Rendering of photorealistic images
in a Unix Network

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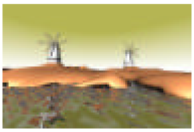

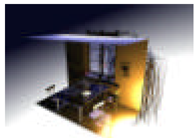

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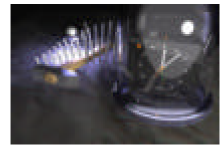
- The VERA Raytracer
- Computeranimation with VERA
- The NetQ
- Presentation of animations
  - Occursus cum Novo
  - Illusion



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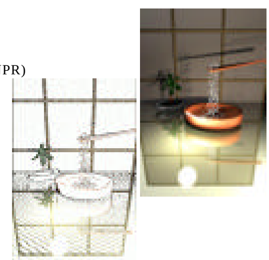
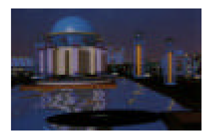
Rendering

- Photorealistic Rendering
- Raytracing
- Radiosity
- Non-Photorealistic Rendering (NPR)
- Image-Based Rendering (IBR)
- Computer Animation



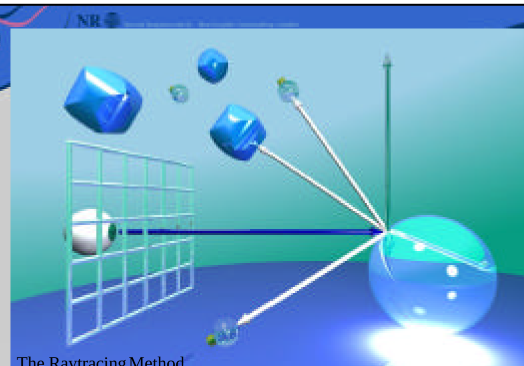
Realistic Computer Animations around 1987

- Quest (Apollo Computers) 1987
- Luxo Junior (John Lasseter, Pixar) 1987
- Red's Dream (John Lasseter, Pixar) 1988
- Tin Toy (John Lasseter, Pixar) 1988
- Stanley and Stella in Breaking the Ice (Larry Malone, Symbolics) 1988
- Jumpin' Jacques Splash (Georges Kular, Isabelle Foucher, Sogitec) 1988
- Eurythmy (Susan Amkraut, Michael Girard) 1989
- Paris 1789 (Xavier Nicholas) 1989

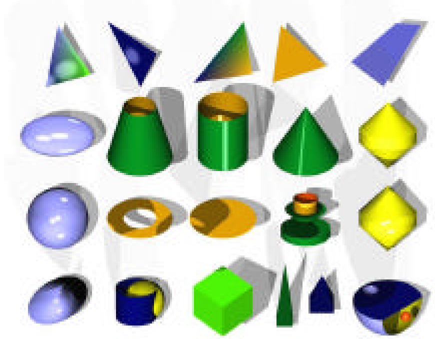


The VERA Raytracer

- VERA = Very Efficient Raytracing Algorithm
- Grid-Method (Müller (1986), Fujimoto et.al (1984), Glassner (1985))
- Development started in 1984 by Prof. Dr. Alfred Schmitt, Institut für Betriebs- und Dialogsysteme, Universität Karlsruhe
- Contributions by R. Lindner, M. Kadisch, M. Kim, O. Devillers, B. Dreyer, and others
- Integration in 1986 by Markus Linsenmann
- VERA-II: textures (R. Reichl)
- VERA-IV: space textures, copper plates, SIRDS, IBR module, ...
- (W. Leister, M. Linsenmann)



The Raytracing Method



Sample objects used for modelling

The Lighting Model

```
Schalter ++-++
                              (*)
+-----------------------------------------------------------+
| Muehle (c) 29. Feb. '87 by  Achim Stoesser    (V 1.2) |
+-----------------------------------------------------------+
                              (*)

(* Ansichts- und Bildparameter ************************)

Raster 780 576
Pixelform 1
  Schatten    (**)
  Anti-Alias -(**)
RayTrTiefe 3
Hellfaktor 0
Kamera 0 -3000 0500
          0     0 1500
          0 -0500 2800
Li  1300 -3500 3500  4700000 .8 .8 .5
Li  -200 -2300 2900  3300000 .8 .6 .4
Himmel 0 0 .2
Horizont .9 .89 1
Erde .89 .9 1
Zenit 2.5 1 -2

BN Muehle

"muehle.geo" line 27 of 77 --35%--
```

```
BN Muehle

(* Hauptszene ****************************************)

Usz Turm Rt 0 0 -12
Usz Fluegelrad Rt 0 0 12 (* Raddrehung *)
               Rt 70 0 -22 Tr 0 -500 2070

(* Unterszenen ***************************************)

Szene Fluegelrad
  Usz Fluegel Rt -7 0 0  Rt 0 0 000
  Usz Fluegel Rt -7 0 0  Rt 0 0 060
  Usz Fluegel Rt -7 0 0  Rt 0 0 120
  Usz Fluegel Rt -7 0 0  Rt 0 0 180
  Usz Fluegel Rt -7 0 0  Rt 0 0 240
  Usz Fluegel Rt -7 0 0  Rt 0 0 300
  Fb hbraun
  Rk 0 0 0 R 0 0 -1 Ge 13 -7 Ge 13 300

Schalter -
  Lies muehle_fluegel.inc
  Lies muehle_turm.inc
Schalter -

(* Material *****************************************)

"muehle.geo" line 52 of 77 --67%--
```

```
Szene Fluegel
Fb dbraun
P3 0 0 0 25 -25 0 25 25 0
P4 25 25 0 25 25 -20 25 -25 -20 25 -25 0
Rk 25 12.5 -12.5 R 1 0 0 An 12.5 0 Ge 12.5 25
P4 50 0 0  50 75 0  1325 75 0  1325 0 0
P4 50 0 0  50 0 -20  1325 0 -20  1325 0 0
P4 50 0 -20  50 25 -20  1325 25 -20  1325 0 -20
P4 50 25 -20  50 75 0  1325 75 0  1325 25 -20
Fb hbraun
P4 50 25 0 50 75 0 75 75 0 75 0 0
P3 75 75 0  75 0 0  150 0 0
P4   150 75 0    225 75 0    300 0 0    225 0 0
P4   300 75 0    375 75 0    450 0 0    375 0 0
P4   450 75 0    525 75 0    600 0 0    525 0 0
P4   600 75 0    675 75 0    750 0 0    675 0 0
P4   750 75 0    825 75 0    900 0 0    825 0 0
P4   900 75 0    975 75 0   1050 0 0    975 0 0
P4 1050 75 0   1125 75 0   1200 0 0   1125 0 0
P3 1200 75 0   1275 75 0   1275 0 0
P4 1275 75 0   1275 0 0   1325 0 0   1325 25 0
Fb glanzbraun
Rk 190 -75 0 R 1 0 0 An 5 0 Ge 5 1140
Kg 190 -75 0  5
Kg 1330 -75 0 5
Rk 190 -150 0 R 1 0 0 An 5 0 Ge 5 1140
Kg 190 -150 0  5
"muehle_fluegel.inc" 77 lines, 2259 characters
```

```
(* Material *****************************************)

Bez hbraun
  Drf 1 .8 .5
Bez dbraun
  Drf .25 .2 .125
Bez glanzbraun
  Spk .97
  Drf .333 .27 .16
Bez weiss Drf 1 1 1
Bez gruen Drf 0 1 0
Bez blau  Drf 0 0 1
Bez rot   Drf 1 0 0
Bez gelb  Drf 1 1 0
Bez spiegel
  Spk .98
  Spd .7 .7 .7
Bez glasaussen
  Bdn .8 .8 .8
  Bkr 1.6
  Spd .2 .2 .2
  Spk .985
  Drf 0 0 0.01
Bez glasinnen
  Bdn .9 .9 .9
  Spd .1 .1 .1

"muehle.geo" line 51 of 77 --66%--
```

```
(* Ansichts- und Bildparameter ***************************)

Raster 780 576
Pixelform 1
  Schatten    (**)
  Anti-Alias  (**)
RayTrTiefe 3
Hellfaktor 0
Kamera 0 -3000 0300
       0     0 1500
       0 -0500 2800
Li  1300 -3500 1500  4200000 .8 .8 .5
Li  -200 -2300 2900  3300000 .8 .6 .4
Himmel 0 0 .2
Horizont .9 .89 1
Erde .89 .9 1
Zenit 2.5 1 -2

DN Muehle.#GEO

(* Hauptszene *****************************************)

Use Turm Rt 0 0 -12
Use Fluegelrad Rt 0 0 #ROT Rt 70 0 -22 Tr 0 -500 2070

(* Unterszenen ****************************************)

"muehle.ani" line 34 of 75 --45%--
```

```
(* muehle.000..014 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% *)
program make_run(output);
  const
    step=1;
    max=14;
    pi = 3.14159265;
    a=' '' ';
    s=' ';
  var
    i: integer;
    minush, w, h, q, phi, c: real;
begin
  i:=0; repeat
    h:=i/max; minush:=1-h; w:=sqrt(h); q:=sqr(h);
    phi:=h*2*pi;
    c:=(1-cos(h*pi))/2;
    (* GEO *)
    write('cd stoesser/muehle; exec muehle.run ');
    if i div step<100 then write('0');
    if i div step<10  then write ('0');
    write(i div step:1,s);
    (* ROT *)
    write(i/(max+1)*60:8:3,s);
    writeln;
  i:=i+step; until i>max;
end.

"muehle.p" 26 lines, 592 characters
```

```
#!/bin/sh -xe
echo goes 'date'": " muehle.$1  >> muehle.don
sed -e 's/#GEO/$1/g' \
    -e 's/#ROT/$2/g' \
    <muehle.geo \
    >muehle.$1.inf
vera -1 muehle.$1.inf -o muehle.$1.pix -p muehle.$1.pro
compress muehle.$1.pix
rm -f muehle.$1.inf
rm -f muehle.$1.pro
echo done 'date'": " muehle.$1  >> muehle.don
exit 0

cd stoesser/muehle; exec muehle.run 000    0.000
cd stoesser/muehle; exec muehle.run 001    4.000
cd stoesser/muehle; exec muehle.run 002    8.000
cd stoesser/muehle; exec muehle.run 003   12.000
cd stoesser/muehle; exec muehle.run 004   16.000
cd stoesser/muehle; exec muehle.run 005   20.000
cd stoesser/muehle; exec muehle.run 006   24.000
cd stoesser/muehle; exec muehle.run 007   28.000
cd stoesser/muehle; exec muehle.run 008   32.000
cd stoesser/muehle; exec muehle.run 009   36.000
cd stoesser/muehle; exec muehle.run 010   40.000
...
cd stoesser/muehle; exec muehle.run 014   56.000

"muehle.run+muehle.mke" 27 lines, 921 characters
```

Distributed Computing of Computer Animations

- Where to get computing power from ?
- Many work stations on campus
- These are not busy most of the time
  - SUN 3/50, SUN 3/60
  - Main Frame Machines (Siemens S7760, VAX)
- GRID Computing / Distributed Computing
- Example today: Seti@Home
- The NetQ

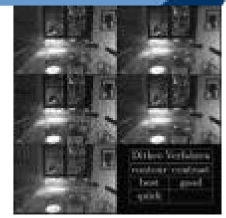
GRID for Computer Graphics in 1987

- Apollo Quest
  - → Node Hunter & Gigabyte Master !!!
- Matthew Merzenbacher, UCLA (centralised, fixed time periods)
- Mike Muuss, (chunks of scan lines (high overhead))
- Frank Heckbert, NYIT (decentralised disk space)
- John W. Petterson, Utah (heterogeneous network)

The NetQ

- GRID / Peer-to-Peer method
- Server
  - Export directory for control and payload data
- Client
  - Have installed netqd program
  - Mount directory from server after idle time,
  - Calculate one image at a time
  - Uses kill-9 when work station is used interactively
  - All action initiated by client

Results

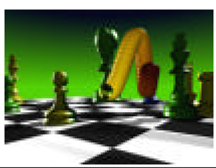


- 786x576
- 7550 frames, ca.4000 rendered
- 9 GB, compressed 2.2 GB
- 70 MB / day
- ca. 1% of jobs bad (bugs in software, new infrastructure, user caused)
- Preview images 156x115 dithered

What	Σ
tasks (frames and previews)	6454
dispatches	9544
interrupted runs	3000
cpu-hours (rendering)	23307
cpu-month (rendering)	≈ 32
actual number of machines	22 – 34

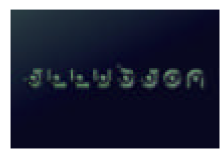
VERA-Animations at IBD Univ. Karlsruhe

- Occursus cum Novo
  - Started early in 1987 after stipend from ORF /Ars Electronica
  - Entirely rendered with VERA raytracer
  - Mostly rendered on SUN 3 network
  - Some scenes on Siemens S7760, and VAX
  - 7750 frames, 23307 CPU-hours
  - Finished in september 1987,
    - Four days before Ars Electronica
  - Video processing: Data Images, Stuttgart
  - Sound: Synthesizer
  - Design: Achim Stößer



VERA-Animations at IBD Univ. Karlsruhe

- Illusion
  - Work from 1988 to 1991
  - Entirely rendered with VERA raytracer
  - All rendered on SUN 3 and SUN 4 network at Universities in Karlsruhe and Freiburg
  - Video processing to analogue video disk
  - Sound: Synthesizer / Atari ST II
  - Design: Achim Stößer



VERA-Animations at IBD Univ. Karlsruhe

- Technologieregion Karlsruhe
  - Trailer for publicity film, 1991
- Universität Karlsruhe
  - Trailer for publicity film, 1991
- ZKM (Zentrum für Kunst- und Medientechnolgie, Karlsruhe)
  - Trailer for publicity film, 1991
- Several students work

- End of the presentation

Thank you for your attention!