SIMULATION OF AIR CONDITIONING FLOW PATTERN IN PASSENGER VAN

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FACULTY OF ENGINEERING
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BORANG PENYERAHAN LAPORAN PROJEK

Judul: SIMULATION OF AIR CONDITIONING FLOW PATTERN IN PASSENGER VAN

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THE SIMULATION OF AIR CONDITIONING FLOW PATTERN IN PASSENGER VAN

ISMANDI BIN JUNAIDI

This report is submitted in partial fulfillment of the requirement for the Degree of Bachelor of Engineering (Hons.) Mechanical and Manufacturing System from the Faculty of Engineering

Universiti Malaysia Sarawak

2001

Dedicated to:

Junaidi Bakar & Norpiah bt. Hj Nawi,

Family and friends.

Approval Sheet

This project report attached here to, entitled **"THE SIMULATION OF AIR CONDITIONING FLOW PATTERN IN PASSENGER VAN"** prepared and submitted by **Ismandi b. Junaidi** as a partial fulfilment of the requirement for the degree of Bachelor of Engineering with Honours in Mechanical and Manufacturing system is hereby read and approved by:

Professor Madya Ir. Dr. Wan Ali Wan Mat   Date : 1 Oktober 2001

(Supervisor)

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BISMILLAHIRRAHMANIRRAHIM

"IN THE NAME OF ALLAH MOST GRACIOUS AND MOST MERCIFUL"

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ABSTRACT

The main objective of the project is to study the air flow pattern for an air conditioning system in passenger van. The study will include an analysis on the velocity and pressure field due to the different location of diffusers, outlets and inlet velocities. The method used in simulating the flow inside the van is Fluent Simulation Program. By doing several tests, the best flow pattern of air from an air conditioning unit would be determined. A well distribution of the air flow system from diffusers will be considered as the best flow pattern for supplying cooled air inside the van. However humidity, compressibility and temperature effects were not being considered at this stage.

ABSTRAK

Objektif utama projek ini ialah untuk mengkaji corak aliran udara yang dihasilkan oleh system penghawa dingin di dalam van penumpang. Kajian ini meliputi analisis terhadap halaju dan tekanan berdasarkan halaju inlet dan outlet serta kedudukan penyaman udara itu sendiri. Melalui eksperimen-eksperimen yang dijalankan, aliran udara yang sesuai akan diperolehi. Aliran udara yang terbaik akan menghasilkan keadaan yang selesa pada suhu yang sesuai di dalam van. Walaupun begitu, factor 'humidity', 'compressibility' dan pengaruh suhu diabaikan dalam kajian ini.

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CHAPTER 1

INTRODUCTION

1.1 Introduction to Simulation

Simulation is one of the most powerful analysis tools available to those responsible for the design and operation of complex process or systems. In an increasingly competitive world, simulation has become a very powerful tool for the planning, design, and control of systems. The term model and system are key components of the definition of simulation. By a model means a representation of a group of object or ideas in some form other than that of the entity itself. By a system means a group or collection of interrelated elements that cooperate to accomplish some stated objective. The author believes that the systems that already exist can be simulated.

To simulate, according to Webster's Collegiate Dictionary, is "to feign, to obtain the essence of, without the reality." According to Schriber [1987], "Simulation involves the modeling of a process or system in such a way that the model mimics the response of the actual system to events that take place over time." So simulation will be defined as the process of designing a model of a real system and conducting experiments with this model for the purpose of understanding the behavior of the system or evaluating various strategies for the operation of the system. There is some more the definition of simulation.

- Simulation is the technique of constructing and running a model of a real system in order to study its behavior without disrupting the environment of the real system [Koskossidis and Brennan, 1984].
- Simulation of dynamic process is the iterative method, which enables the study of a system's properties through experimentation with the corresponding model of real plant [Korn and Wait, 1978].
- Simulation is the process of imitating important aspects of the behavior of a system in real time, compressed time or expanded time by constructing and experimenting with a model of the system [Neelamkavil, 1987].
- In comparison with analytical methods, simulation is more realistic and easily understandable but only where used correctly.
- Simulation enables the substitution of real world, complex experiments and pilot plants using the cheap and simple microcomputer, so that the experimentation is possible without any risk while the results are very illustrative.
- Simulation is a technique for conducting experiments on a model.
- Simulation is the procedure of solving differential equations through integration.

Thus, simulation can also be said as an experimental and applied methodology that seeks to accomplish the following:

- Describe the behavior of systems
- Construct theories or hypotheses that account for the observed behavior
- Use the model to predict future behavior

1.1 Simulation in Manufacturing

Regarding to the fierce competition, industry is now being forced into implementing expensive factory automation and is, therefore, carefully reexamining its operating policies and procedures. Simulation predicts the behavior of complex manufacturing systems by calculating the movement and interaction of system components. By evaluating the flow of parts through the machines and workstations and by examining the conflicting demands for limited resources, physical layout, equipment selections, and operating procedures also can be evaluated.

Simulation gives the ability to experience on the model rather than the real-world system, thereby allowing examining contemplated changes or new designs before actual purchase or installation.

1.3 Objective Of The Study

This study is about the simulation that had been done to the flow pattern of air conditioning in passenger van. From the simulation result the author will determine the specification and the design of the air-conditioning in the van, where should be the input and the output of the flow itself. So, the comfort condition is achieved in the passenger van itself.

From the analysis, the flow pattern of velocity vector and pressure is gathered.

The process in determining the pattern is done by using the FLUENT and preBFC V4 program. FLUENT Version 4 is designed to run as a stand-alone program. Geometries, which can be modeled with Cartesian coordinates in either 2D or 3D, may be solved using FLUENT V4 alone. For other analyses in which body-fitted coordinates are required, preBFC V4 can be used to set up the geometry and grid. Grid geometry also can be done directly by using FLUENT.

CHAPTER 2

LITERATURE REVIEW

By using the simulation software has done many researches. From the research a lot of improvement are gathered for a better product. Apart from that simulation also can reduce the cost instead of reducing the product production time.

2.1 Unstructured CFD Reduces Design Cycle for Automotive Air Conditioning and Heating Systems at the Climate Control Division of Ford.

According to George Anderson and Tim Hall, 1999, the product design engineers of Ford Motor Company, the new approach to model the design of air handling system and component such as evaporator cases, fans, and defrosters for vehicles air conditioning and heater system is by using RAMPANT from Fluent, Inc., Lebanon New Hampshire. RAMPANT is the first computational fluid dynamics software package that has found to be suitable for use by design engineers. RAMPANT reduced weeks of testing of a cowl box by showing why water under certain vehicle operating conditions was being drawn into the air inlet to the system and helped in evaluate alternate solution to the job. [FLUENT Journal Article, 1999]

2.2 HVAC Ductwork

Pressure losses in ducts used for heating and ventilating have a significant impact on overall system energy requirements and component sizing. CFD modeling helps eliminate the guesswork when estimating duct losses. Traditional duct fitting losses coefficients are based on fully developed flow and don't correctly account for close-coupled fittings. CFD allows you to quantify the real losses and avoid excessive margins of safety in your system design. [Fluent Inc., 2001]

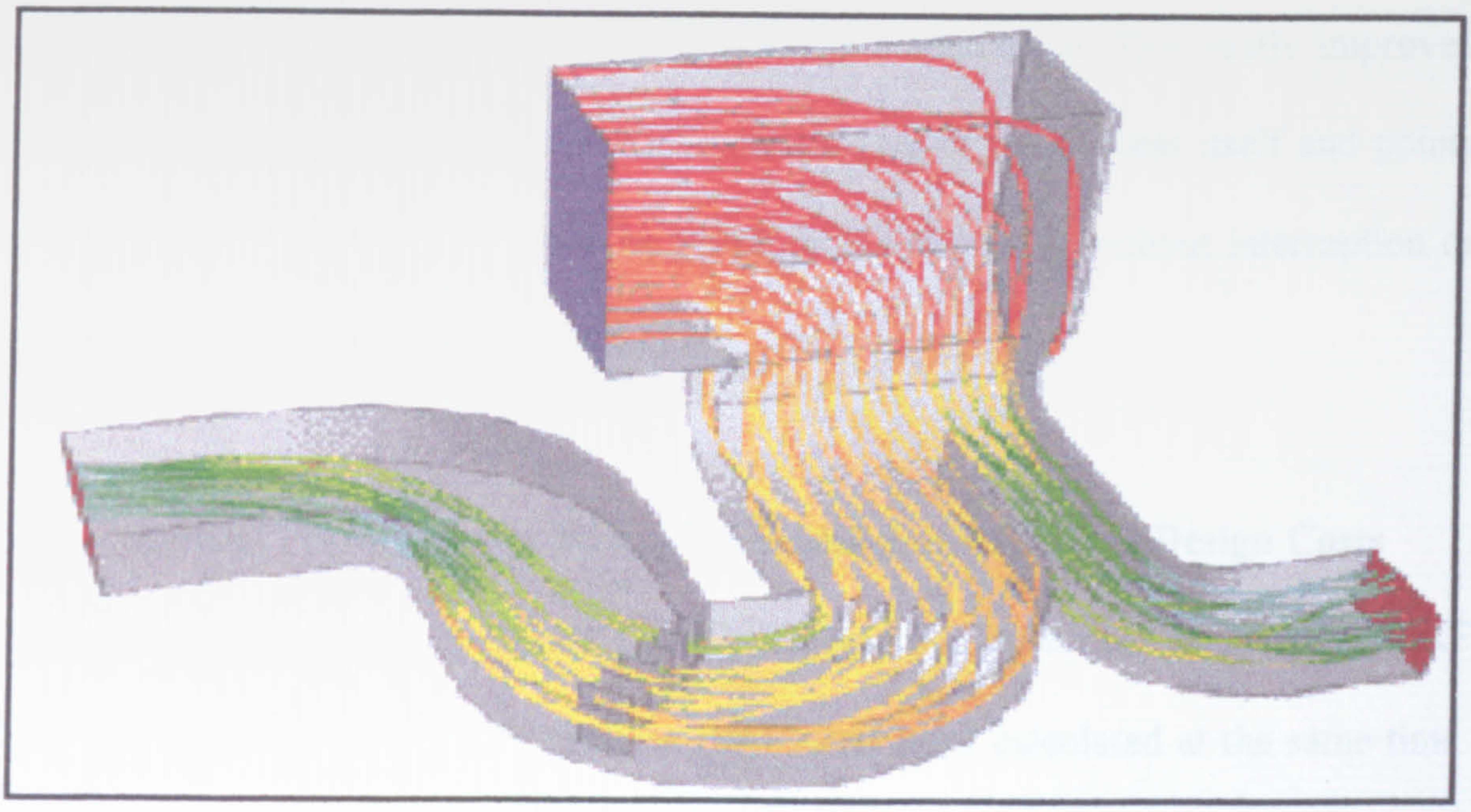

Figure 2.1 Flow path lines colored by pressure quantify head loss and reveal that turning vanes in the 180 hard-bend are not able to eliminate a large separated region downstream of the fitting. [Fluent Inc., 2001].

2.1 Limit Design Costs with Fluid Flow Simulation

According to the journal articles by Fluent Software Users by Brian Drew, the Business Unit Director of Fluent Inc. Lebanon, the existence of fluid flow simulation software is becoming popular as a tool to reduce the cost of design. During the designing process the design engineers are need to test various process chamber configurations without being to build and physically test each one. Understanding flow patterns inside a processing chamber can lead to improve uniformities and fewer particles at a lower development costs. [FLUENT Journal Article, 1999]

2.2 POLYFLOW Simulates An Internal Flow.

POLYFLOW is the tools to provide a wealth of information over the whole flow domain, which no affordable experiments could reveal. Data such as velocity and pressure distributions in the fluid, temperature and residence times, particle trajectories and stresses are typically obtained in a simulation. This vastly improved insight into the flow provides a better understanding of the process itself and points out improvements. These can then be tested on the computer without interruption of the production line. [Fluent Inc., 2001]

2.3 Virtual Prototyping at Mitsubishi Significantly Reduces Design Costs

MMC developed a model using FLUENT's multiple reference frames, or MRF model, in which stationary and rotating fluid zones were calculated at the same time. To validate the model, experimental data were taken using test equipment that was comprised of an inter-cooler, a radiator, a shroud, and a cooling fan. A Laser Doppler Velocimeter (LDV), located on the rear surface of the hub, was used to measure the flow data. Grid adaption and a standard turbulent model were used in the prediction model. The results of the CFD predictions showed good agreement with the experimental data to within 5 percent accuracy. At high-pressure loss locations, some reverse flow was observed and fluctuation of flow rate distribution was predicted because of swirling flow. [Fluent Inc., 2001]

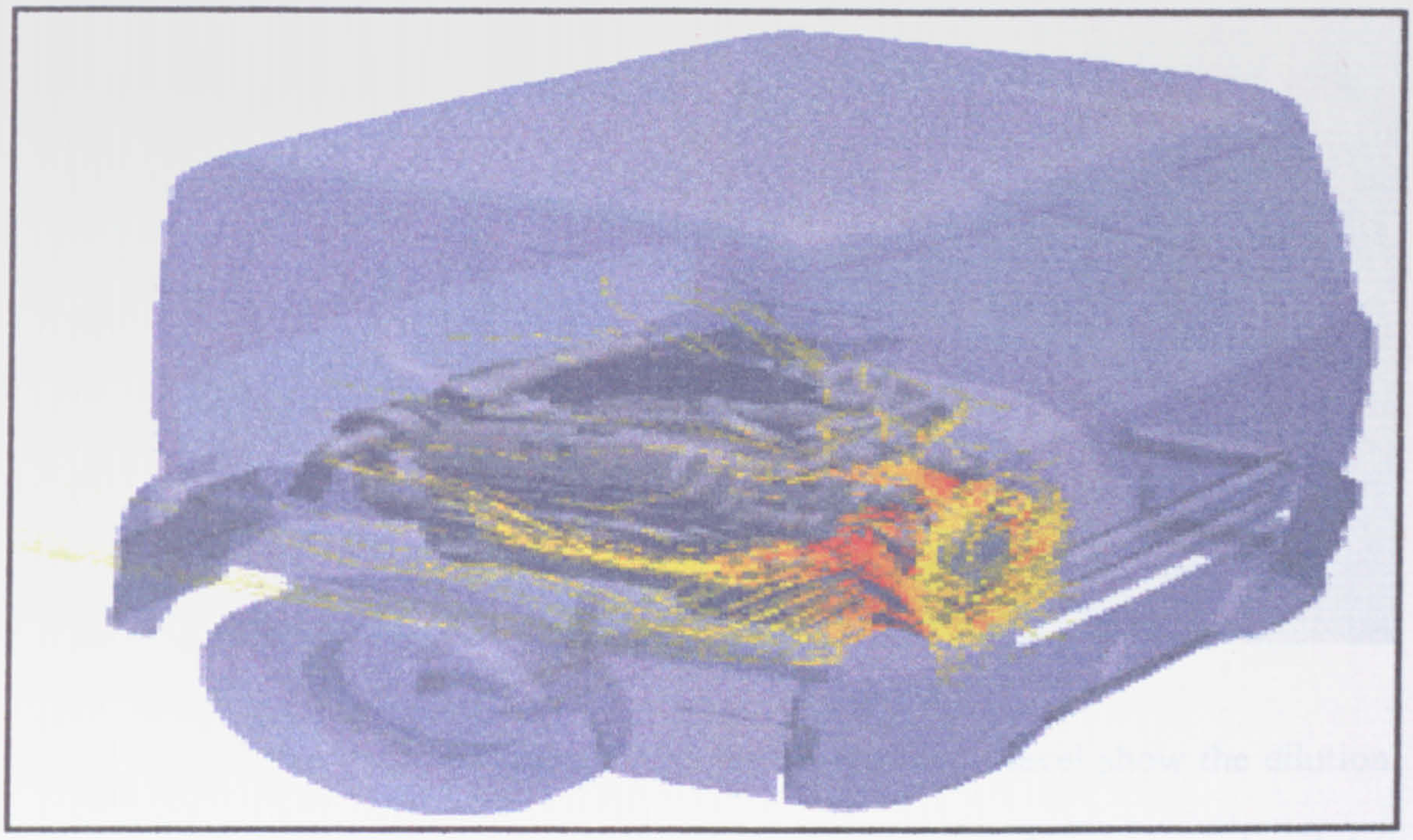

Figure 2.2 Flow pathlines inside the engine compartment. [Fluent Inc., 2001]

2.4 Building Air Intake and Exhaust Design: Plumes from Stacks in a City Block

Proper design of building air intake and exhaust systems requires understanding of the complex behavior that plumes from stacks can exhibit when the building exhausts are located within the midst of several other nearby buildings, structures, or terrain. To meet the needs for accurate predictions of exhaust dilution and airflow patterns between buildings, Airpak has provide physical modeling as the economical alternative to full-scale field evaluations. [Fluent Inc., 2001]

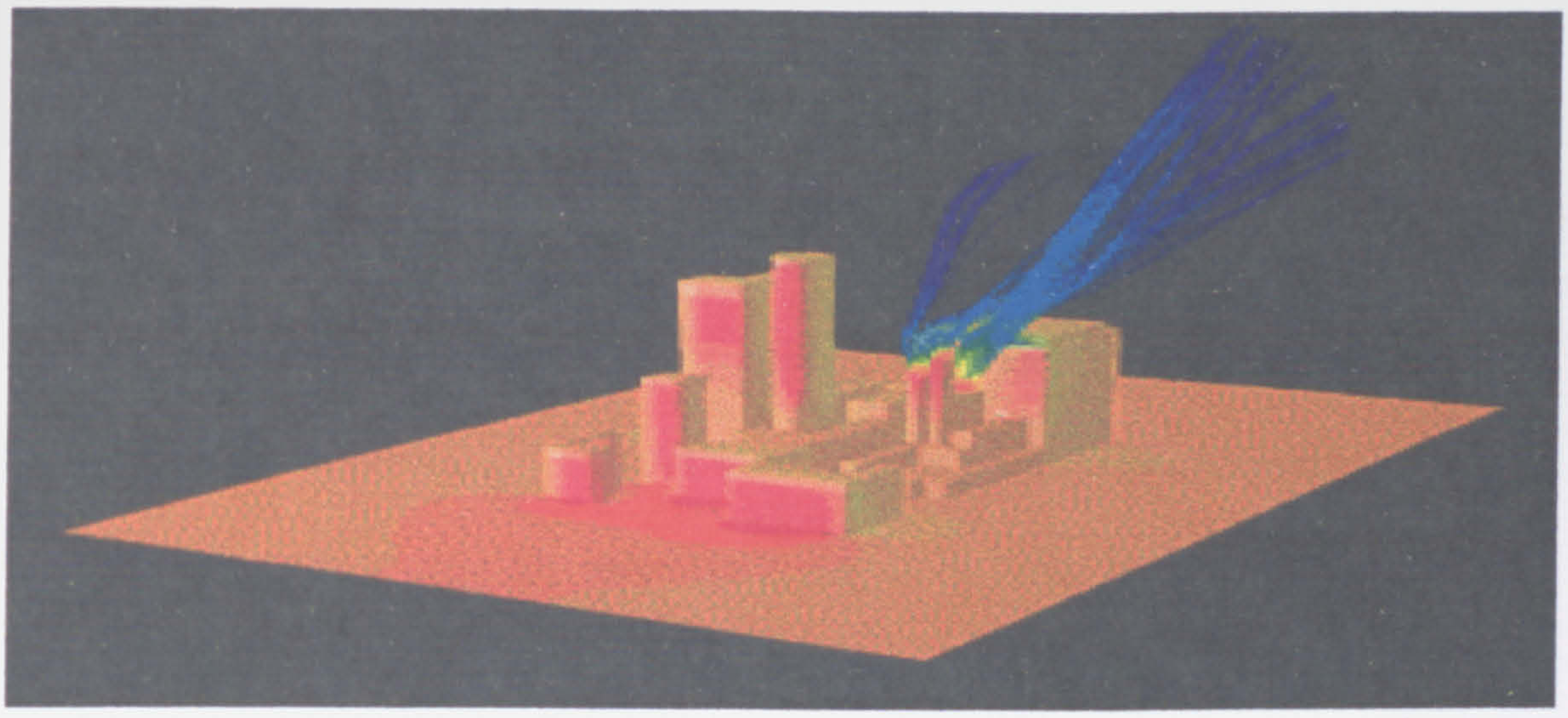

Figure 2.3 Plume particle traces colored by concentration level show the dilution and trajectory of the contaminants while surfaces are colored by surface pressure magnitude. [Fluent Inc., 2000]

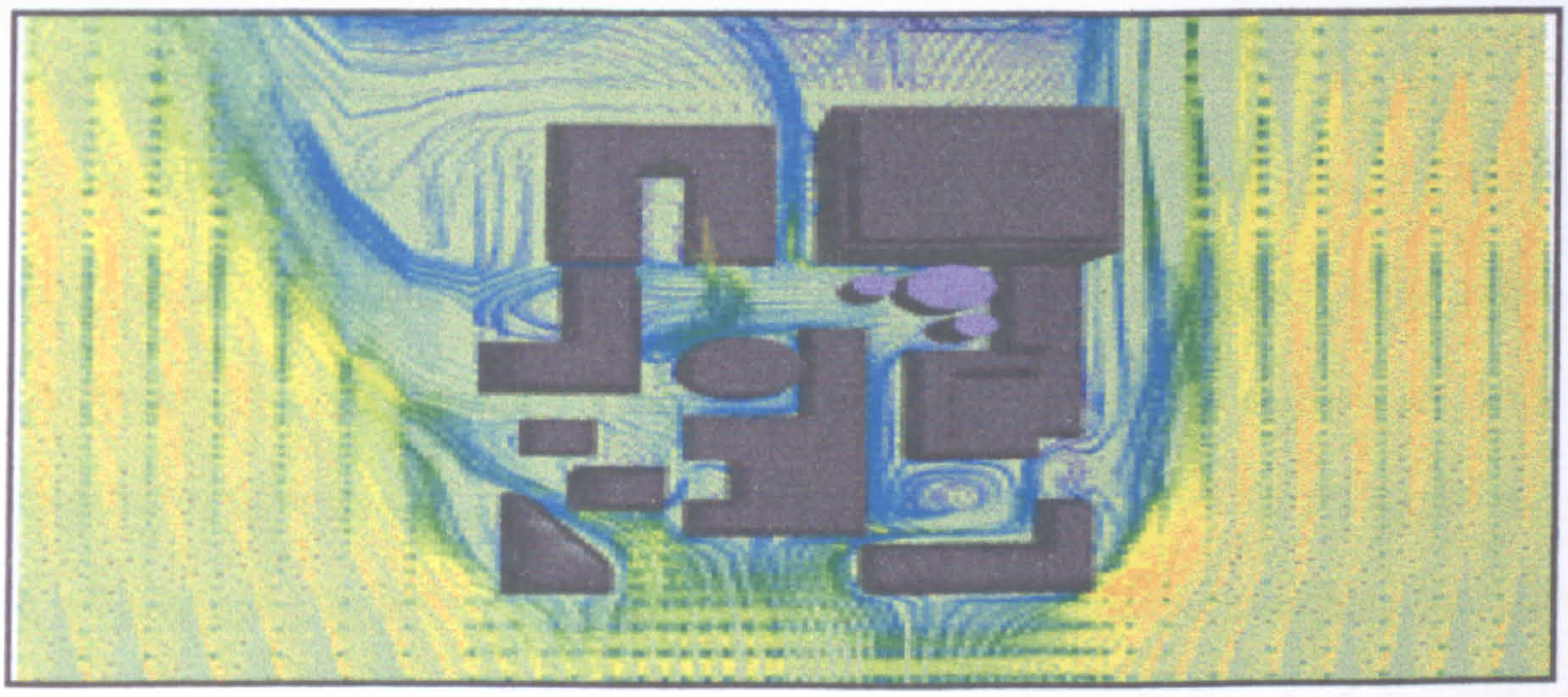

Figure 2.4 Velocity vectors on a horizontal cross-section show the complex airflow patterns that develop between buildings. [Fluent Inc., 2000]