

# PHILIPS

sense and simplicity



## GEMINI TF

For the benefit of patients and caregivers:  
Advanced physics in a simple box.

Matthias Egger, PhD  
Sales & Marketing Director PET/CT International

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What is a better PET/CT ?

- **Increased diagnostic confidence:**  
miss fewer lesions, localise them correctly and quantify uptake
- **Less intimidating for the patient:**  
quick, « comfortable, » reassuring
- **Extends PET scanning to a larger patient population:**  
children, claustrophobic patients, anaesthetised patients, obese patients, critical patients
- **User-friendly:**  
time-saving operation, fewer operator errors, efficient reading, data communications
- **Supports the whole care cycle:**  
tools and connectivity for diagnosis, treatment simulation, follow-up comparisons
- **Makes economic sense:**  
high patient throughput, future safe, shared use with radiology, reliable, dose savings
- **Ready for research and future applications:**  
demanding applications, low tracer concentrations, dynamic imaging

# PHILIPS

sense and simplicity

(19) **United States Patent Applic**  
 (12) **GAGNON et al.**

(54) **POSITRON EMISSION TIME-OF-FLIGHT LIS RECONSTRUCTION W RESPONSE FUNCTION**

(75) Inventors: **Daniel GAGN (US); Joel KA Lucretiu M. I PA (US)**

Correspondence Address: **PHILIPS INTELLECTU STANDARDS 595 MINER ROAD CLEVELAND, OH 4414**

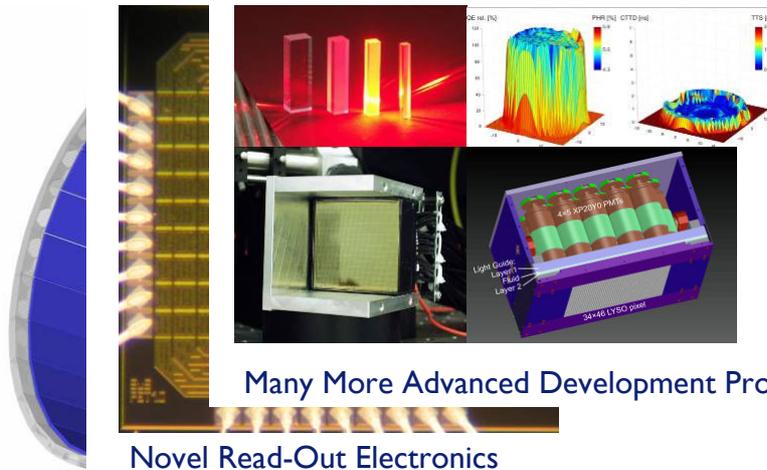
(73) Assignee: **KONINKLIJ TRONICS N.**

(21) Appl. No.: **11/464,53**

(22) Filed: **Aug. 15, 2006**

Depth-of-Interaction Detectors

PSF Deconvolution with ToF modelling



Many More Advanced Development Projects...

Novel Read-Out Electronics

ToF Technology was found to have :

- great technical complexity, but can be realised with today's technologies;
- largest immediate impact on performance: better use of counts;
- largest long-term impact: future safe hardware platform.

Clear decision to prioritise ToF technology and bring to market the technology platform which will serve as base for all other Advanced Development projects.

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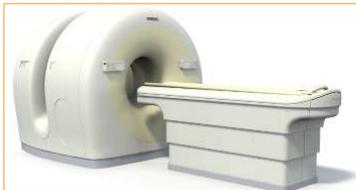
Introducing **GEMINI TF**

Perfect for every body.

**GEMINI TF PET/CT.**

The new benchmark in speed, comfort, clarity and flexibility.

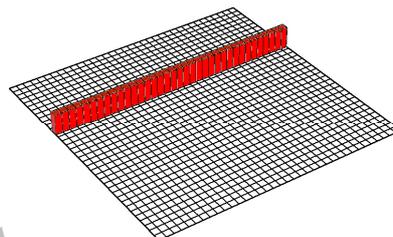
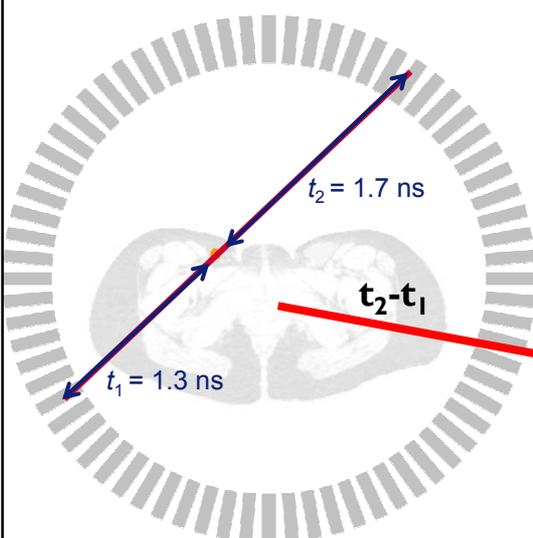
Breakthrough technology to address today's and tomorrow's challenges.



**first clinical ToF PET/CT system announced March 06**

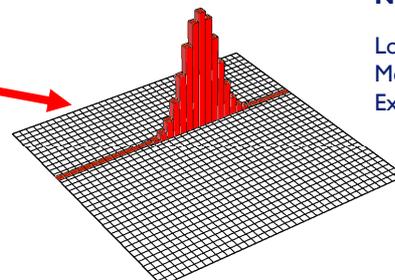
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Time of Flight PET Systems



**BEFORE** (Conventional PET)

Localisation information is diluted

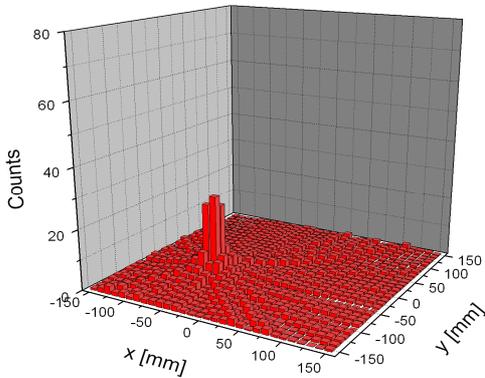


**NOW** (Time-of-Flight PET)

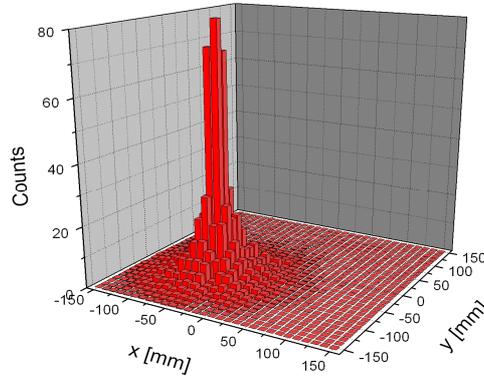
Localisation possible within < 10 cm  
More information in each event  
Exploit counts better

**ToF: extract more information**

Backprojecting several events (no filtering)...



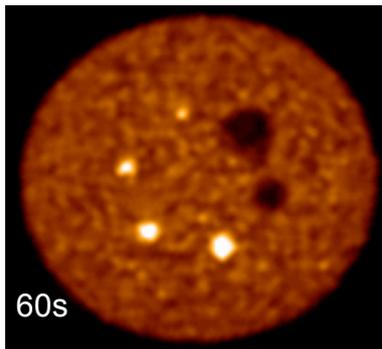
Conventional PET



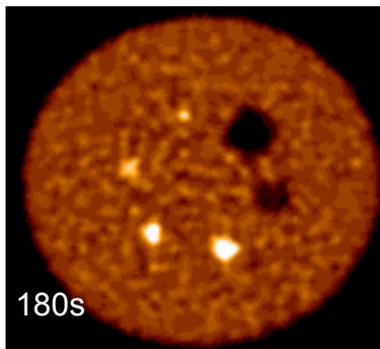
Time-of-Flight PET

**ToF: more signal, less noise**

TOF



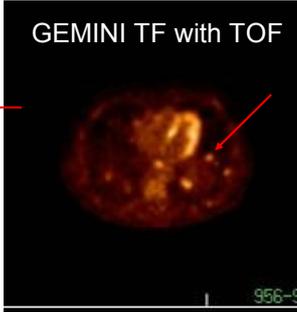
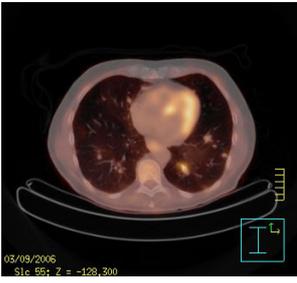
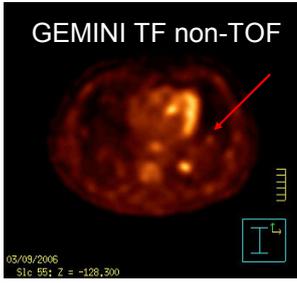
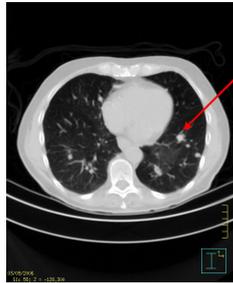
Non-TOF



6-to-1 contrast

Slide courtesy Joel Karp,  
University of Pennsylvania

**3x higher effective sensitivity**  
**same quality with fewer counts**



*improved  
detectability of  
small mets in lung*

67 kg; BMI = 29.0  
9.8 mCi; 1 hr post-inj.

Data courtesy of J. Karp, University of Pennsylvania

**TruFlight Technology – System design**

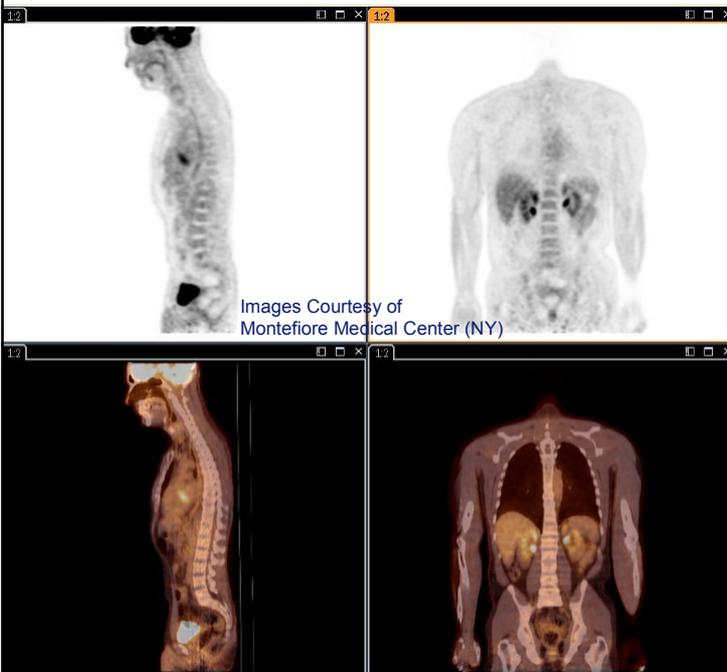
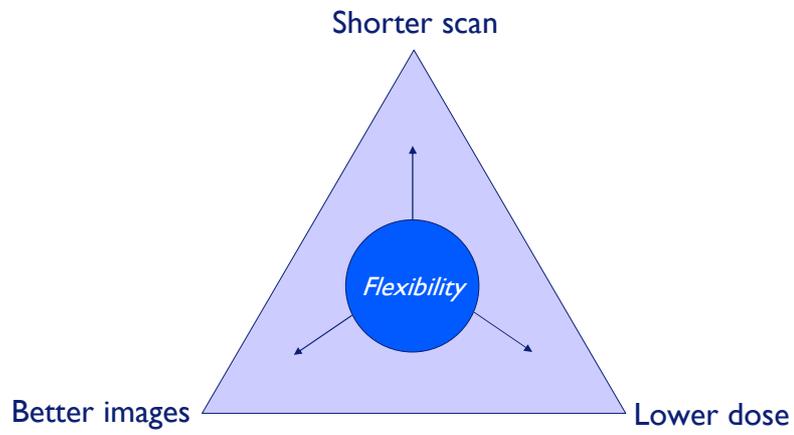
Implementation of time of flight technology

- Scintillator: Stopping power & Timing Resolution
- PMT: Timing and uniformity
- Detector: Resolution / encoding & Light collection
- Electronics: Calibration stability & Accuracy
- Reconstruction (required computer power)



- Time of flight technology requires innovative development in ALL elements of the system
- Each of these elements was addressed in the design of the GEMINI TF

Note: early ToF research systems built in the early 1980s did not address all these aspects and were not clinically viable.



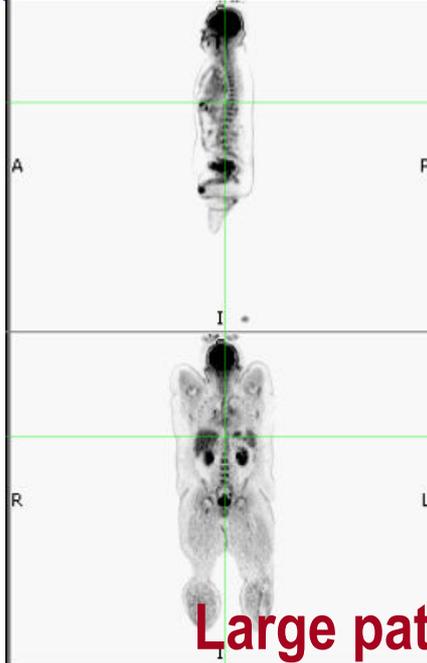
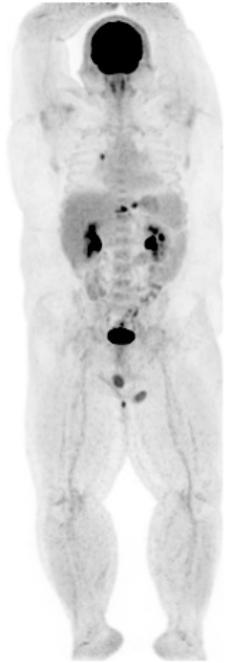
Images Courtesy of Montefiore Medical Center (NY)

- GEMINI TF PET/CT**
- 40 y.o. Male
  - 9.5 mCi / 351 MBq, 60 min uptake
  - **9 min PET Acquisition**
  - 74 kg / 163 lb Patient Weight
  - 140 kV, 50 mAs

**9 min**  
**very short scan time**

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GEMINI TF Patient Images



- GEMINI TF PET/CT**
- Colorectal cancer
  - 15.9 mCi, 60 min uptake
  - 17 min PET Acquisition, Total Body
  - 150 kg Patient Weight
  - 120 kV, 44 mAs

Images Courtesy of St. Louis University Hospital (MO)

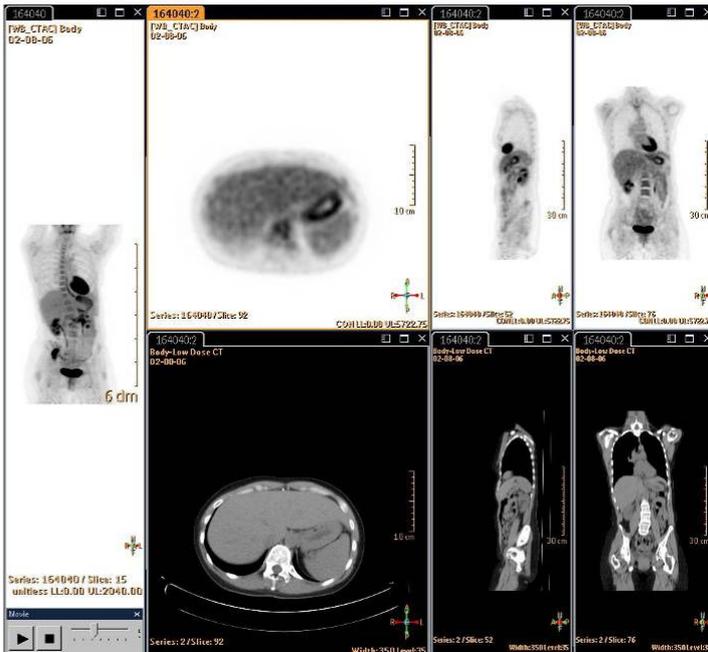
**1 min/bed**  
**150 kg**  
**Large patient, short time**

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GEMINI TF Patient Images

**Stomach.**  
**Scantime:**  
**1:30 min / bp**  
**Activity:**  
**176 MBq**  
**Scan 1 hour**  
**post injection**



After three days, mobile service was discontinued and doses reduced to less than half.

=> Low dose (4,7 mCi), standard uptake time, 15 min total acq time.

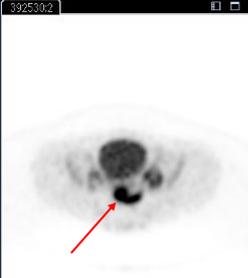
Images courtesy of AvL/NKI Amsterdam

**5 mCi**  
**very low dose**

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GEMINI TF Patient Images



Images Courtesy of University Hospitals, Cleveland



**GEMINI TF PET/CT**

- Female, Tumor evaluation
- 11 mCi / 407 MBq, 60 min uptake
- **18 min PET Acquisition**
- 113.4 kg / 250 lb Patient Weight
- 120 kV, 100 mAs

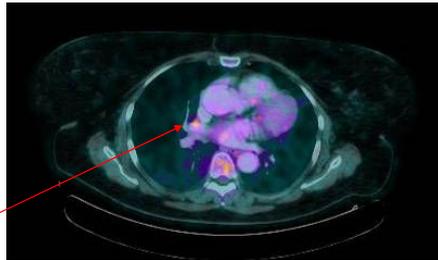


**113 kg**

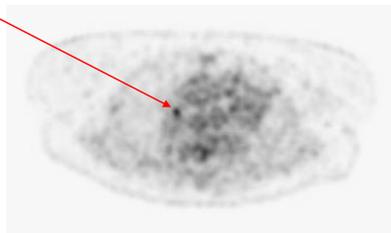
**Spectacular image quality in obese patients**

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GEMINI TF Patient Images



**1.9 mm**



67 y/o female  
**115 kg**, BMI 30  
180 MBq FDG, 60 min uptake  
**18 min PET Acquisition**

Metastatic disease incl. **1.9 mm** unsuspecting lymph node clearly visible on PET with SUV ~ 3

Scan Protocol:  
PET: 180 MBq FDG, 60 min uptake  
12 steps @ 90 s/step  
CT: 187 mAs, 120 kVp, 3 mm slices

**115 kg**  
**5 mCi**  
**1.9 mm**

Images courtesy of Brüder Krankenhaus Paderborn, Germany

**large patient, very low dose, small lesions**

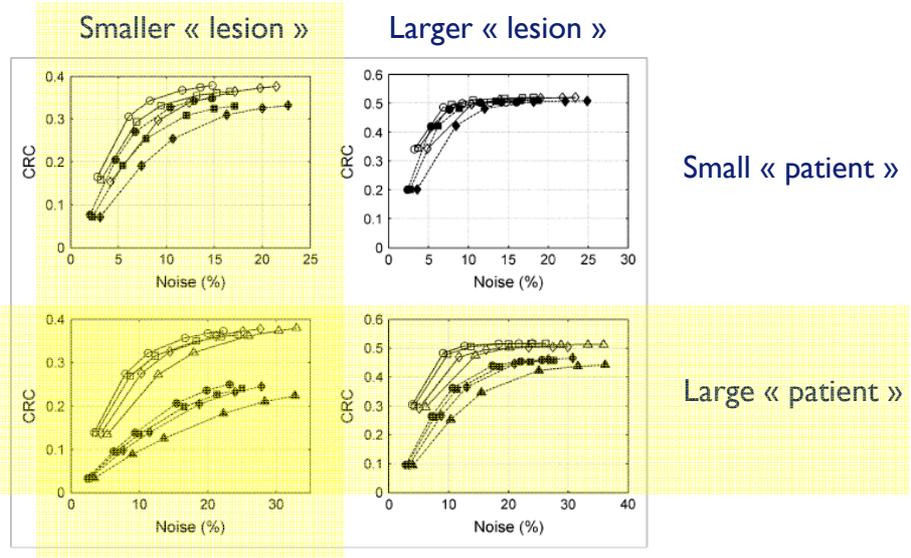


FIGURE 2. CRC vs. noise curves for 13-mm (left) and 17-mm (right) hot spheres with 6:1 contrast in 27-cm (top) and 35-cm (bottom) cylinders. Scan times on the Gemini TF scanner were 1 (◆, ◇), 2 (■, □), and 3 (●, ○) min (27-cm phantom) and 2 (▲, △), 3 (◆, ◇), 4 (■, □), and 5 (●, ○) min (35-cm phantom), with closed symbols for non-TOF and open symbols for TOF reconstruction as a function of number of iterations (1, 2, 5, 10, 15, and 20).

Karp et al, "Benefit of Time-of-Flight in PET," JNM Vol. 49, No 3, 2008

**CONCLUSION**

In this work, we have demonstrated that the benefit of TOF in PET seen in simulation carries through to measured phantom and patient studies. On the basis of our findings, we conclude that TOF leads to a better CRC versus noise trade-off in both phantoms and patients, but the TOF gain is not adequately expressed by a single gain factor, because the advantages of TOF are more than a simple increase in effective sensitivity. TOF reconstruction leads to a higher contrast recovery at matched noise with faster and more uniform convergence, and the benefit is even greater for larger patients. This article attempts to quantify the TOF benefit using clinical data and shows results that are con-

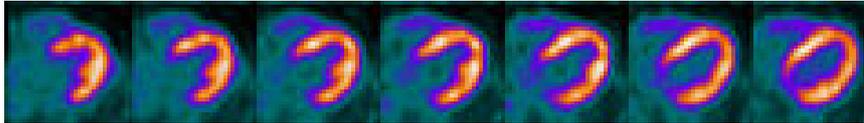
Karp et al, "Benefit of Time-of-Flight in PET," JNM Vol. 49, No 3, 2008

Recon delay = 180 s

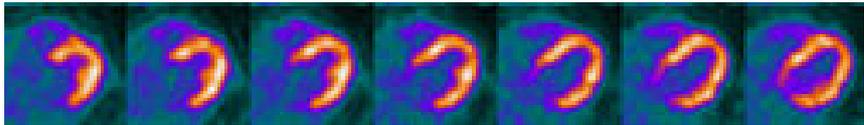
Counts =  $63 \times 10^6$

RAMLA 3D recon

CNR = 6.2



BMI = 30  
50 mCi Rb-82  
different delays p.i.



ToF yields equivalent image quality with one-fifth of the counts as RAMLA 3D

Recon delay = 300 s

Counts =  $12 \times 10^6$

ToF recon

CNR = 7.0

**needs 5x fewer counts**  
**Improved cardiac workflow**

WIP

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**Brilliance Big Bore CT**

- 85cm aperture
- 60cm standard FOV
- BB CT features

**RTP Workflow**

- CT sim protocols
- PET/CT sim protocols
- Respiratory gating
- RTP Accessories
- Connectivity

**Radiation Oncology Table**

- AAPM TG-66 compliant
- 53cm integrated flat table
- 500 lb (227 kg) capacity
- Low patient loading position

**OpenView**

- Open gantry
- Separation

**GEMINI TF PET**

- Time-of-Flight
- 4x4mm LYSO detector
- 85cm aperture

**FDA 510k Cleared**

**RTP Connectivity**

**Brilliance Big Bore CT Simulation Capabilities**

**TG-66 Positional Accuracy**

**Philips Oncology Expertise**

**GEMINI TF TOF PET functional imaging**

**OpenView Gantry**

**PET/CT Pulmonary toolkit**

**Diagnostic PET/CT imaging**

**Tumour Track & Follow-up**

**Everything in one system:**  
Anatomic and Biologic simulation combined into one system

**Designed for radiation oncology needs, with support for diagnostic image quality**

- **GEMINI TF:**  
Highest performance technology for the most demanding PET/CT Applications :
  - increase diagnostic confidence,
  - boost workflow,
  - address larger patient population,
  - support out-of-the-ordinary research studies.
- Future-safe platform for further technological advances.

## **GEMINI TF™ PET/CT.**

The new benchmark in speed, comfort, clarity and flexibility.

