



extending quality life
equal

Improving inclusive design by understanding the biomechanical and psychological performance of older adults.

EPSRC

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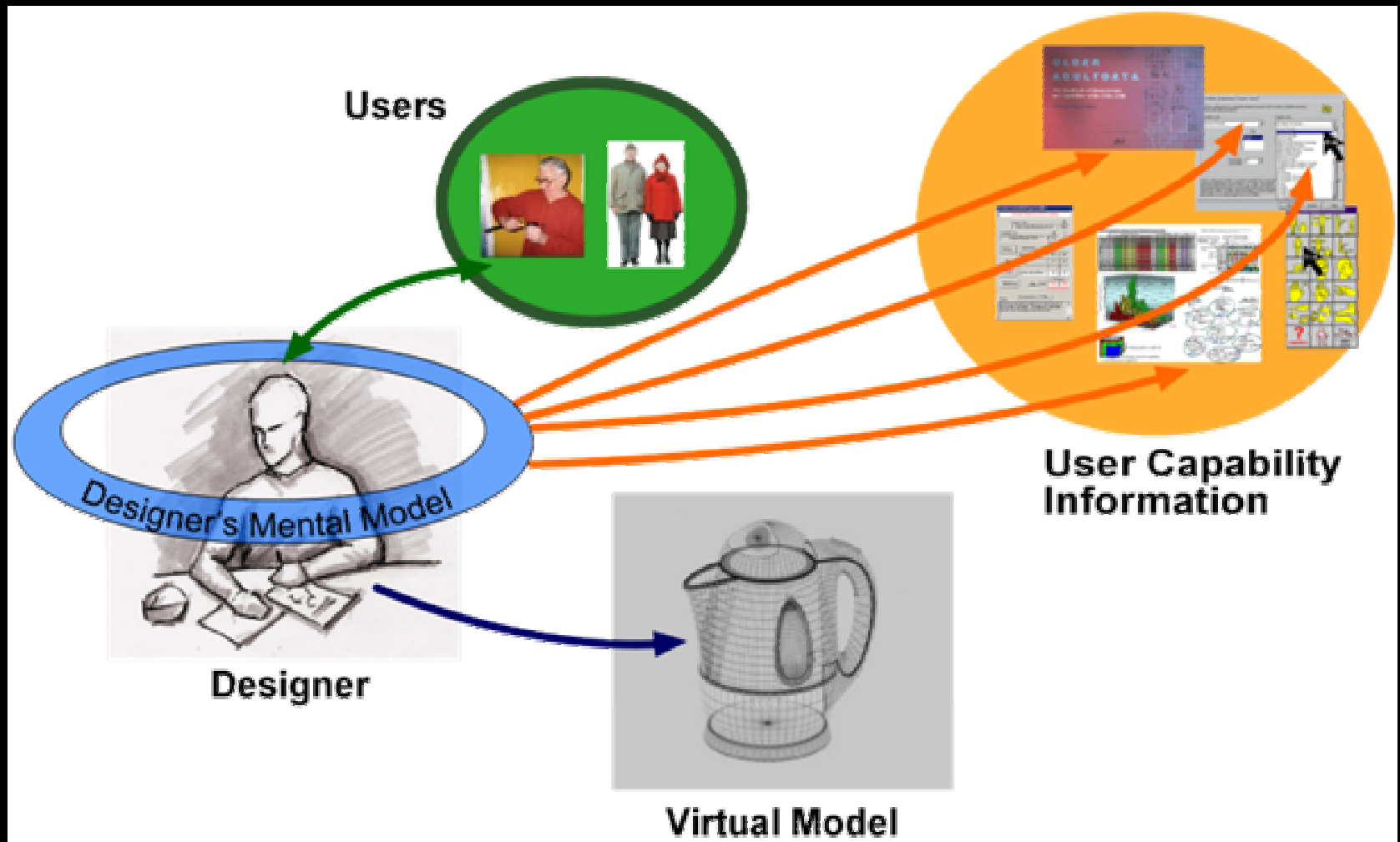
Is it fair to exclude people?



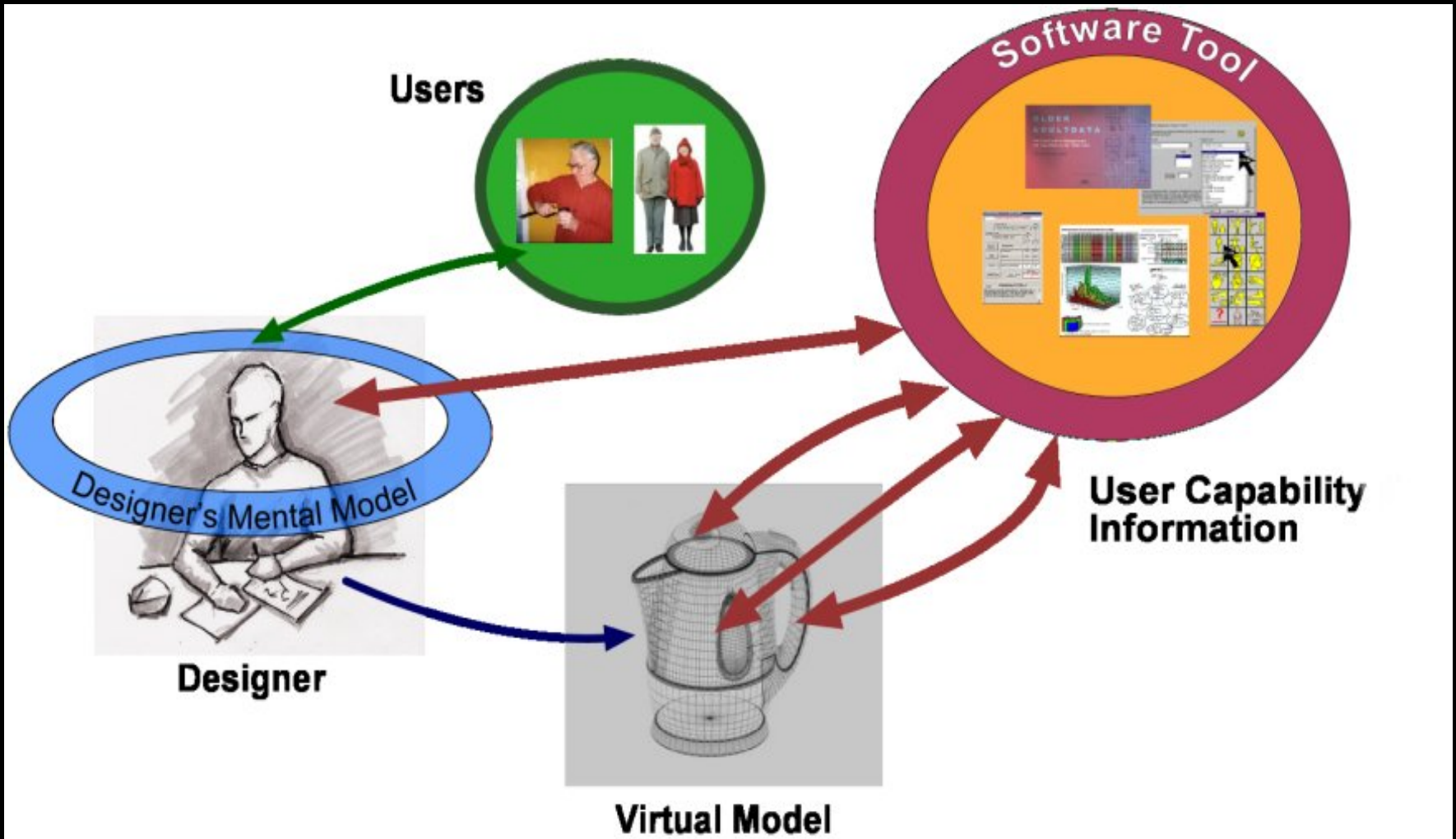
Inclusive Design

- a design approach to prevent *unintentionally* excluding those with impaired capabilities from using products through *lack of consideration* of their needs and wants.

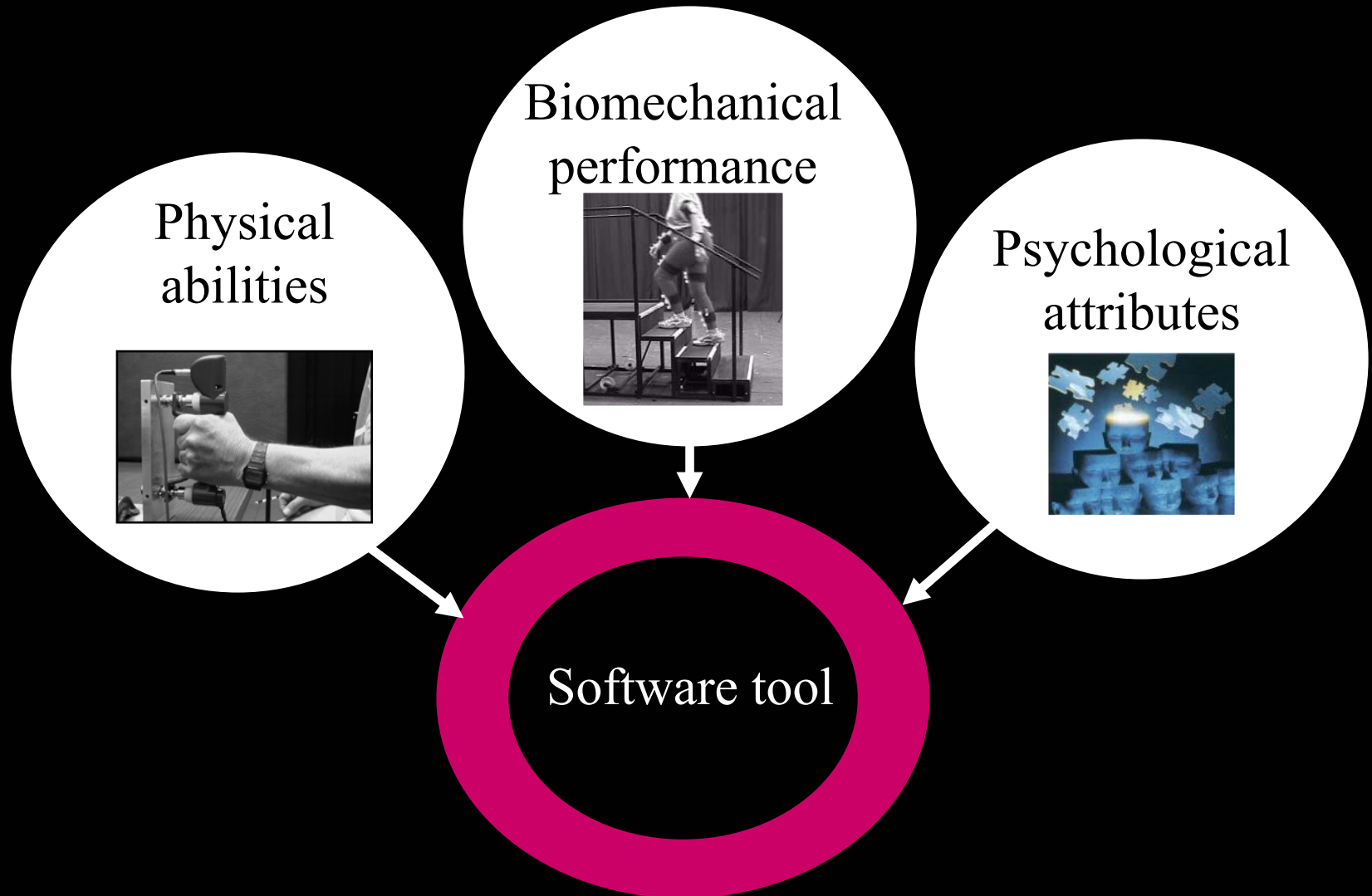
Current situation for designer



Alternative situation



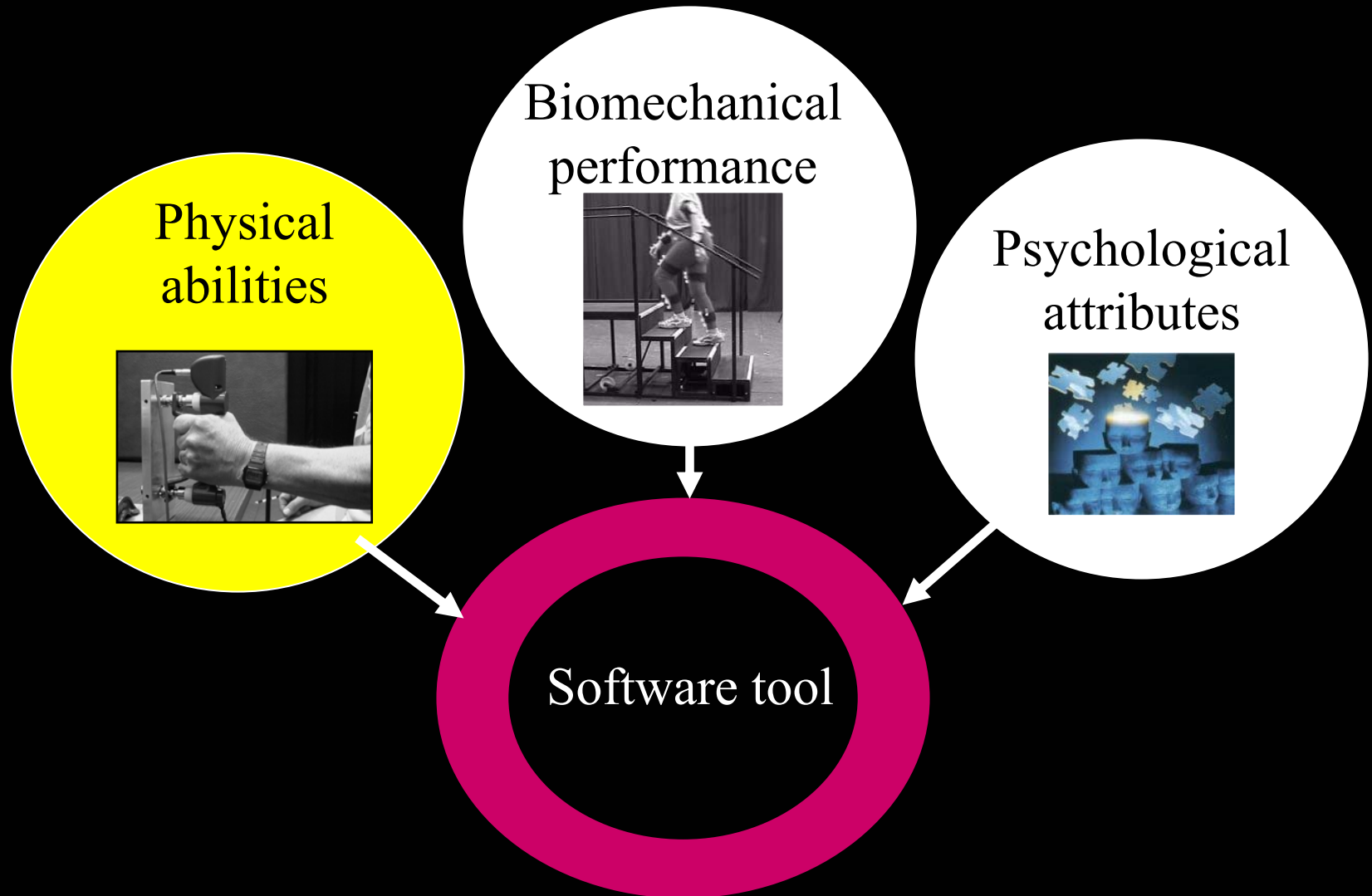
Inputs to software tool



Lab testing – University of Strathclyde

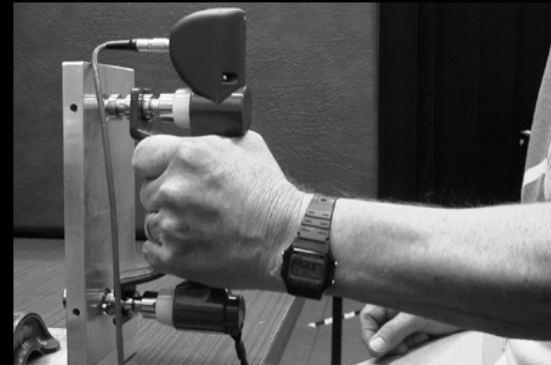
- 84 healthy older adults
- 3 age groups 60+ (15 ♀ 15 ♂)
 70+ (15 ♀ 15 ♂)
 80+ (11 ♀ 13 ♂)
- 900 hours of lab testing

Inputs to software tool

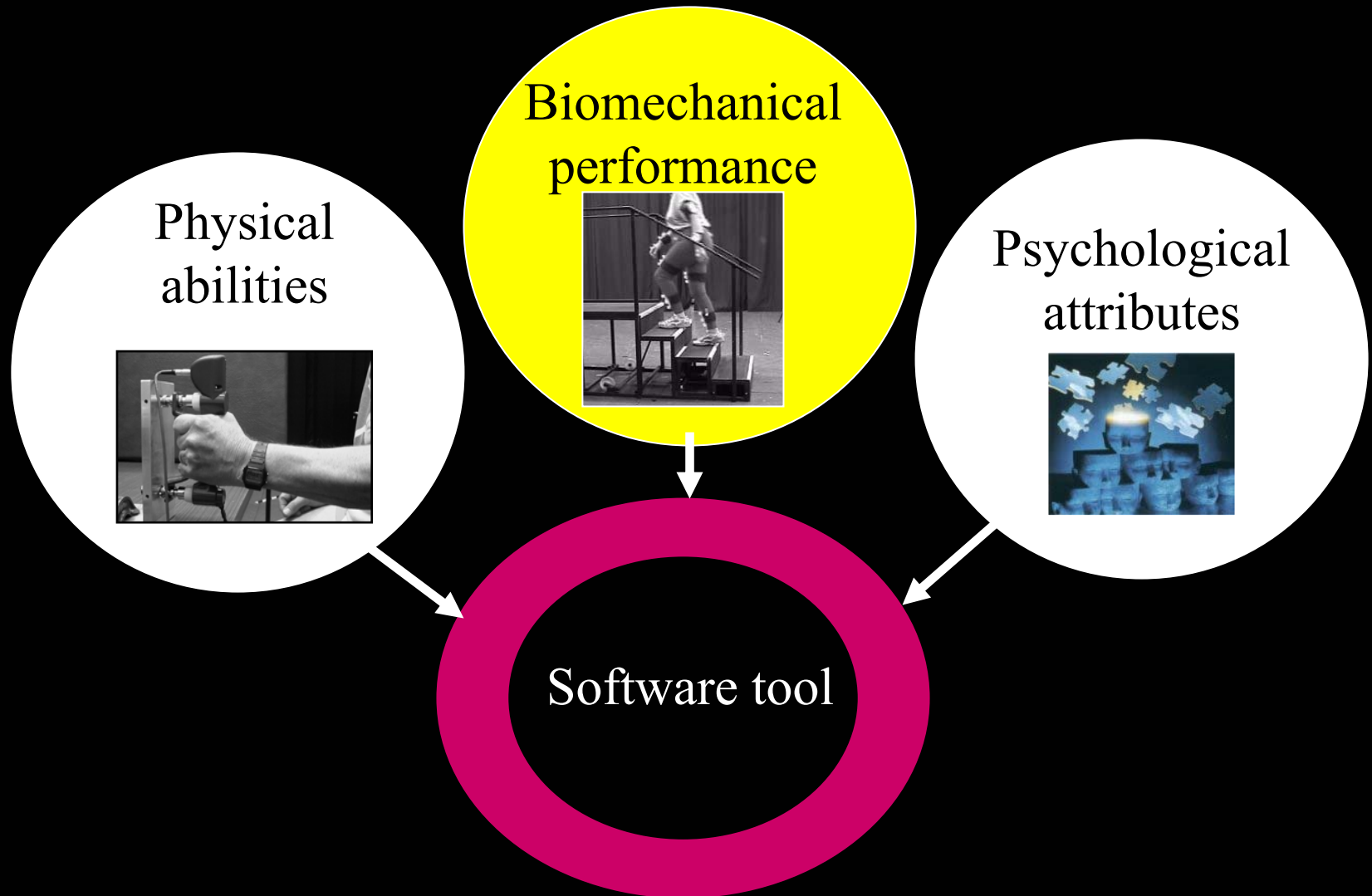


Physical Assessment

- Hip and knee strength in three positions
- Grip strength
- Range of motion of upper and lower limb joints



Inputs to software tool



Biomechanical Assessment

- Full body biomechanics

Stairs

Chair

Door

Lifting

Walking

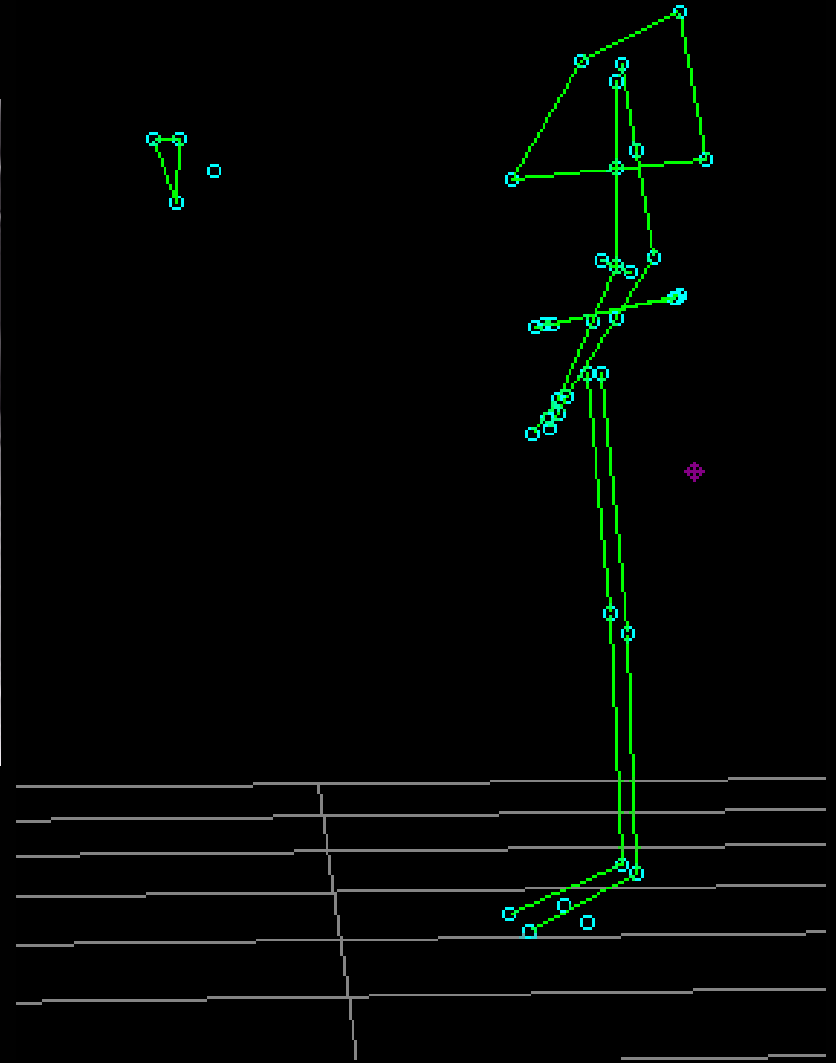
- Hand biomechanics

Remote control

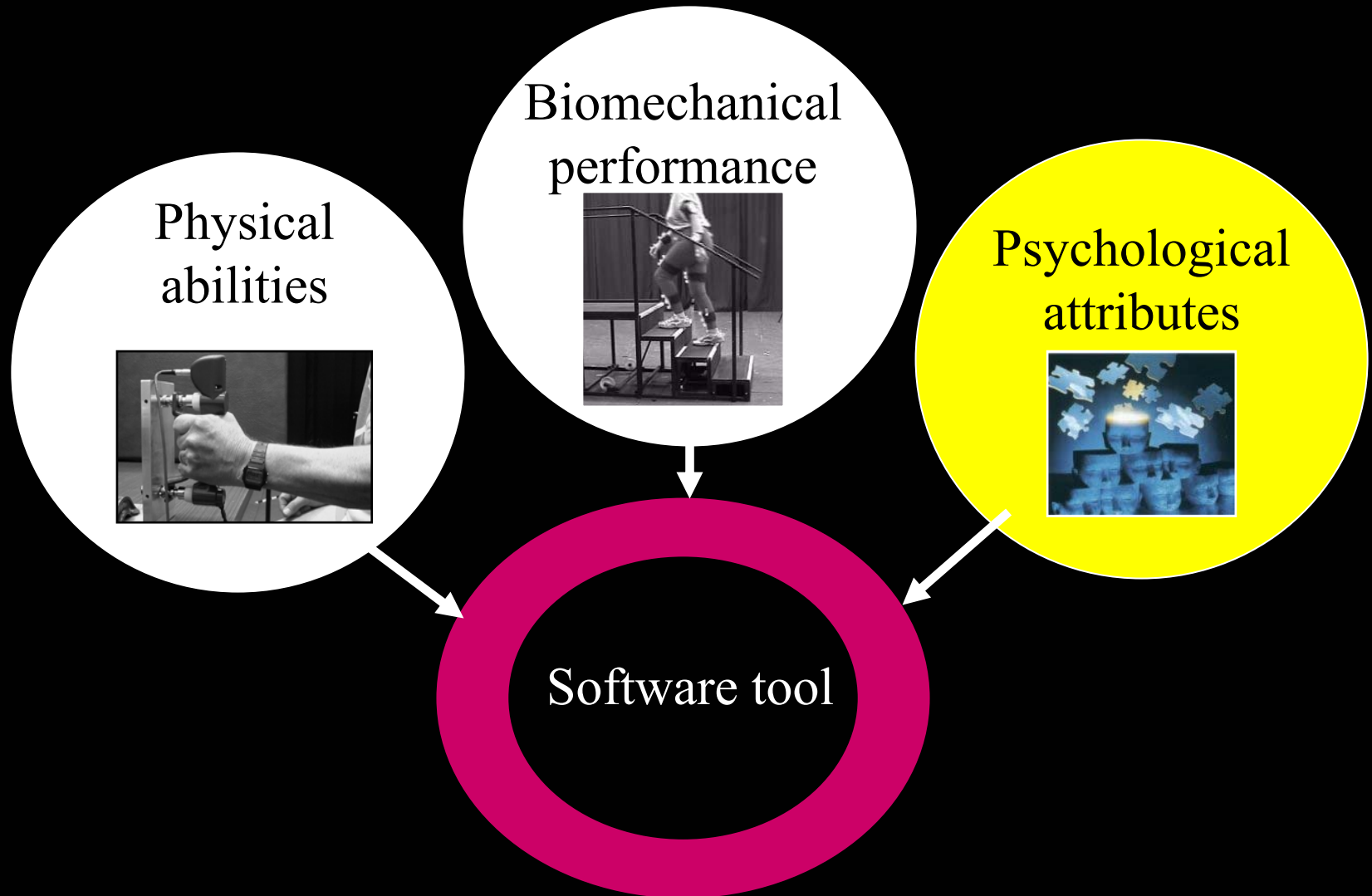
Turning key

Opening jar





Inputs to software tool



Psychological input

Problems for designers:

- Capability beliefs of older adults
- Ability of older adults to deal with novel objects and procedures

Capability beliefs

Do older adults acknowledge changing abilities?

- Over-estimation: risks physical injury
- Under-estimation: loss of independence spirals

Capability beliefs questionnaire

- Physical flexibility
- Physical endurance
- Walking ability
- Manual ability
- Co-ordinate precise movements
- Motor ability in demanding contexts
- Motor ability in novel contexts
- Confidence in motor ability in face of aging
- Motor ability relative to same-age peers
- **Over-cautious and over-confident indicator**

Levels of capability beliefs

Confidence level (%)

100

80

60

40

20

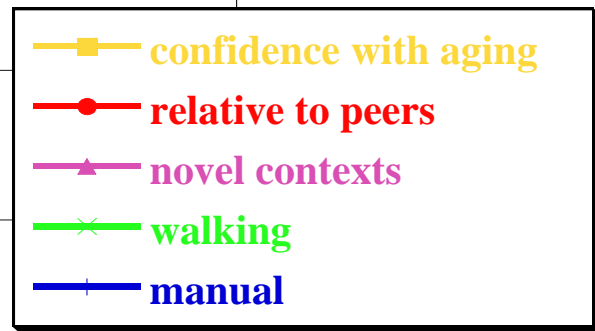
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60's

70's

80's

Older age-group



Levels of Capability Beliefs

Over-confident:

- 56% of 60's
- 61% of 70's
- 32% of 80's

Over-cautious:

- 30% of 60's
- 7% of 70's
- 49% of 80's

Over-riding the 'old way of doing things'

Failed to over-ride:

- 52% of 60's
- 67% of 70's
- 81% of 80's

Learned with practice:

- 80% of 60's
- 17% of 70's
- 22% of 80's

Higher levels of confidence:

- Better performance among less able older adults
- Poorer performance among more able older adults

Over-riding inappropriate action

More 'failures to over-ride'

- In 60's compared to 20's only
- In 70's and 80's compared to all younger age-groups

Even when succeeded to over-ride:

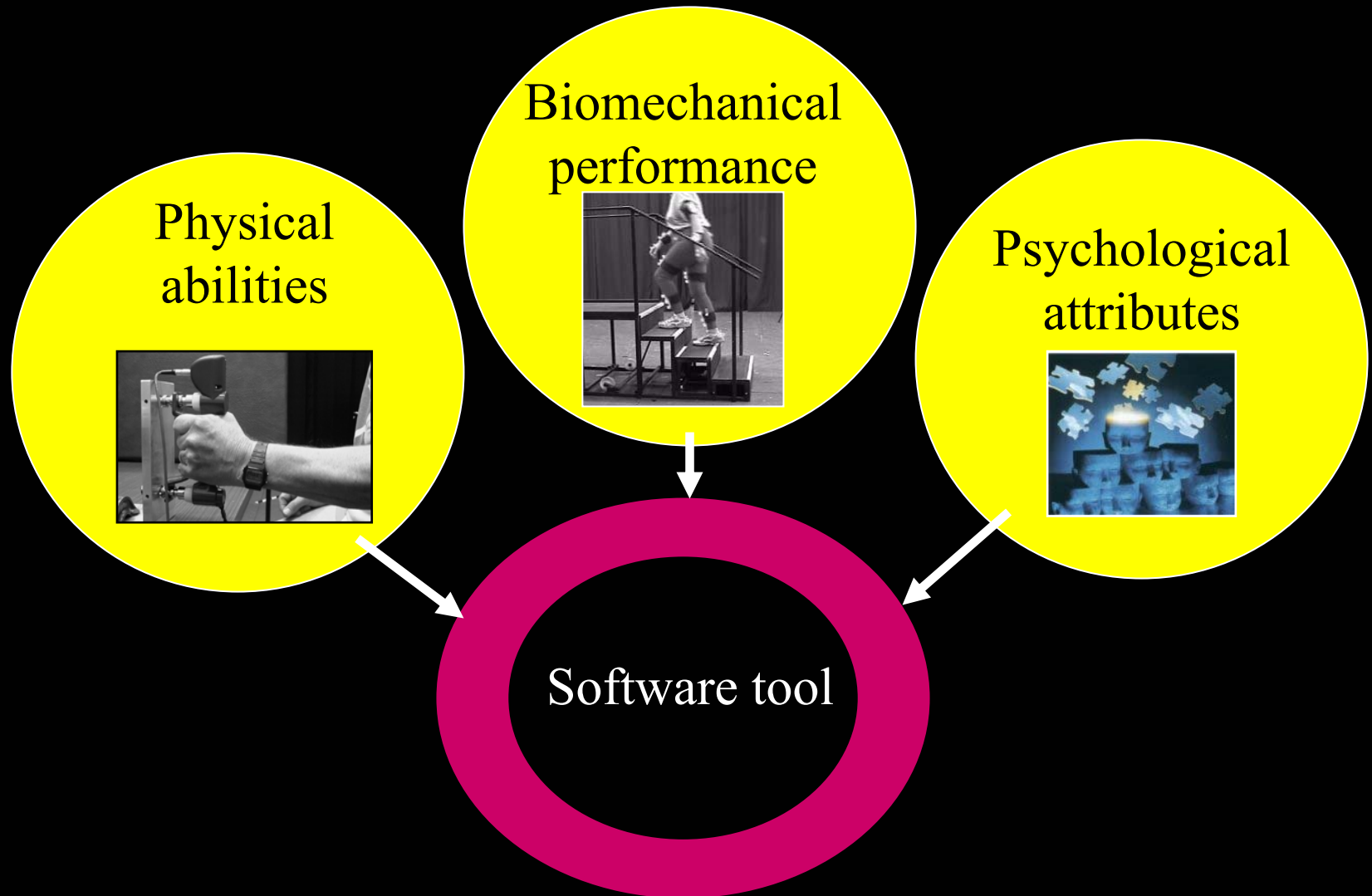
- Still errors in controlling ongoing action
- Emerged from as young as 40's
- Became more frequent and extreme with older age

Over-riding inappropriate action

For each older age-group:

- Different types of capability beliefs related to
 - Type of motor errors produced
 - Increases in error frequencies

Inputs to software tool



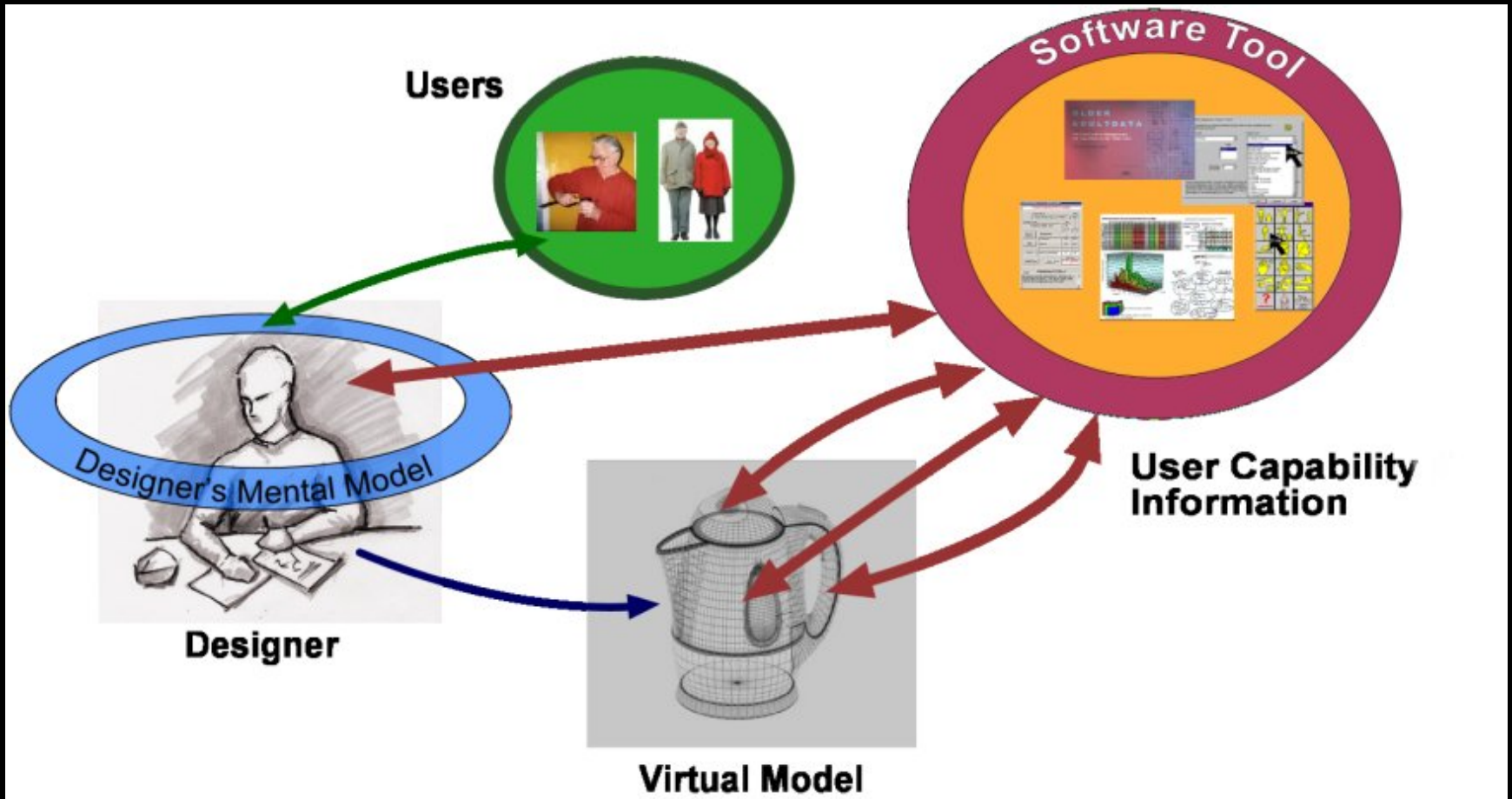
Data

A	B	C	D	E	F	G	H	I	J	K	L	LK
Field	Time	RHJC:X	RHJC:Y	RHJC:Z	LHJC:X	LHJC:Y	LHJC:Z	RKJC:X	RKJC:Y	RKJC:Z	LKJC:X	LKJC:Y
1	0	-636.735	-203.669	849.3331	-636.103	-28.5994	849.0754	-759.973	-151.982	454.9656	-501.132	-4
2	0.0083	-629.256	-203.563	847.2938	-627.786	-27.9388	846.9444	-755.041	-150.637	454.7546	-492.817	-4
3	0.0167	-621.496	-203.381	845.4076	-619.339	-27.2996	844.9385	-749.782	-149.512	454.4905	-484.301	-4
4	0.025	-613.46	-203.123	843.676	-610.763	-26.68	843.0613	-744.194	-148.59	454.1714	-475.596	-4
5	0.0333	-605.154	-202.789	842.1017	-602.059	-26.0762	841.3209	-738.262	-147.838	453.8021	-466.727	-4
6	0.0417	-596.591	-202.38	840.6908	-593.231	-25.4832	839.7327	-731.959	-147.207	453.3945	-457.734	-4
7	0.05	-587.786	-201.895	839.4527	-584.279	-24.8952	838.3197	-725.244	-146.646	452.9628	-448.663	-
8	0.0583	-578.763	-201.333	838.4003	-575.207	-24.3063	837.11	-718.07	-146.125	452.5127	-439.558	-4
9	0.0667	-569.551	-200.698	837.548	-566.022	-23.7105	836.1332	-710.386	-145.66	452.0329	-430.454	-4
10	0.075	-560.189	-199.992	836.9102	-556.737	-23.1011	835.4149	-702.138	-145.305	451.4936	-421.38	-
11	0.0833	-550.718	-199.223	836.498	-547.368	-22.471	834.9731	-693.276	-145.15	450.8517	-412.361	-4
12	0.0917	-541.182	-198.397	836.3167	-537.939	-21.8122	834.8154	-683.755	-145.293	450.0573	-403.428	-4
13	0.1	-531.627	-197.522	836.364	-528.476	-21.1165	834.9366	-673.529	-145.823	449.0623	-394.618	-5
14	0.1083	-522.092	-196.605	836.629	-519.005	-20.3775	835.3188	-662.552	-146.787	447.828	-385.982	-5
15	0.1167	-512.614	-195.656	837.0934	-509.554	-19.5919	835.9326	-650.769	-148.175	446.3324	-377.581	-
16	0.125	-503.225	-194.682	837.7328	-500.149	-18.7611	836.7391	-638.118	-149.91	444.5758	-369.479	-5

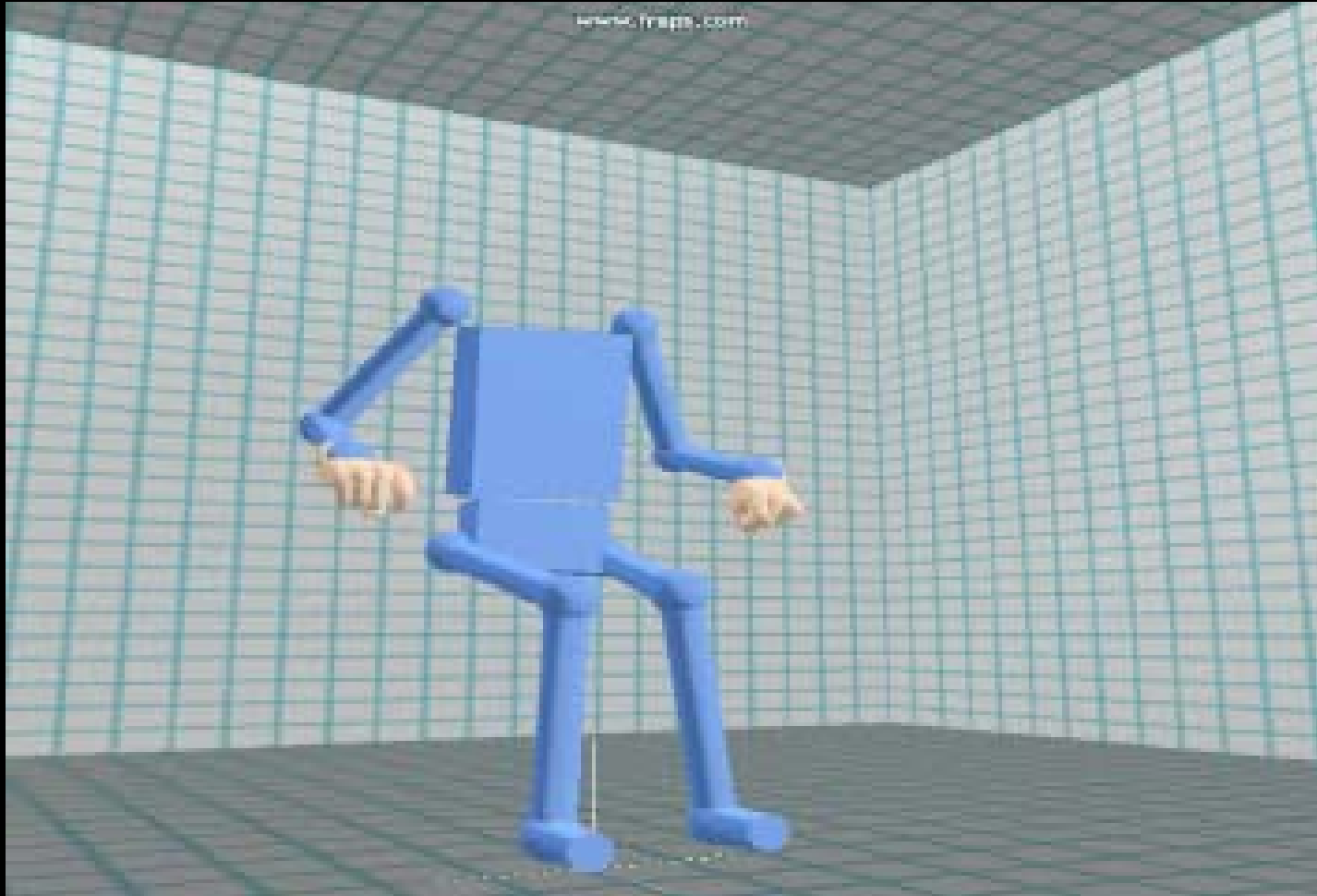
Key points

- Information which designers cannot find out on their own
 - Only externally visible through the effects on movement
- Data (+ specialist knowledge) must be translated into a meaningful form for design

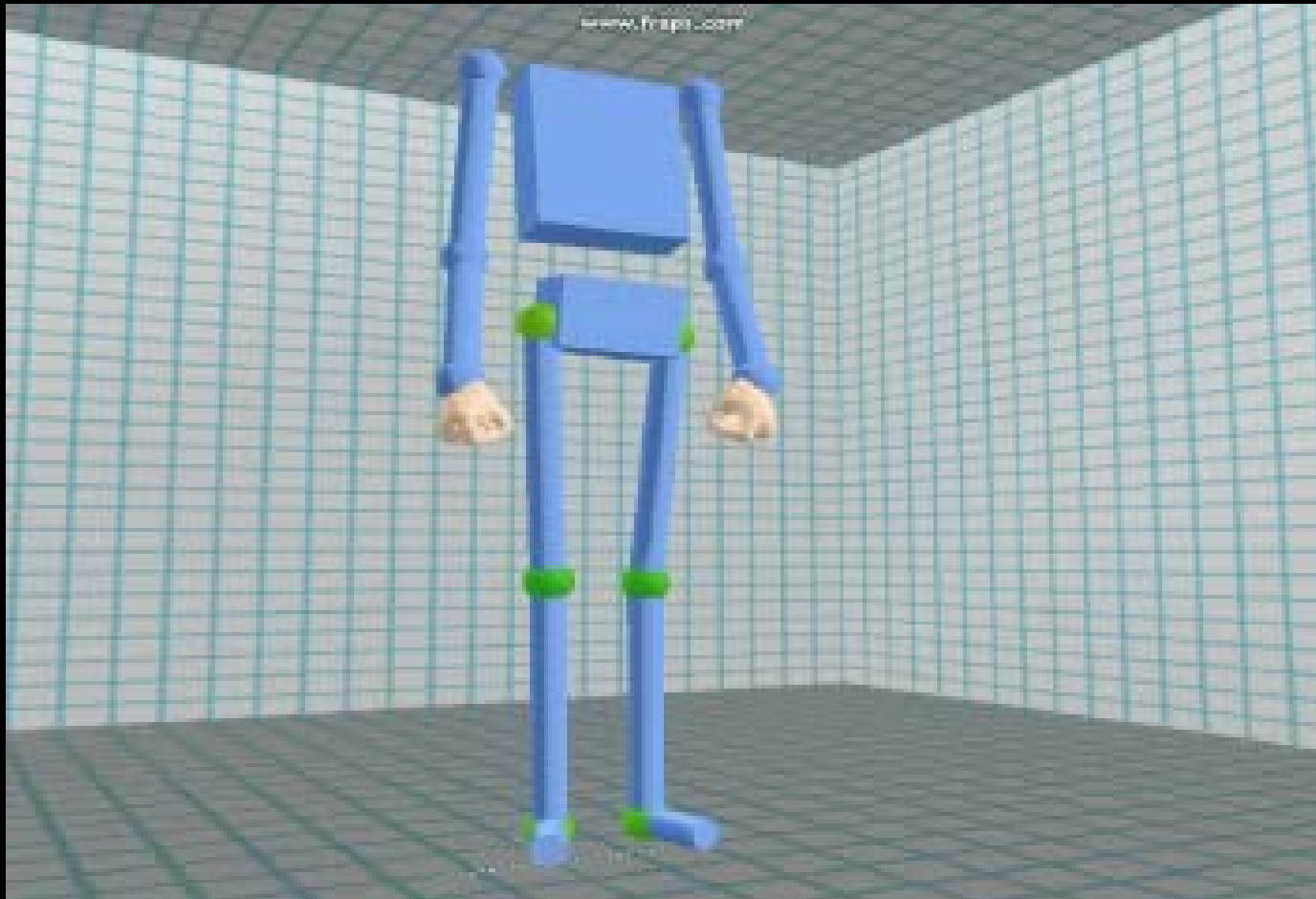
New model



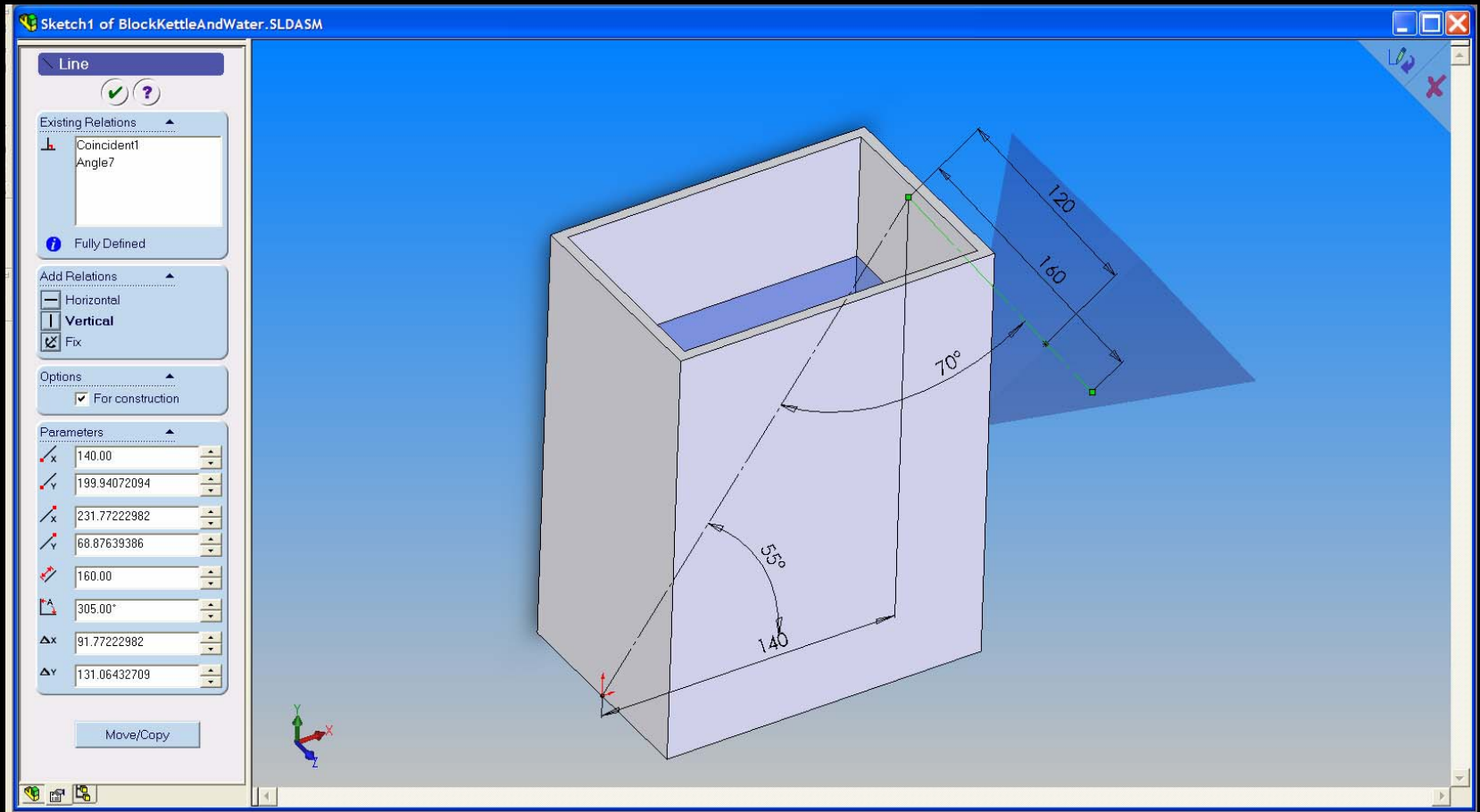
What happens in real movements?



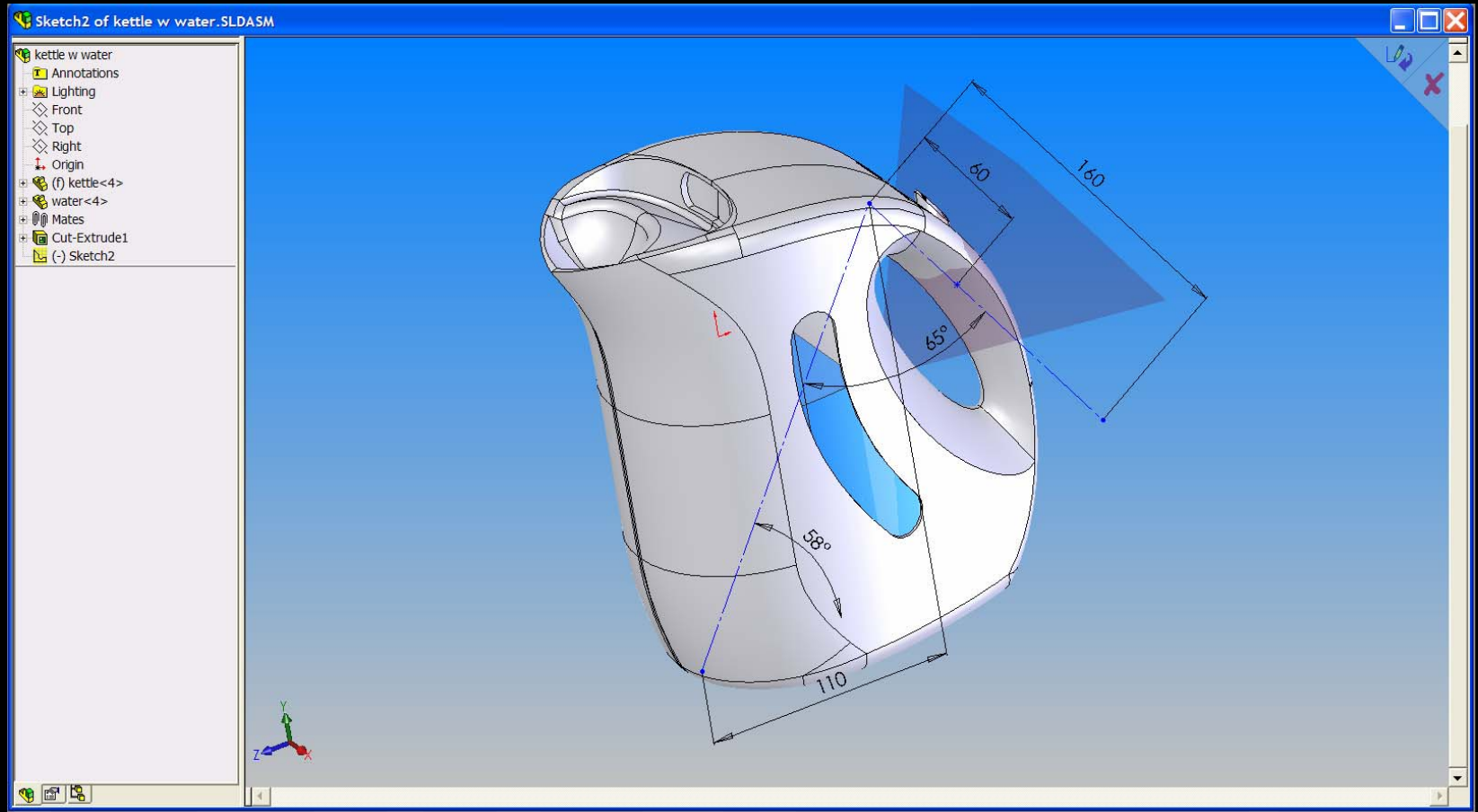
What happens in real movements?



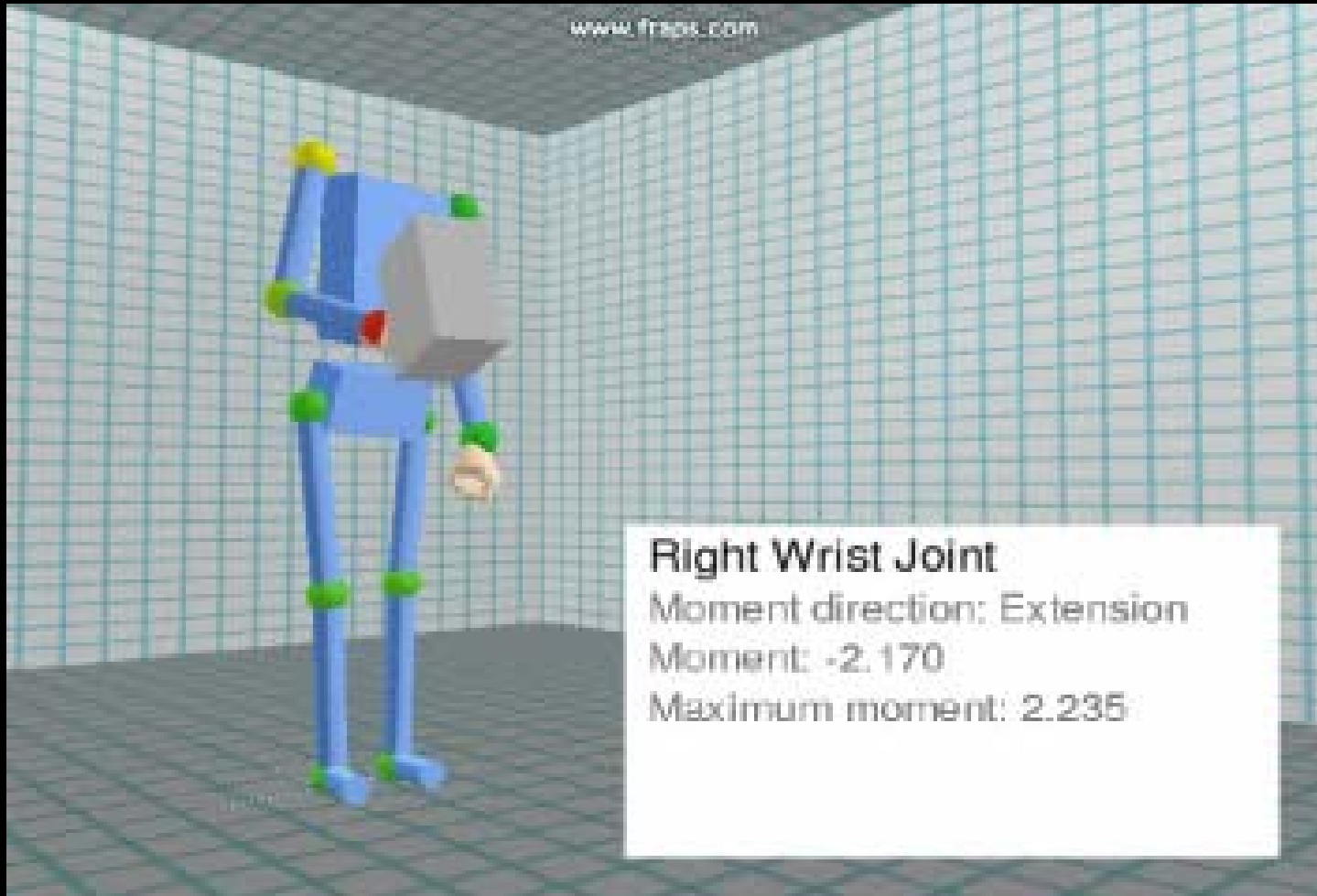
Interaction with design software



Interaction with design software



What if ?



Next steps

- Integrate psychological findings
- Expand richness of information
- Add design guidelines and strategies
- Investigation of ways to enable the designer to empathise with the situation of the user

Questions

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