Introduction to Illustrative Flow Visualization

Andrea Brambilla (University of Bergen)

Robert Carnecky (ETH Zurich)

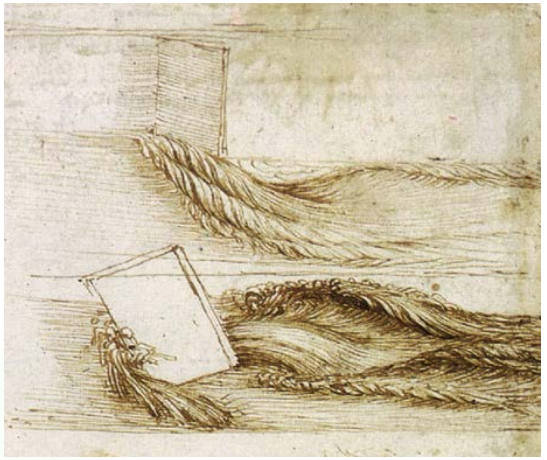
Motivation

- Which image would you use for navigation?

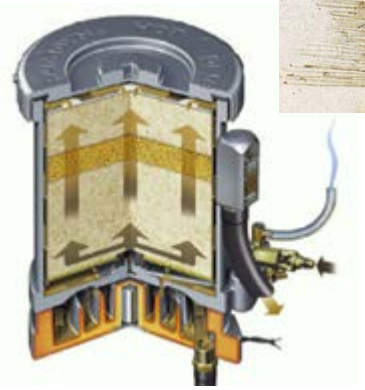
Images from Google Maps

Illustrative Visualization

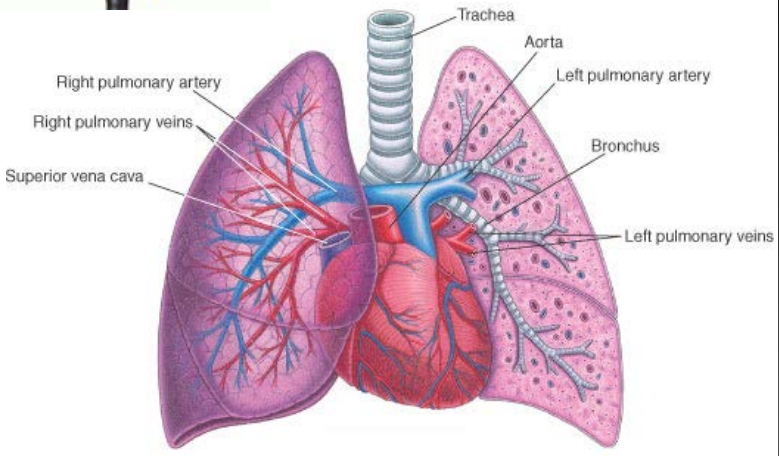
- Inspired artists and illustrators



- … but **interactive**



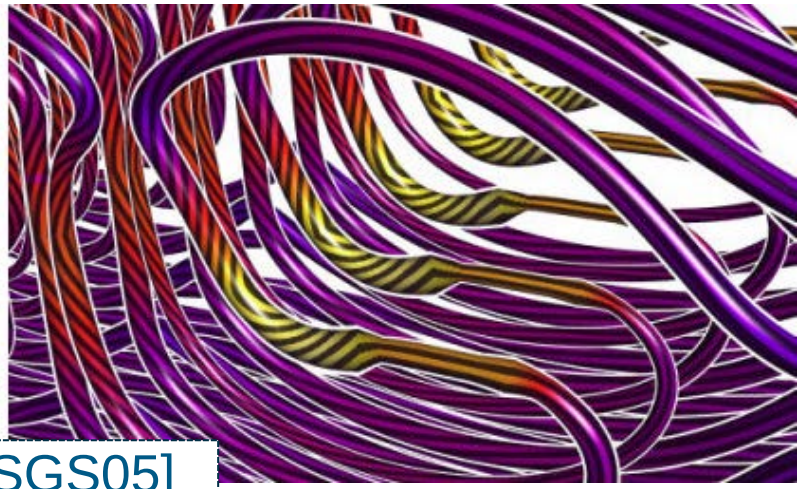
- Show **relevant information**…



- …using **visual abstractions**

Illustrative Visual Abstraction

Perceptual Effectiveness

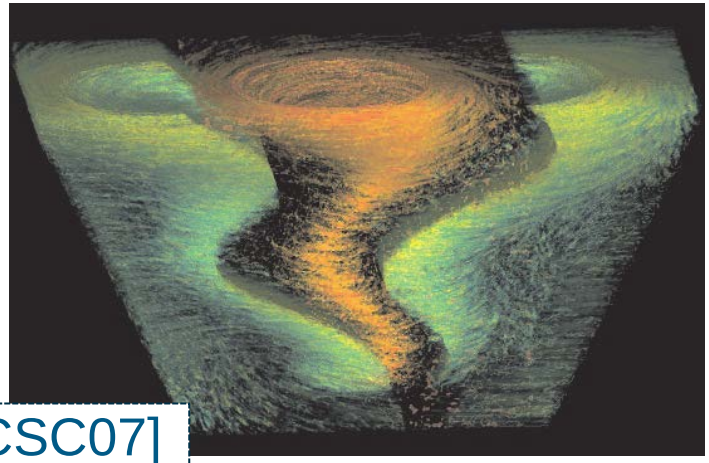


[SGS05]

Visibility Management

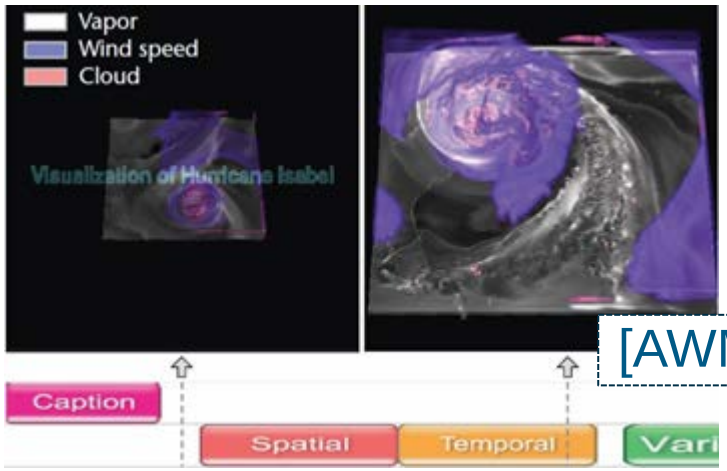
[CFM*XX]

Focus Emphasis



[CSC07]

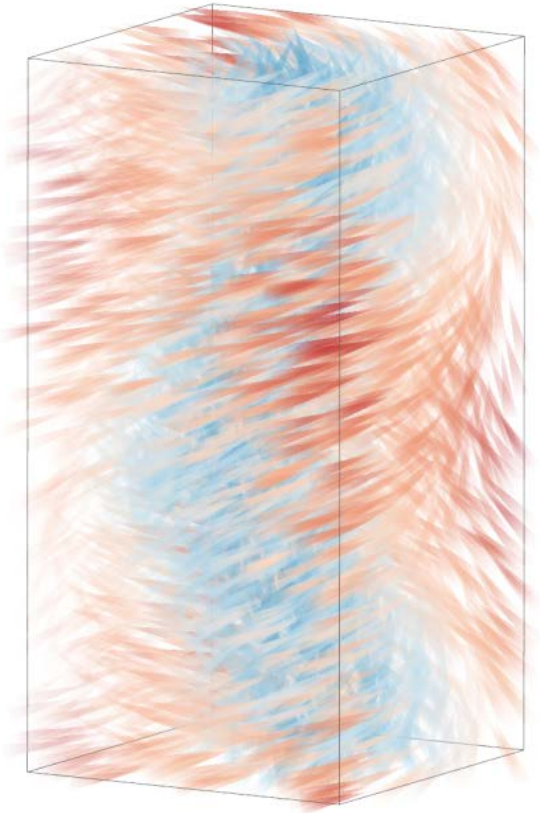
Visual Explanation



[AWM10]

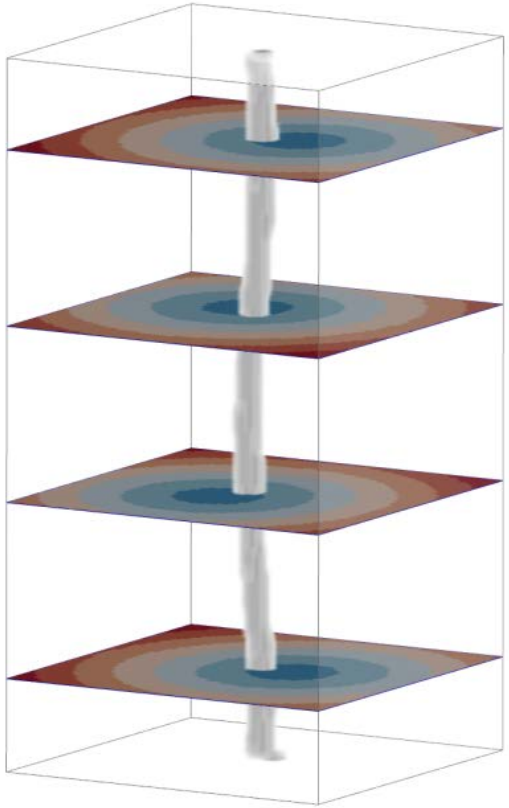
Flow Data Representations

Raw Data



Integral Structures

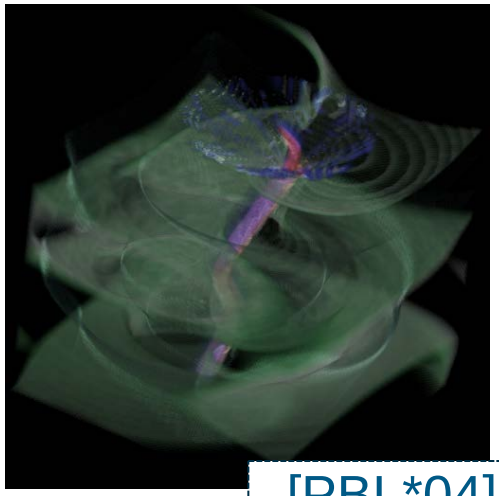
Flow Features



Images generated with SimVis

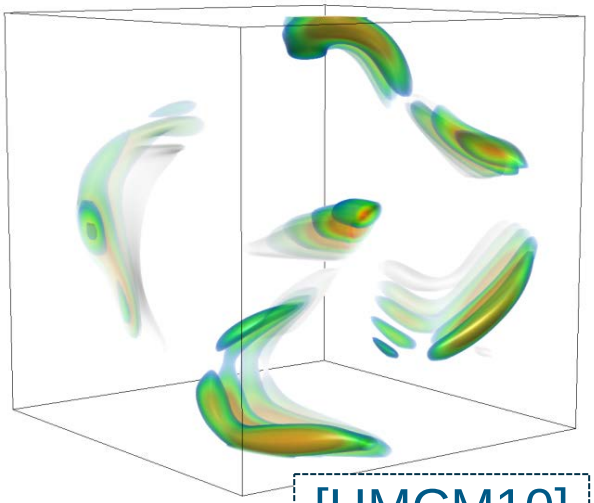
Challenges in flow visualization

- Flow data is *multivariate* → What to show? How?
- Flow data is *dense* → Cluttering and occlusion
- Flow data is *unsteady* → Temporal evolution hidden



[PBL*04]

[CFM*XX]



[HMCM10]

IllustraFlowVis Classification

- Visualization user
  - Data representation ✓
  - Visualization needs ✓
  - Technical Vis details ✗
- 2-axis classification based on user knowledge:

Data repr.

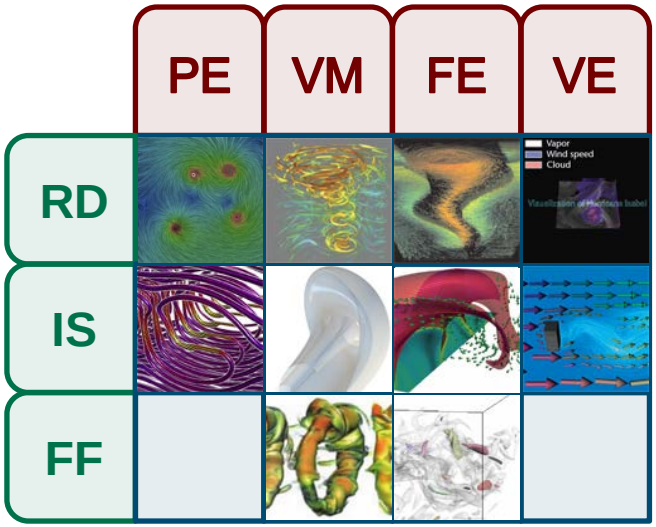
- RAW DATA
- INTEGRAL STRUCTURES
- FLOW FEATURES

X

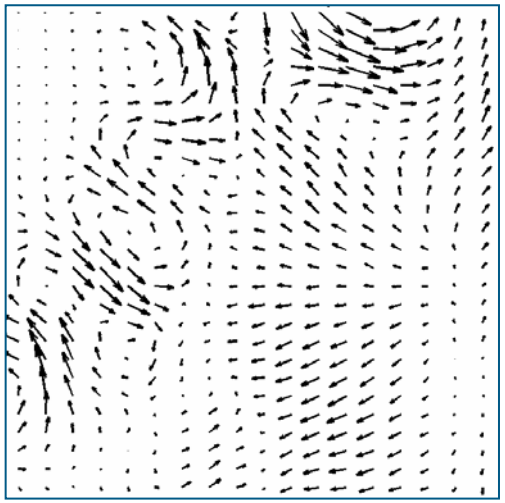
Vis needs

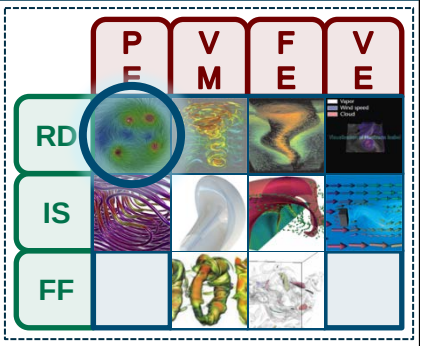
- PERCEPTUAL EFFECTIVENESS
- VISIBILITY MANAGEMENT
- FOCUS EMPHASIS
- VISUAL EXPLANATION

→



Example: Basic Concepts



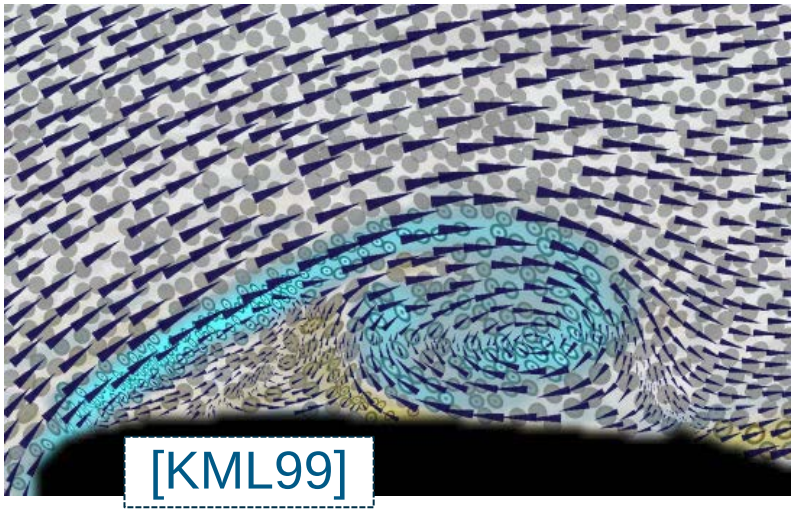


Classic hedgehog vis

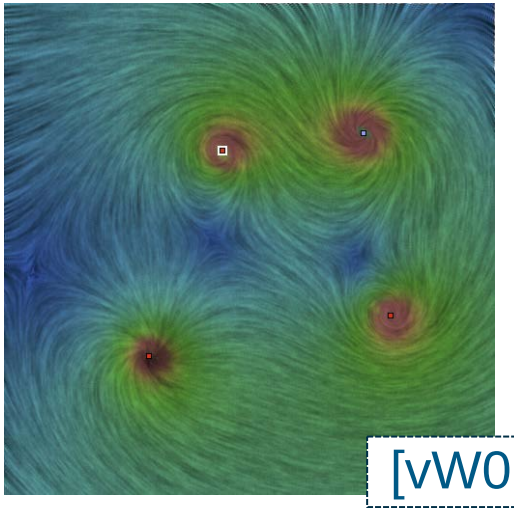
- Inefficient
- Hard to grasp

Data Painting and Texture Advection

- Display multiple variables at once
- Convey additional information



[KML99]



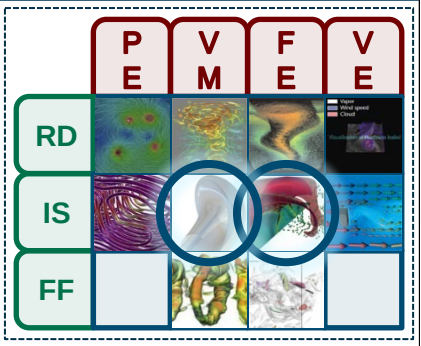
[vW02]

Example: Occlusion & Cluttering

[CFM*XX]

Simple trasparency

- Details are hidden
- Depth-ordering issues



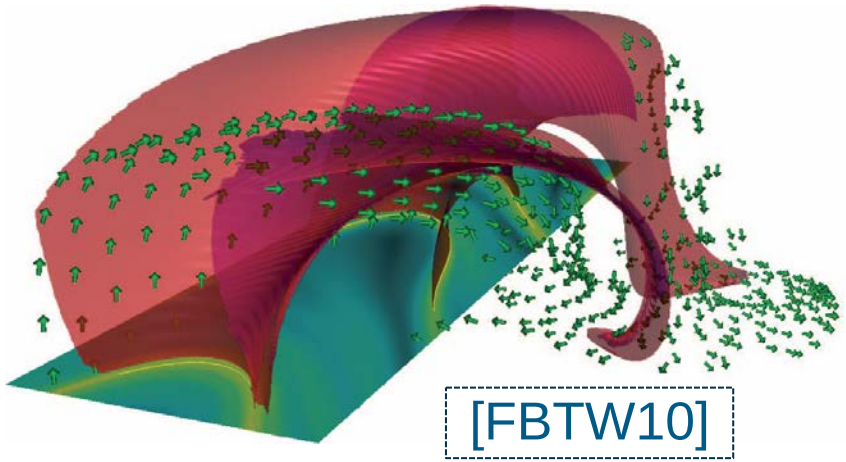
Smart shading

- Uncover small details
- Improve spatial perception

[CFM*XX]

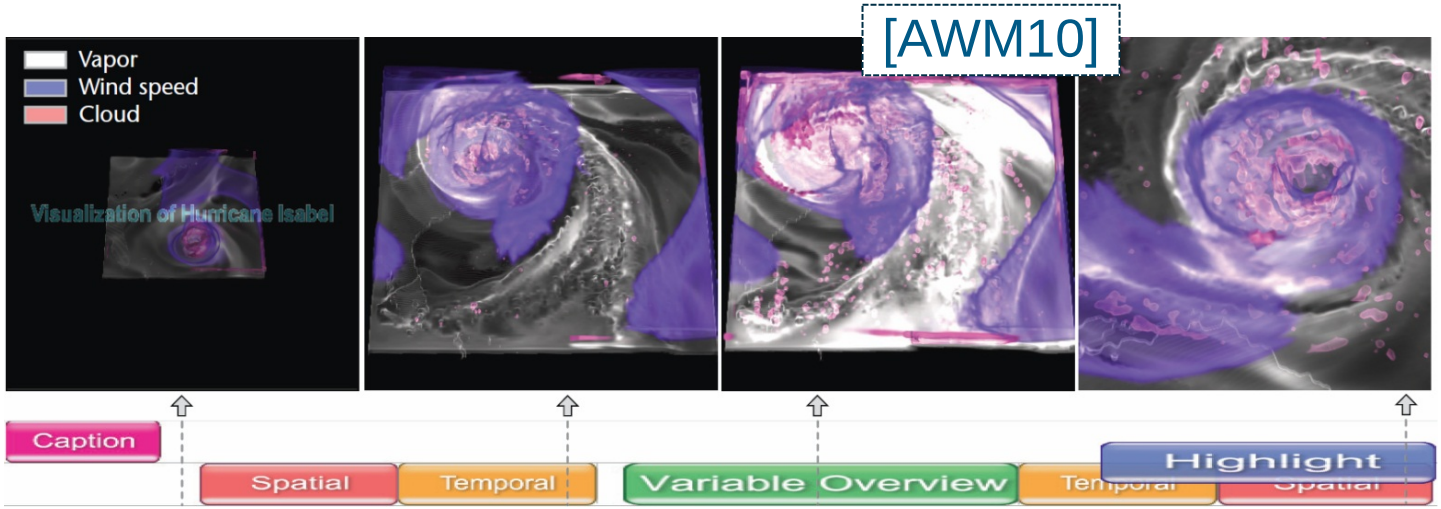
Focus-based Seeding

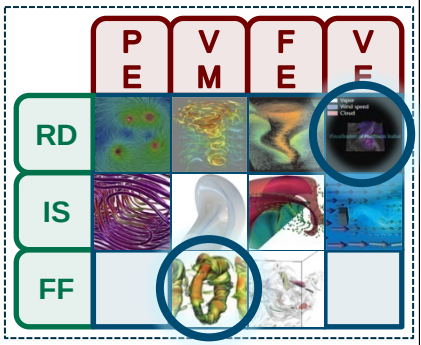
- Convey important info
- No occlusion from context



[FBTW10]

Example: Advanced Techniques





Storytelling

- Expressive presentation
- Multiple points of view

Temporal Implosion

- Data from many timestep
- Temporal evolution of flow

Conclusion & future works

- IllustraFlow Vis enables flow analysis at different **visual abstraction levels**:
  - Make flow data more understandable
  - Expose hidden aspects of flow data
- Choosing the right technique is easy:
  - What is the current **flow data representation**?
  - What **visual enhancements** are needed?
- What should we expect?
  - IllustraFlow Vis based on **semantic** aspects and **physical** properties of the flow phenomena
  - Close **collaboration** between visualization experts and application experts

Thanks for your attention!

Questions?

- Based on: BRAMBILLA A., CARNECKY R., PEIKERT R., VIOLA I., HAUSER H.: **Illustrative Flow Visualization: State of the Art, Trends and Challenges**. To appear in *Eurographics 2012 State-of-the-Art Reports* (Cagliari, Italy, 2012)
- The project SemSeg acknowledges the financial support of the Future and Emerging Technologies (FET) programme within the Seventh Framework Programme for Research of the European Commission, under FET-Open grant number 226042.

andrea.brambilla@uib.no – crobi@inf.ethz.ch

References

[AWM10] AKIBA H., WANG C., MA K.-L.: Aniviz: A template-based animation tool for volume visualization. *IEEE Computer Graphics and Applications* 30, 5 (sept.-oct. 2010), 61–71. 7, 14

[BKKW08] BURGER K., KONDRATIEVA P., KRUGER J., WESTERMANN R.: Importance-driven particle techniques for flow visualization. In *Proc. of the IEEE Pacific Visualization Symposium. PacificVis '08* (mar. 2008), pp. 71–78. 7, 14, 15

[CFM*XX] CARNECKY R., FUCHS R., MEHL S., JANG Y., PEIKERT R.: Smart transparency for illustrative visualization of complex flow surfaces. *Unpublished*.

[CSC07] CORREA C., SILVER D., CHEN M.: Illustrative deformation for data exploration. *IEEE Transactions on Visualization and Computer Graphics 13*, 6 (nov.-dec. 2007), 1320–1327. 7, 12

[FBTW10] FERSTL F., BURGER K., THEISEL H., WESTERMANN R.: Interactive separating streak surfaces. *IEEE Transactions on Visualization and Computer Graphics 16*, 6 (nov.-dec. 2010), 1569–1577. 7, 13

[HMCM10] HSU W.-H., MEI J., CORREA C., MA K.-L.: Depicting time evolving flow with illustrative visualization techniques. In *Arts and Technology, vol. 30 of Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering*. Springer Berlin Heidelberg, 2010, pp. 136–147. 7, 11

[KML99] KIRBY R., MARMANIS H., LAIDLAW D.: Visualizing multivalued data from 2D incompressible flows using concepts from painting. In *Proc. of IEEE Visualization '99* (Los Alamitos, CA, USA), VIS '99, IEEE Computer Society Press, pp. 333–340. 6, 7, 8

[PBL04] PARK S., BUDGE B., LINSEN L., HAMANN B., JOY K.: Multi-dimensional transfer functions for interactive 3d flow visualization. In *Proc. of the 12th Pacific Conference on Computer Graphics and Applications* (oct. 2004), pp. 177–185. 6, 7

[SGS05] STOLL C., GUMHOLD S., SEIDEL H.-P.: Visualization with stylized line primitives. In *Proc. of IEEE Visualization 2005* (oct. 2005), pp. 695–702. 7, 8

[vW02] VAN WIJK J.: Image based flow visualization. In *Proc. of the 29th Int'l Conf. on Computer Graphics and Interactive Techniques (SIGGRAPH 2002)* (New York, NY, USA, 2002), SIGGRAPH '02, ACM, pp. 745–754. 7