Early Examples

Rivet Glasses

Countess of Lovelace  
Roulette

"Recent"  
Examples

Computing on the Wrist  
Environmental Sensing  
Human Sensing

More Examples

Fashion  
Communication  
Mobility  
Implantables

Dimensioning  
Examples

# Countess of Lovelace

“Augusta Ada King-Noel, Countess of Lovelace (Ada Lovelace) was an English mathematician and writer, chiefly known for her work on Charles Babbage’s early mechanical general-purpose computer, the Analytical Engine. Her notes on the engine include what is recognized as the first algorithm intended to be carried out by a machine. As a result, she is often regarded as the first computer programmer.” <sup>a</sup>

---

<sup>a</sup>[https://en.wikipedia.org/wiki/Ada\\_Lovelace](https://en.wikipedia.org/wiki/Ada_Lovelace)



Dimensions of  
Functionality  
Axes

Early Examples

Rivet Glasses  
Countess of Lovelace  
Roulette

“Recent”  
Examples

Computing on the Wrist  
Environmental Sensing  
Human Sensing

More Examples

Fashion  
Communication  
Mobility  
Implantables

Dimensioning  
Examples

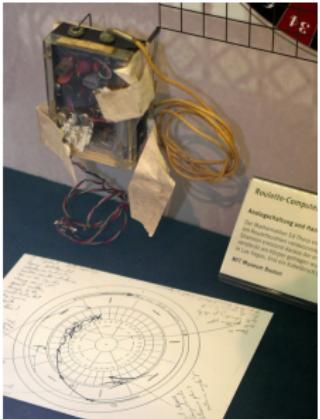
Dimensions of  
Functionality  
Axes

Early Examples  
Rivet Glasses  
Countess of Lovelace  
Roulette

"Recent"  
Examples  
Computing on the Wrist  
Environmental Sensing  
Human Sensing

More Examples  
Fashion  
Communication  
Mobility  
Implantables

Dimensioning  
Examples



# Roulette Computer

August of 1961 Edward O. Thorp and Claude Shannon, of MIT

"They worked as a team. Shannon watched the wheel, clandestinely clocking the speeds of the rotor and the ball by flipping micro switches in his shoe with his big toe. The signals coursed through wires that ran up his pant leg to a small computer strapped to his waist. The machine calculated the ball's final resting position and then transmitted this prediction wirelessly to a receiver under Thorp's shirt. Through a tiny speaker in his ear, Thorp heard one of eight distinct tones that advised him on how to bet."<sup>a</sup>

<sup>a</sup><http://spectrum.ieee.org/consumer-electronics/portable-devices/wearable-computers-will-transform-language>

# Computing on the Wrist

Casio CA-90  
(1970s)



Seiko UC-2100 (1984?)



Casio Data Bank  
(1980s to  
current!)



Dimensions of  
Functionality

Axes

Early Examples

Rivet Glasses

Countess of Lovelace

Roulette

"Recent"  
Examples

Computing on the Wrist

Environmental Sensing

Human Sensing

More Examples

Fashion

Communication

Mobility

Implantables

Dimensioning  
Examples

# Environmental Sensing

INF632  
(EE499/EE599)

Winfree

Dimensions of  
Functionality

Axes

Early Examples

Rivet Glasses

Countess of Lovelace

Roulette

"Recent"  
Examples

Computing on the Wrist

Environmental Sensing

Human Sensing

More Examples

Fashion

Communication

Mobility

Implantables

Dimensioning  
Examples



# Human Sensing

INF632  
(EE499/EE599)

Winfree

Dimensions of  
Functionality

Axes

Early Examples

Rivet Glasses

Countess of Lovelace

Roulette

"Recent"  
Examples

Computing on the Wrist

Environmental Sensing

Human Sensing

More Examples

Fashion

Communication

Mobility

Implantables

Dimensioning  
Examples



# Little Boots Cyber Cinderella LED Dress

INF632  
(EE499/EE599)

Winfree

Dimensions of  
Functionality

Axes

Early Examples

Rivet Glasses

Countess of Lovelace

Roulette

“Recent”  
Examples

Computing on the Wrist

Environmental Sensing

Human Sensing

More Examples

Fashion

Communication

Mobility

Implantables

Dimensioning  
Examples

See ‘1 - Little Boots Cyber Cinderella LED Dress [HD,  
1280x720p].mp4’

# Signing

INF632  
(EE499/EE599)

Winfree

Dimensions of  
Functionality

Axes

Early Examples

Rivet Glasses

Countess of Lovelace

Roulette

"Recent"  
Examples

Computing on the Wrist

Environmental Sensing

Human Sensing

More Examples

Fashion

Communication

Mobility

Implantables

Dimensioning  
Examples

# Orthotics and Prosthetics

INF632  
(EE499/EE599)

Winfree

Dimensions of  
Functionality

Axes

Early Examples

Rivet Glasses

Countess of Lovelace

Roulette

"Recent"  
Examples

Computing on the Wrist

Environmental Sensing

Human Sensing

More Examples

Fashion

Communication

Mobility

Implantables

Dimensioning  
Examples

See '3 - Can Prosthetics Outperform Real Limbs Cyborg Nation [HD, 1280x720p].mp4'

Dimensions of  
Functionality

Axes

Early Examples

Rivet Glasses

Countess of Lovelace

Roulette

“Recent”  
Examples

Computing on the Wrist

Environmental Sensing

Human Sensing

More Examples

Fashion

Communication

Mobility

Implantables

Dimensioning  
Examples

See ‘4 - Amputee Makes History with APL’s Modular  
Prosthetic Limb [HD, 1280x720p].mp4’

# Cochlear Implants

INF632  
(EE499/EE599)

Winfree

Dimensions of  
Functionality

Axes

Early Examples

Rivet Glasses

Countess of Lovelace

Roulette

“Recent”  
Examples

Computing on the Wrist

Environmental Sensing

Human Sensing

More Examples

Fashion

Communication

Mobility

Implantables

Dimensioning  
Examples

See ‘5 - How A Cochlear Implant Works by Advanced Bionics [HD, 1280x720p].mp4’

# Cochlear Implants

INF632  
(EE499/EE599)

Winfrey

Dimensions of  
Functionality

Axes

Early Examples

Rivet Glasses

Countess of Lovelace

Roulette

"Recent"  
Examples

Computing on the Wrist

Environmental Sensing

Human Sensing

More Examples

Fashion

Communication

Mobility

Implantables

Dimensioning  
Examples

See '6 - Kai hearing hearing her voice for the first time [Low, 480x360p].mp4'

# Dimensioning Examples

INF632  
(EE499/EE599)

Winfree

Dimensions of  
Functionality  
Axes

## Early Examples

Rivet Glasses  
Countess of Lovelace  
Roulette

## "Recent" Examples

Computing on the Wrist  
Environmental Sensing  
Human Sensing

## More Examples

Fashion  
Communication  
Mobility  
Implantables

## Dimensioning Examples

