

**ANTHROPOMORPHIC
VOXEL PHANTOMS:
BEYOND ORGAN SHAPES & SIZES**

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**UNIVERSITY OF
SURREY**



OUR PERCEPTION OF *HIGH-TECH*

ABCDEF

ALIASSED STEP
ARTEFACTS OFTEN
PATRONIZED AS
THE COMPUTERNESS
WITH
THE ELECTRONIC FEEL

ABCDEF

THIS IS IN FACT
HIGHER-TECH
MY FIRST COMPUTER
COULD NOT HAVE
DONE THIS

THE DEVIL'S ADVOCATE

ABCDEF



VOXEL PHANTOMS
ARE PROBABLY NOT
THE ULTIMATE

ABCDEF

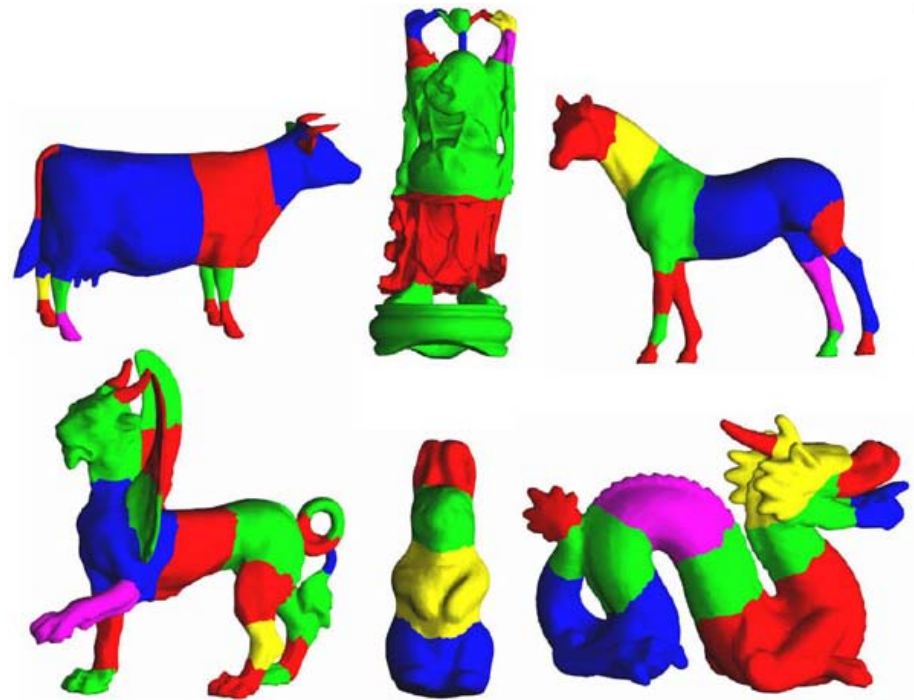
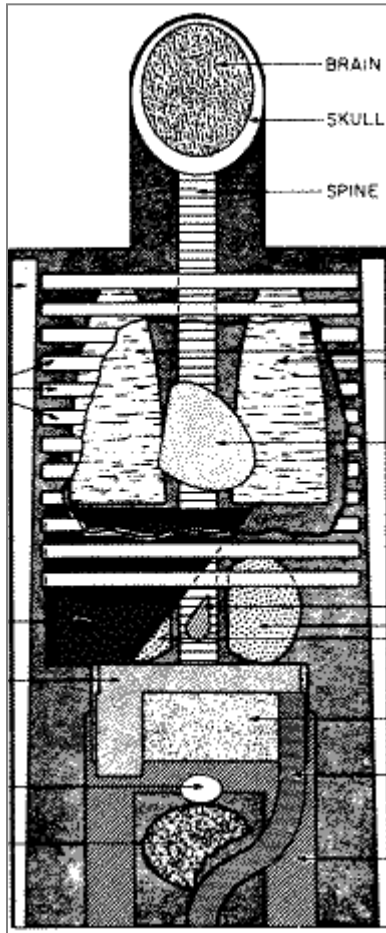
SO WHAT IS WRONG
WITH
MATHEMATICAL
PHANTOMS?

MISLEADING ASSOCIATION

MIRD

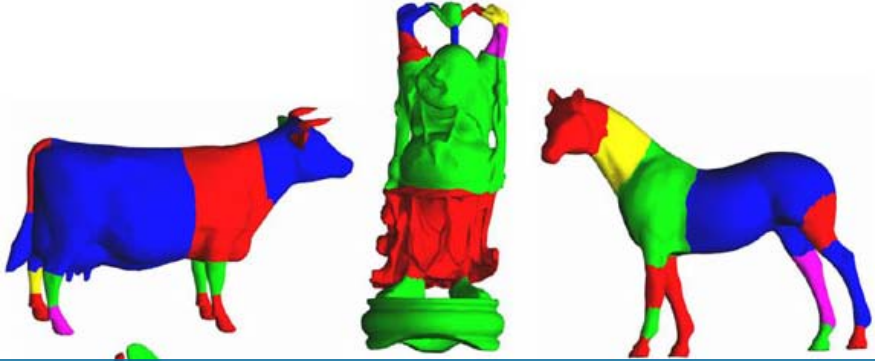
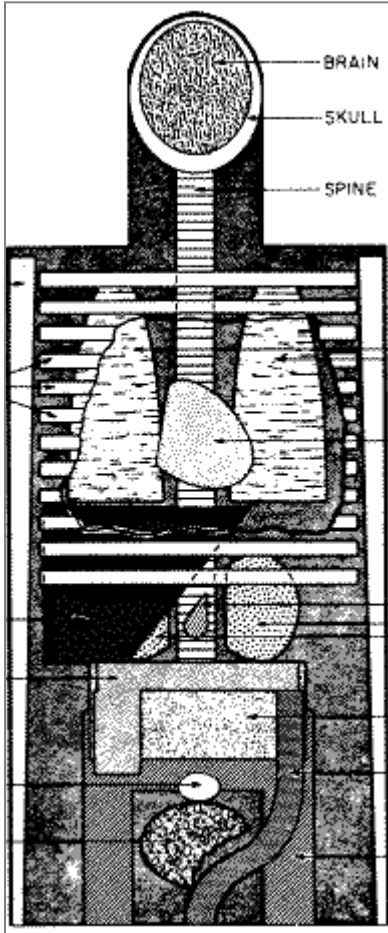
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MATHEMATICAL PHANTOMS



Eugene Zhang *et al* 2005 *Feature-based surface parameterization and texture mapping*
ACM Trans Graphics

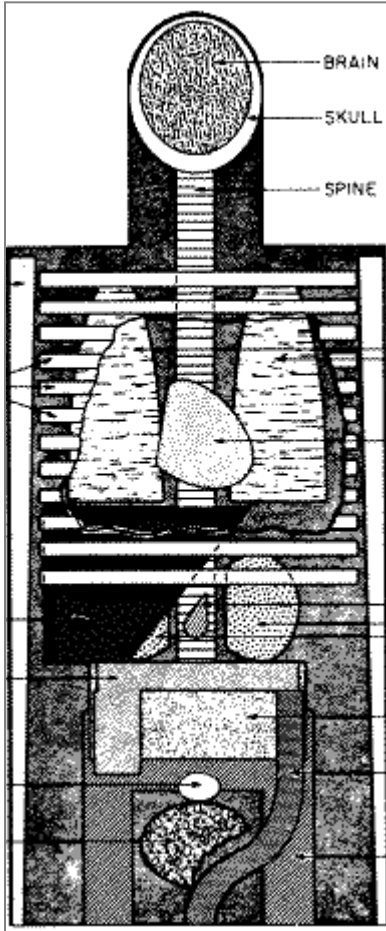
MISLEADING ASSOCIATION



IF MATH CAN DESCRIBE
THE LAUGHING GOD
WHY CAN'T IT
DESCRIBE OUR LIVER
OR SPLEEN?

Engene Zhang et al 2005 Feature-based
surface parameterization and texture mapping
ACM Trans Graphics

MISLEADING ASSOCIATION



AUTOCAD WORKS
NOT WITH
VOXELS BUT
MATH
EQUATIONS &
PARAMETERS

BOUNDARY, BOUNDARY BOUNDARIES!

(u, v, w) NO CHANGE
IN DIRECTION

3000	1	40	1	199	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.00000E+00
-0.11700E+02	-0.87718E+01	0.12289E+02	64	0	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.16498E+00
3000	2	11	0	1	199	64	0	0.10000E+01	0.00000E+00	0.00000E+00
-0.11400E+02	-0.87718E+01	0.12289E+02	64	0	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.38495E+00
3000	3	11	0	1	199	64	0	0.10000E+01	0.00000E+00	0.00000E+00
-0.11000E+02	-0.87718E+01	0.12289E+02	64	0	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.60493E+00
3000	4	11	0	1	199	64	0	0.10000E+01	0.00000E+00	0.00000E+00
-0.10600E+02	-0.87718E+01	0.12289E+02	64	0	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.82490E+00
3000	5	11	0	1	199	64	0	0.10000E+01	0.00000E+00	0.00000E+00
-0.10200E+02	-0.87718E+01	0.12289E+02	64	0	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.10449E+01
3000	6	11	0	1	199	64	0	0.10000E+01	0.00000E+00	0.00000E+00
-0.98000E+01	-0.87718E+01	0.12289E+02	64	0	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.12648E+01
3000	7	11	0	1	199	64	0	0.10000E+01	0.00000E+00	0.00000E+00
-0.94000E+01	-0.87718E+01	0.12289E+02	64	0	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.14848E+01
3000	8	11	0	1	199	64	0	0.10000E+01	0.00000E+00	0.00000E+00
-0.90000E+01	-0.87718E+01	0.12289E+02	64	0	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.17048E+01
3000	9	11	0	1	199	64	0	0.10000E+01	0.00000E+00	0.00000E+00
-0.86000E+01	-0.87718E+01	0.12289E+02	64	0	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.19248E+01
3000	10	11	0	1	199	64	0	0.10000E+01	0.00000E+00	0.00000E+00
-0.82000E+01	-0.87718E+01	0.12289E+02	64	0	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.21447E+01
3000	11	11	0	1	199	64	0	0.10000E+01	0.00000E+00	0.00000E+00
-0.78000E+01	-0.87718E+01	0.12289E+02	64	0	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.23647E+01
3000	12	11	0	1	199	64	0	0.10000E+01	0.00000E+00	0.00000E+00
-0.74000E+01	-0.87718E+01	0.12289E+02	64	0	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.25847E+01
3000	13	11	0	1	199	64	0	0.10000E+01	0.00000E+00	0.00000E+00
-0.70000E+01	-0.87718E+01	0.12289E+02	64	0	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.28047E+01
3000	14	11	0	1	199	64	0	0.10000E+01	0.00000E+00	0.00000E+00
-0.66000E+01	-0.87718E+01	0.12289E+02	64	0	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.30246E+01
3000	15	11	0	1	199	64	0	0.10000E+01	0.00000E+00	0.00000E+00
-0.62000E+01	-0.87718E+01	0.12289E+02	64	0	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.32446E+01
3000	16	11	0	1	199	64	0	0.10000E+01	0.00000E+00	0.00000E+00
-0.58000E+01	-0.87718E+01	0.12289E+02	64	0	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.34646E+01
3000	17	11	0	1	199	64	0	0.10000E+01	0.00000E+00	0.00000E+00
-0.54000E+01	-0.87718E+01	0.12289E+02	64	0	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.36846E+01
3000	18	11	0	1	199	64	0	0.10000E+01	0.00000E+00	0.00000E+00
-0.50000E+01	-0.87718E+01	0.12289E+02	64	0	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.39045E+01
3000	19	11	0	1	199	64	0	0.10000E+01	0.00000E+00	0.00000E+00
-0.46000E+01	-0.87718E+01	0.12289E+02	64	0	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.39045E+01

BOUNDARY BOUNDARY, BOUNDARIES!

(x, y, z) ONLY X
CHANGED

JUST WASTING
TIME

	4	0							
0.11700E+02 -0.87718E+01 0.12289E+02	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.00000E+00			
3000 2 11 0 1 199 64 0									
0.11400E+02 -0.87718E+01 0.12289E+02	0.10000E+01	0.00000E+00	0.00000E+00	.17284E-01	0.10000E+01	0.16498E+00			
3000 3 11 0 1 199 64 0									
0.11000E+02 -0.87718E+01 0.12289E+02	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.38495E+00			
3000 4 11 0 1 199 64 0									
0.10600E+02 -0.87718E+01 0.12289E+02	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.60493E+00			
3000 5 11 0 1 199 64 0									
0.10200E+02 -0.87718E+01 0.12289E+02	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.82490E+00			
3000 6 11 0 1 199 64 0									
0.98000E+01 -0.87718E+01 0.12289E+02	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.10449E+01			
3000 7 11 0 1 199 64 0									
0.94000E+01 -0.87718E+01 0.12289E+02	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.12648E+01			
3000 8 11 0 1 199 64 0									
0.90000E+01 -0.87718E+01 0.12289E+02	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.14848E+01			
3000 9 11 0 1 199 64 0									
0.86000E+01 -0.87718E+01 0.12289E+02	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.17048E+01			
3000 10 11 0 1 199 64 0									
0.82000E+01 -0.87718E+01 0.12289E+02	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.19248E+01			
3000 11 11 0 1 199 64 0									
0.78000E+01 -0.87718E+01 0.12289E+02	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.21447E+01			
3000 12 11 0 1 199 64 0									
0.74000E+01 -0.87718E+01 0.12289E+02	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.23647E+01			
3000 13 11 0 1 199 64 0									
0.70000E+01 -0.87718E+01 0.12289E+02	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.25847E+01			
3000 14 11 0 1 199 64 0									
0.66000E+01 -0.87718E+01 0.12289E+02	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.28047E+01			
3000 15 11 0 1 199 64 0									
0.62000E+01 -0.87718E+01 0.12289E+02	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.30246E+01			
3000 16 11 0 1 199 64 0									
0.58000E+01 -0.87718E+01 0.12289E+02	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.32446E+01			
3000 17 11 0 1 199 64 0									
0.54000E+01 -0.87718E+01 0.12289E+02	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.34646E+01			
3000 18 11 0 1 199 64 0									
0.50000E+01 -0.87718E+01 0.12289E+02	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.36846E+01			
3000 19 11 0 1 199 64 0									
0.46000E+01 -0.87718E+01 0.12289E+02	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.39045E+01			

BOUNDARY, BOUNDARY, BOUNDARIES!

3000	1	40	1	199	64	0	-0.11700E+02	-0.87718E+01	0.12289E+02	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.00000E+00	
3000	2	11	0	1	199	64	0	-0.11400E+02	-0.87718E+01	0.12289E+02	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.16498E+00
3000																
3000																
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3000	6	11	0	1	199	64	0	-0.98000E+01	-0.87718E+01	0.12289E+02	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.10449E+01
3000	7	11	0	1	199	64	0	-0.94000E+01	-0.87718E+01	0.12289E+02	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.12648E+01
3000	8	11	0	1	199	64	0	-0.90000E+01	-0.87718E+01	0.12289E+02	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.14848E+01
3000	9	11	0	1	199	64	0	-0.86000E+01	-0.87718E+01	0.12289E+02	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.17048E+01
3000	10	11	0	1	199	64	0	-0.82000E+01	-0.87718E+01	0.12289E+02	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.19248E+01
3000	11	11	0	1	199	64	0	-0.78000E+01	-0.87718E+01	0.12289E+02	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.21447E+01
3000	12	11	0	1	199	64	0	-0.74000E+01	-0.87718E+01	0.12289E+02	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.23647E+01
3000	13	11	0	1	199	64	0	-0.70000E+01	-0.87718E+01	0.12289E+02	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.25847E+01
3000	14	11	0	1	199	64	0	-0.66000E+01	-0.87718E+01	0.12289E+02	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.28047E+01
3000	15	11	0	1	199	64	0	-0.62000E+01	-0.87718E+01	0.12289E+02	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.30246E+01
3000	16	11	0	1	199	64	0	-0.58000E+01	-0.87718E+01	0.12289E+02	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.32446E+01
3000	17	11	0	1	199	64	0	-0.54000E+01	-0.87718E+01	0.12289E+02	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.34646E+01
3000	18	11	0	1	199	64	0	-0.50000E+01	-0.87718E+01	0.12289E+02	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.36846E+01
3000	19	11	0	1	199	64	0	-0.46000E+01	-0.87718E+01	0.12289E+02	0.10000E+01	0.00000E+00	0.00000E+00	0.17284E-01	0.10000E+01	0.39045E+01

ALL ARE SURFACE-CROSSING EVENTS!



WHAT IS THE OPTIMUM RESOLUTION?

SOME PARTS OF THE BODY ARE
MORE HOMOGENEOUS (eg LIVER)
THAN THE REST (eg BONE)



TISSUE COMPOSITION

DESCRIPTIONS WHICH MAKE NO SENSE TO RADIATION PHYSICS

id	organ	id	organ	id	organ
0	outside phantom	81	horn of mandible	96	hippocampus
1	skin	82	nasal septum	97	pituitary gland
2	cerebral fluid	83	white matter	98	fat
3	spinal cord	84	superior sagittal sinus	99	uncus (ear bones)
4	skull	85	medulla oblongata	100	turbinates
5	spine	22	fat	101	caudate nucleus
70	dens of axis	23	blood pool	102	zygoma
71	jaw bone	89	frontal lobes	103	insula cortex
72	parotid gland	26	bone marrow	104	sinuses/mouth cavity
9	skeletal muscle	91	pons	105	putamen
74	lacrimal glands	92	third ventricle	106	optic nerve
75	spinal canal	29	trachea	107	internal capsule
76	hard palate	30	cartilage	108	septum pellucidum
77	cerebellum	95	occipital lobes	109	thalamus
78	tongue			110	eyeball
15	pharynx			111	corpus collosum
16	esophagus			112	special region frontal lobes
				113	cerebral falx
				114	temporal lobes
				115	fourth ventricle
				116	frontal portion eyes
				117	parietal lobes
				118	amygdala
				119	eye
				120	globus pallidus
				121	lens
				122	cerebral aqueduct
				123	lateral ventricles
				124	prefrontal lobes
				125	teeth



DESCRIPTIONS WHICH MAKE NO SENSE TO RADIATION PHYSICISTS

id	organ	id	organ	id	organ
0	outside phantom	81	horn of mandible	96	hippocampus
1	skin	87	hypopharynx	113	cerebral falx
2	cornea	90	nasopharynx	114	lobes
3	spine	91	uvula	115	ventricle
4	skin	92	uvula	116	portion eyes
5	spine	93	uvula	117	lobes
70	dentures	94	uvula	118	a
71	jaw	95	occipital lobes	119	allidus
72	palate	100	trachea	120	aqueduct
9	skin	101	trachea	121	ventricles
74	larynx	102	trachea	122	al lobes
75	spine	103	trachea	123	
76	hard palate	29	trachea	108	septum pellucidum
77	cerebellum	30	cartilage	125	teeth
78	tongue	95	occipital lobes	109	thalamus
15	pharynx			110	eyeball
16	esophagus			111	corpus collosum
				112	special region frontal lobes

GREAT TEACHING MATERIAL FOR THE CLASSROOM

BUT MAKE NO SENSE TO MONTE CARLO CODES

THIS IS WHAT WE NEED FOR RADIATION PHYSICS

CLASSIFICATION OF THE ELEMENTS FOUND IN HUMAN TISSUES

Structural elements	Electrolyte elements	Trace elements		
		Biologically important	Toxic	Others
Carbon	Calcium	Group 1	Potentially toxic	Silver
Calcium*	Chlorine	Cobalt	Arsenic	Aluminum
Hydrogen	Potassium	Chromium	Beryllium	Gold
Nitrogen	Magnesium	Copper	Cadmium	Boron
Oxygen	Sodium	Iron	Mercury	Barium
Phosphorus	(Bicarbonate	Iodine	Lead	Bismuth
Sulfur	Sulfate	Manganese	Selenium	Bromine
	Phosphate)	Molybdenum	Thallium	Cerium
		Selenium		Cesium
		Zinc	Major environmental contaminants	Gallium
		Group 2		Germanium
		Arsenic	Cadmium	Lithium
		Fluorine	Mercury	Neptunium
		Nickel	Lead	Platinum
		Silicon		Rare earths
		Tin	Industrial hazards	Rubidium
		Vanadium		Scandium
			Arsenic	Strontium
			Beryllium	Tellurium
			Chromium	Thorium
			Mercury	Titanium
			Manganese	Uranium
			Nickel	Tungsten
			Lead	Zirconium
			Antimony	
			Silicon	



ELEMENTAL COMPOSITION OF THE BODY LACK OF DATA

YES

WE HAVE ICRP PUBLICATION 23 (1975)

BUT

VALUES ARE BASED ON DEAD BODIES

WE HAVE SO FAR BEEN REPRESENTED BY
CADAVERS

ICRP REFERENCE PHANTOM TO BE
RELEASED NEXT YEAR



ELEMENTAL COMPOSITION OF THE BODY LACK OF DATA

BY STATING, "RESULTS WERE
CALCULATED BASED ON ICRP23
VALUES" PAPERS ARE NOT IMMUNED
FROM BEING QUESTIONED

WE HAVE SO FAR BEEN REPRESENTED BY
CADAVERS



WIDE VARIATION IN TISSUE COMPOSITION

ASH / DRY / WET

HE / SHE

AGE

DIET

METABOLIC CONDITIONS

EVEN THE SAME PERSON

CAN HAVE DIFFERENT

COMPOSITION AT DIFFERENT

TIMES OF THE DAY

DOES IT MATTER?

$$R = \frac{\sigma_T C}{A_w}$$

TRACE
ELEMENTS
CANNOT BE
DISMISSED AS
NEGLIGIBLE

The diagram illustrates the equation for reaction rate R . The equation is $R = \frac{\sigma_T C}{A_w}$. Each term is labeled with a teal box and an arrow pointing to it: σ_T is labeled 'TOTAL CROSS-SECTION', C is labeled '% PER GRAM', and A_w is labeled 'ATOMIC WEIGHT'. The entire equation is labeled 'REACTION RATE'.

$$R = \frac{\sigma_T C}{A_w}$$

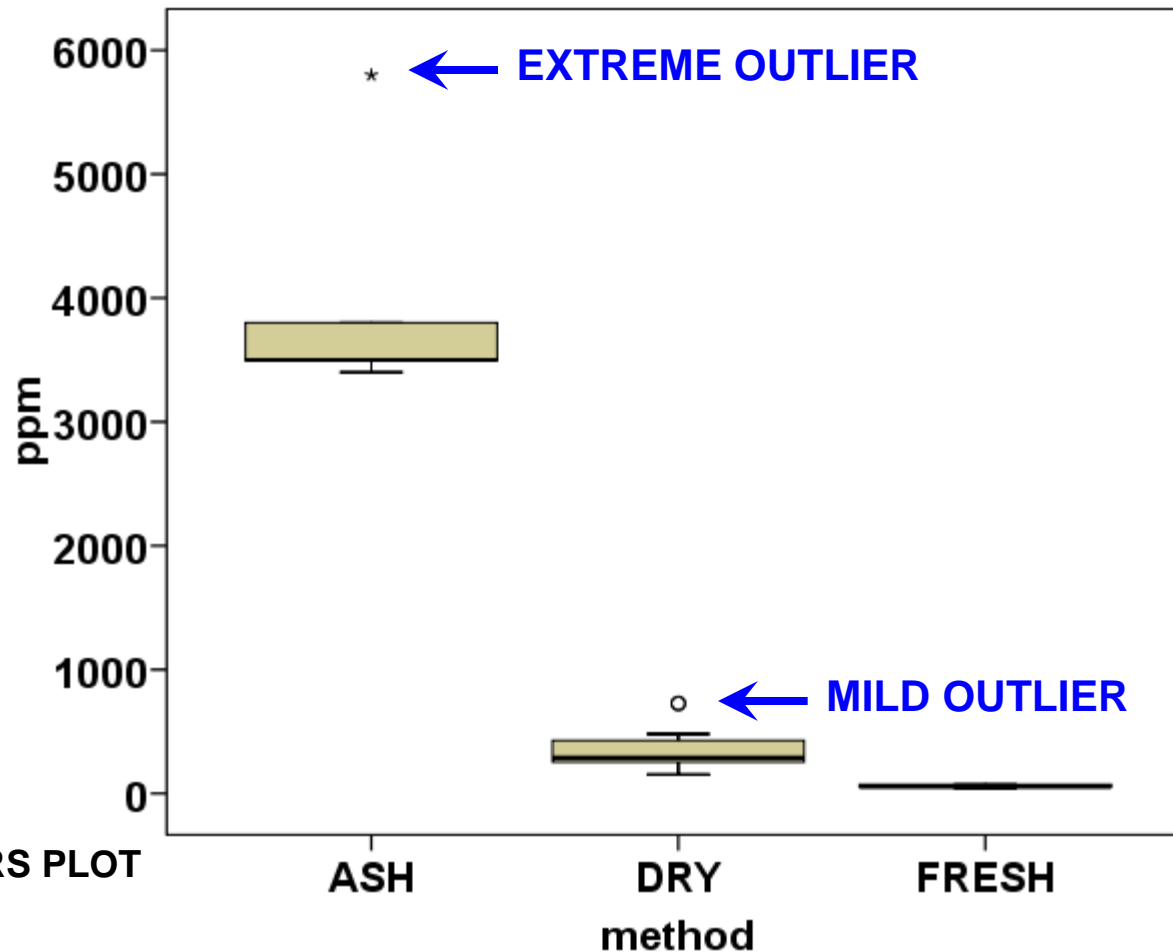
TOTAL CROSS-SECTION

% PER GRAM

REACTION RATE

ATOMIC WEIGHT

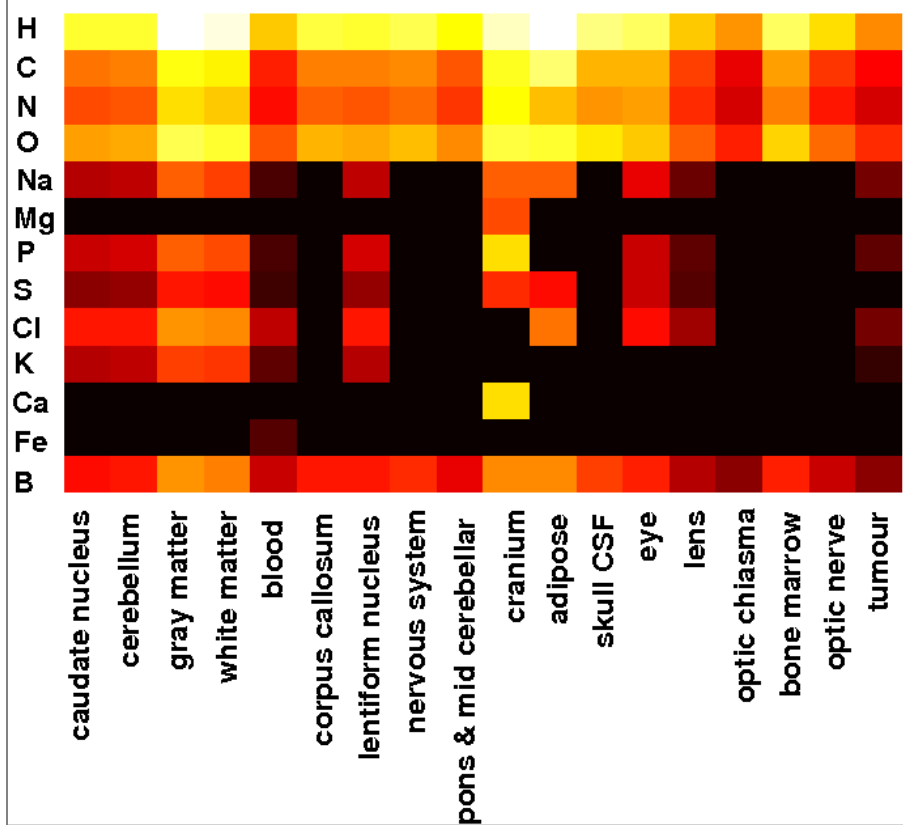
UNCERTAINTIES DUE TO LIMITED DATA ON ELEMENTAL COMPOSITION



IRON IN BRAIN

Data extracted from Iyengar *The Elemental Composition of Human Tissues and Body Fluids*
Verlag Chemie (Weinheim) 1978

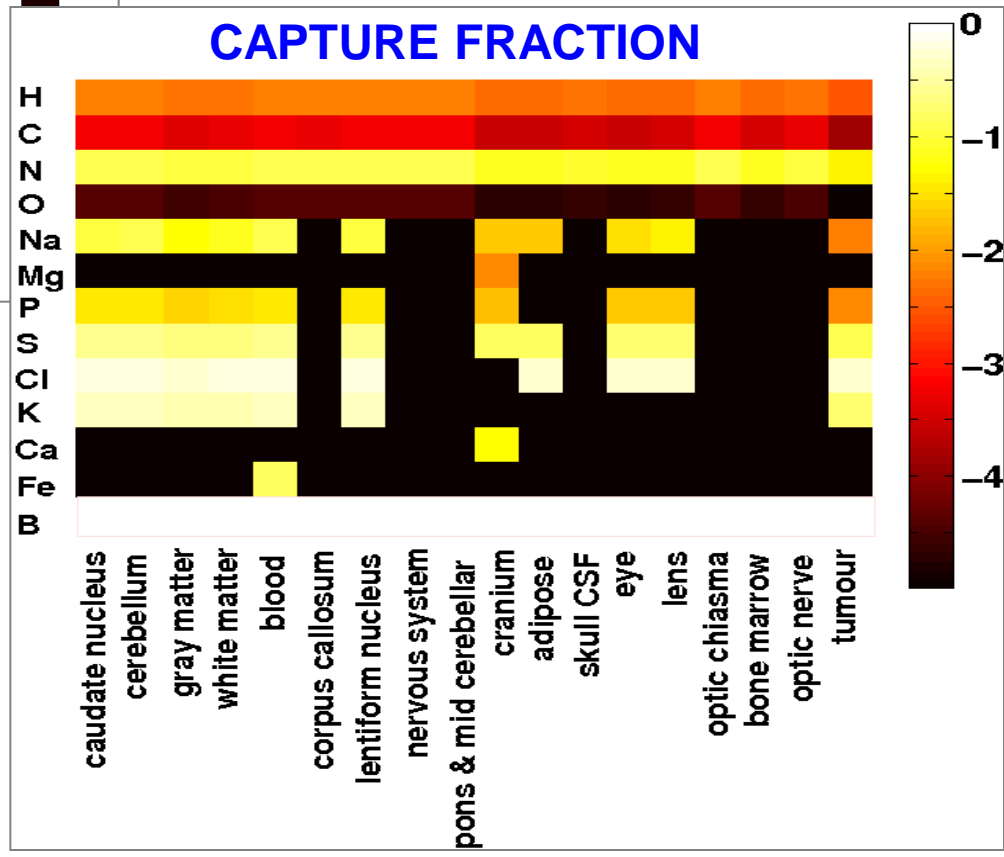
NEUTRON COLLISIONS



EXAMPLE: BORON
NEUTRON CAPTURE
THERAPY (BNCT)
OF THE BRAIN

EVEN MINOR & TRACE
ELEMENTS PLAY
SIGNIFICANT ROLES
IN RADIATION
TRANSPORT

CAPTURE FRACTION



THE 'ANCIENT' TEXT
THAT GOT IT RIGHT

THE CHEMISTRY OF THE BLOOD OF NORMAL CHICKENS

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In an investigation of the effect of the Rous sarcoma no. 1 upon the chemistry of the blood of hens (Roe and Dyer, '30, '31; Dyer and Roe, '32), it was necessary to establish normal values by determining the constituents of the blood of control hens. Since the literature contains very little information upon the blood chemistry of hens and hens are used rather extensively in certain types of experimental work, the authors feel that a published summary of their findings will be of value. In this paper we are reporting a summary of chemical

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The hens used were of the Barred Plymouth Rock strain and were obtained from market stock. Their average weight was approximately 2 kg. They were kept on a diet of water and 'scratch feed,' which is a commercial preparation of cracked corn, wheat, barley, buckwheat, milo maize, and sunflower seed. All analyses were performed after the hens had been fasted for approximately 24 hours.

The methods of analysis were thoroughly tested and sufficient analytical skill to obtain reproducible results was developed before undertaking the study of a blood constituent. Because of the undesirable influence of excessive bleeding,

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VOXEL DEFINITION

TISSUE TYPE



ELEMENTAL
COMPOSITION

MOST MONTE CARLO
WORK STOP HERE



ISOTOPIC
COMPOSITION

NOT FORGETTING
NEUTRONS



CHEMICAL BINDING
& STRUCTURE

NOT FORGETTING
POSITRONS

ZUBAL vs VIP-MAN,
MAX, FAX,
NORMAN, MIRD, ...

THE NEED FOR
(THE LACK OF)
CONTROLLED
EXPERIMENTS

Whether the effective dose (E) per unit fluence differs between anthropomorphic phantoms X and Y depends on the following variables (see the annotated equation). As Ali pointed out, some papers say X and Y produce the same results whereas other papers report the contrary. To nail down the discrepancy, each variable should be studied in isolation. Simulations should be done by allowing only one variable to vary, while keeping all the others constant. Note: such controlled investigations have not been done in existing comparative studies / published papers.

$$E = \sum_T w_T \left(\sum_R w_R D_{T,R} \right)$$

(I)

Different sets of values recommended by different ICRP revisions.

Different criteria in excluding and including certain organs (e.g. which are 'designated' and which are 'remaining').

Different assumptions with respect to male vs female (e.g. averaging testes and ovaries!)

(II)

Different sets of values recommended by different ICRP revisions.

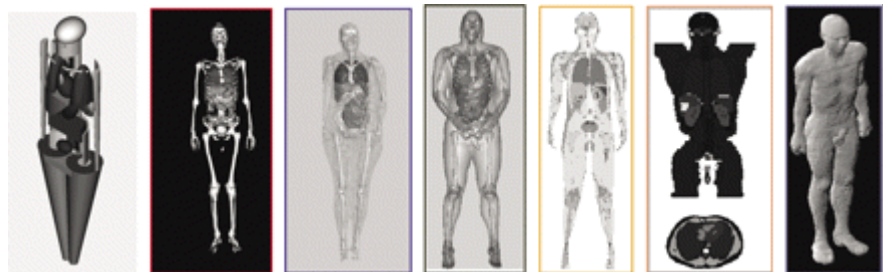
This is the emphasis I hammered into Hussien's paper at ANS 2007. It is a hot issue because:

- of the recent official release of ICRP103
- ICRP revisions have been dramatic for neutrons

(III)

This factor should be further broken down into:

- MCNPX transport settings (e.g. light water treatment for thermal neutrons)
- cross-sections (e.g. which evaluation)
- anthropomorphic phantoms in the aspect of organ shape and size
- anthropomorphic phantom in the aspect of tissue composition
- heterogeneity within an organ itself



ADAM, GOLEM, DONNA, VIP-MAN, MAX, VOXELMAN, NORMAN

*Will the ICRP
Reference Phantom
2009 provide an
answer?*

Magic words for grant application?



EXTRAPOLATIONS

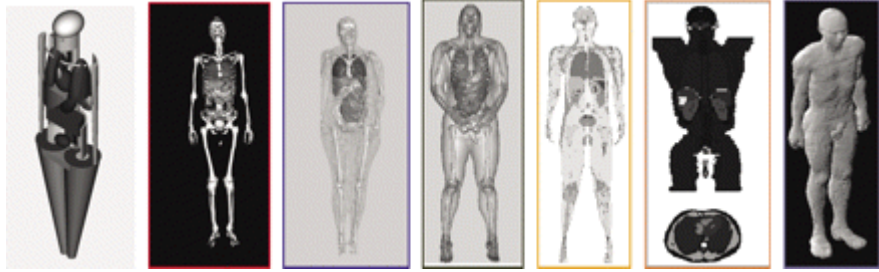
POPULATION
MEDICINE

LONG WAY TO GO



PERSONALISED
MEDICINE

BEYOND ORGAN SHAPES & SIZES



ADAM, GOLEM, DONNA, VIP-MAN, MAX, VOXELMAN, NORMAN

HE / SHE
PREGNANT
SITTING
BREATHING
AFRICAN
KOREAN
GERMAN
JAPANESE
CHINESE

POSTURE & MOTION BUT NOT COMPOSITION!

THE LIST IS
GROWING

THE FAMILY IS
PROLIFERATING

BUT THEN
EFFORTS ARE
CONCENTRATED
ON GEOMETRIES

WE NEED MORE
DATA ON TISSUE
COMPOSITION

WE NEED TO ZOOM
INTO THE VOXEL

LEARNING FROM OUR NEIGHBOURS THE BIOLOGISTS

OUR FIELD COULD ADVANCE
MORE EFFICIENTLY IF WE
SHARE MORE, AND SET
STANDARDS TO TALK IN A
UNIFIED LANGUAGE...

It is crucial that individual research groups are able to exchange their models and create commonly accepted repositories and software environments that are available to all. **Systems Biology Markup Language (SBML; <http://www.sbml.org/>), CellML (<http://www.cellml.org/>) and the Systems Biology Workbench** are examples of efforts that aim to form a *de facto* standard and open software platform for modelling and analysis^{11,12}. These significantly increase the value of the new generation of databases concerned with biological pathways, such as the Kyoto

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insight overview

DATA SHARING

in genomics & proteomics

Condition of publication Journals

require authors to submit sequence data to one of the public databases:

- GenBank
- EMBL (European Molecular Biology Laboratory) Database
- DDBJ (DNA Databank of Japan)

The three form the International Nucleotide Sequence Database Collaboration (INSDC)

PHYSICISTS ARE NOT THERE YET

COMPUTATIONAL PHYSICS

**We started off earlier
(spurred by the bombs)**

Mostly FORTRAN

Equations, equations, ...

**Monte Carlo: use statistics
to reach convergence for
stochastic processes**

?

COMPUTATIONAL BIOLOGY

**Bioinformatics is younger
(spurred by the human
genome sequence)**

Object-oriented: JAVA!

Data, data, data, ...

**Use statistics to discover
patterns in a far noisier
background**

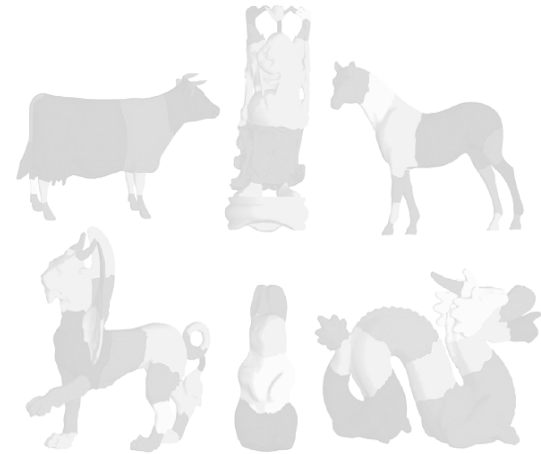
**Data sharing, organisation
and coordination –
international community**



ABCDEF



ABCDEF



Eugene Zhang *et al* 2005
*Feature-based surface
parameterization and
texture mapping* ACM Trans
Graphics

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