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Chapter 1 : 2 + 1 Highways: Overview and Future Directions

Future Directions One possible direction is to continue expanding the material database of MINIMOS-NT with multinary III-V materials of relevance, such as III-Nitrides and III-Antimonides. Including group II-VI semiconductors is also feasible.

Highlight and copy the desired format. On Epidemiology and Geographic Information Systems: A Review and Discussion of Future Directions. Emerging Infectious Diseases, 2 2 , Abstract Geographic information systems are powerful automated systems for the capture, storage, retrieval, analysis, and display of spatial data. While the systems have been in development for more than 20 years, recent software has made them substantially easier to use for those outside the field. The systems offer new and expanding opportunities for epidemiology because they allow an informed user to choose between options when geographic distributions are part of the problem. Even when used minimally, these systems allow a spatial perspective on disease. Used to their optimum level, as tools for analysis and decision making, they are indeed a new information management vehicle with a rich potential for public health and epidemiology. Geographic information systems GIS are "automated systems for the capture, storage, retrieval, analysis, and display of spatial data" 1. Common to all GIS is a realization that spatial data are unique because their records can be linked to a geographic map. The component parts of a GIS include not just a database, but also spatial or map information and some mechanism to link them together. GIS has also been described as the technology side of a new discipline, geographic information science 2 , which in turn is defined as "research on the generic issues that surround the use of GIS technology, impede its successful implementation, or emerge from an understanding of its potential capabilities. Few would argue that GIS has little to offer the health sciences. On the other hand, like other new technologies, GIS involves concepts and analytic techniques that can appear confusing and can lead to misunderstanding or even overselling of the technology. In this article, we attempt to bridge the gaps between the principles of geographic information science, the technology of GIS, the discipline of geography, and the health sciences. Computers were first applied to geography as analytical and display tools during the s 3. GIS emerged as a multidisciplinary field during the s. Several factors combined in the s to reinforce GIS development. First, computers became more accessible and less costly. Second, mainframe computers gave way to minicomputers and then workstations, which gave great power to the user and included the access to networks that has led to its own revolution in technology. Third, the types of user interface required to operate technical software changed from batch, command-line, and remote access to windowing systems and "point and click" graphic interaction. What had been expensive, slow, and difficult has rapidly become inexpensive, fast, and easy to use. A final but essential precondition to GIS development was the broad availability of public domain digital map data, in the form of maps of the landscape from the U. Geologic Survey and for census areas from the U. The current GIS World Sourcebook 5 lists hundreds of system suppliers and sources of information and catalogs system capabilities. In short, GIS has now come of age, to the extent that the contributions of a growing number of parallel disciplines have both influenced and been influenced by GIS. Other disciplines now affecting GIS include forestry, transportation planning, emergency services delivery, natural hazards planning, marketing, archeology, surveying, and criminal justice. A wide array of capabilities and information awaits the health scientist ready to pursue an interest in GIS. In this article, we consider the functional capabilities of GIS and how they can relate to epidemiology. We then review studies in epidemiology and health science where GIS has already made a contribution and introduce the technologic and analytic background. We review spatial analytic methods and concepts of use in epidemiology and conclude by examining what the near future holds for technologic changes and what these changes mean for the study of emerging infectious diseases and other health applications. GIS functional capabilities follow the standard GIS definitions; therefore, GIS can bring together the elements necessary for problem solving and analysis. Data capture implies that 1 data can be input into the GIS from existing external digital sources; this is particularly the case when no data exist for a project, and the base data must be assembled from other studies, public domain datasets, and images. This usually means that GIS must be able to import the most

common data formats both for image-type raster and line-type vector maps. Data storage implies storage of both map and attribute data. Attribute data are usually stored in a relational database management system contained within the GIS and accessed by a spreadsheet or query-driven user interface. For storage, map data must be encoded into a set of numbers so that the geometry of the map is available for query, but also so that the map is stored digitally in one or more files. Image maps are usually stored as gridded arrays. Line maps are encoded by any one of several systems, but usually by using both the coordinate information and encoded topology, so that the relationships between points, lines, and areas, such as the adjacency of regions or the connectedness of lines, are known in advance. The more efficient and flexible these data formats or structures, the more operations can be performed on the map data without further processing. Data records in GIS can be retrieved in one of two ways. GIS also allows spatial retrieval. The user could select all clinics by region, by their latitude, or by their distance from the capital. The user could also select all clinics that are more than 10 km from a major road and within m of a river or lake. In addition, combining searches is possible. There could be several data "layers," for example vegetation, rivers, transportation, and population of villages. A single retrieval could combine data from each of these layers in a single query. Layers can also be weighted, so that rivers, for example, are twice as important as roads in selecting villages with a population under surrounded by forest. Display functions include predominantly the making of maps. Tools must exist for constructing many types of maps, such as contours, symbols, shading or choropleth, and sized symbols. Formal map display often follows a series of more temporary map images, usually without a strict map composition, and the result of a test, an analysis, or a query. In addition, the GIS must be able to output finished format of maps to a medium, such as PostScript, on a plotter or printer, or onto photographic film. Many tools exist to support field data collection. Tasks in which ancillary demographic information needs to be input and coregistered are simple. Habitat associated with a vector e. If these data are georegistered, integration is possible. One of the most useful functions is called address matching, in which street addresses with house numbers and street names are automatically placed into an administrative unit or placed as a dot on the map. Thus a digital phone list or mailing list of patients can be merged with the remainder of the data. The ability to display maps often goes far beyond their final or use in the laboratory. Often a GIS image map is more accurate and up to date than anything available locally. Existing Applications of GIS in Epidemiology Epidemiologists have traditionally used maps when analyzing associations between location, environment, and disease 6. GIS is particularly well suited for studying these associations because of its spatial analysis and display capabilities. Recently GIS has been used in the surveillance and monitoring of vector-borne diseases 7 - 9 water borne diseases 10 , in environmental health 11 - 13 , modeling exposure to electromagnetic fields 14 , quantifying lead hazards in a neighborhood 15 , predicting child pedestrian injuries 12 , and the analysis of disease policy and planning In a recent study in Baltimore County, Maryland, GIS and epidemiologic methods were combined to identify and locate environmental risk factors associated with Lyme disease 7. Ecologic data such as watershed, land use, soil type, geology, and forest distribution were collected at the residences of Lyme disease patients and compared with data collected at a randomly selected set of addresses. A risk model was generated combining both GIS and logistic regression analysis to locate areas where Lyme disease is most likely to occur. Combined with data from surveillance and management activities, GIS and GPS provide a powerful tool for the analysis and display of areas of high disease prevalence and the monitoring of ongoing control efforts. GIS is being used to identify locations of high prevalence and monitor intervention and control programs in areas of Guatemala for onchocerciasis 9 and in Africa for trypanosomiasis Spatial and ecologic data are combined with epidemiologic data to enable analysis of variables that play important roles in disease transmission. This integration of data is essential for health policy planning, decision making, and ongoing surveillance efforts. GIS enabled researchers to locate high prevalence areas and populations at risk, identify areas in need of resources, and make decisions on resource allocation Epidemiologic data showed a marked reduction in prevalence in villages where pumps were introduced. GIS was used in designing a national surveillance system for the monitoring and control of malaria in Israel The system included data on the locations of breeding sites of Anopheles mosquitoes, imported malaria cases, and population centers. The GIS-based surveillance system provided means for administrative collaboration and a network to mobilize localities in

the case of outbreaks. A major aspect of the program was to identify environmental factors that affect the patterns of disease risk and transmission. The overall goal of the program was to develop predictive models of vector population dynamics and disease transmission risk using remotely sensed data and GIS technologies. Remotely sensed data have been used in many vector disease studies 8 , 17 , 21 - Remote sensing and GIS were used to identify villages at high risk for malaria transmission in the southern area of Chiapas, Mexico 8. In Kwara State, Nigeria, a temporal analysis of Landsat Thematic Mapper TM satellite data was used to test the significance of the guinea worm eradication program based on changes in agricultural production Spatial Analysis and GIS GIS applications show the power and potential of such systems for addressing important health issues at the international, national, and local levels. Spatial analysis refers to the "ability to manipulate spatial data into different forms and extract additional meaning as a result" It encompasses the many methods and procedures, developed in geography, statistics, and other disciplines, for analyzing and relating spatial information. Spatial relationships, those based on proximity and relative location, form the core of spatial analysis. Gatrell and Bailey 26 describe three general types of spatial analysis tasks: These range in complexity from simple map overlay operations to statistical models such as spatial interaction and diffusion models. However, with its extensive data management and display capabilities, GIS offers much more than simple mapping. Map overlay operations allow the analyst to compute new values for locations based on multiple attributes or data "layers" and to identify and display locations that meet specific criteria For example, in targeting locations for mosquito vector control, one might want to identify areas that have low elevation, specific types of vegetation favored by mosquitoes, and are within m of ponds or other water bodies. Each of these attributes comprises a distinct data layer. With GIS, one can create m buffers around water bodies and then select areas meeting all three criteria. Display of these areas on a GIS-generated map has obvious benefits for planning vector control strategies. As indicated previously, this general class of procedures for weighing and overlaying maps, also known as "suitability analysis," has been used in diverse health applications. Typically the criteria and weights attached to them are specified by the analyst based on expert knowledge or prior research. Using the computational and visual display capabilities of GIS, one can then explore the sensitivity of results to the weights and cutoff values used. Another approach is to employ regression analysis to generate the linear combination of factors that best explain spatial variation in disease prevalence. The weights from the regression model are used to create a composite index of risk which can then be mapped 7. Visualization is also an important tool for showing the change in disease patterns over time.

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Chapter 2 : CalSim 2 Future Directions

Future directions The future is only ahead of us and it can be incredible when it comes to space travel. There are many different ways that robotics can help the expansion and the creation of new ways to travel in space.

Data residency is also a consideration of data owners responsible for protecting and securing data from unintended access. Given the complexity of the issue, a stepwise improvement plan is necessary. Jan 30 36 mins Dr. SDRs handle waveforms programmatically are used in fundamentally new ways for multiple domains e. Strategic use of these QoS policies enables intelligent behavior in middleware and allows the application developer to focus on the domain. In this webinar, we examine one application in detail and explore how it uses DDS QoS policies to address several non-functional requirements. Considering the technological trends towards data-centricity and the rate of adoption, tomorrow DDS will be at the heart of an incredible number of Industrial IoT IIoT systems. From authentication and access control to integrity and encryption, learn how to leverage DDS Security features to secure your connected system against cyber attacks, while maintaining a flexible, scalable architecture. This presentation describes the directions and approach for the next generation of SysML v2 to provide capabilities that address the limitations of SysML v1, and enable the evolving practice of MBSE. This webinar, Part II of the OMG DDS Webinar series, will cover in detail the mechanisms available in DDS to meet challenging real-world application requirements; from discovery to state management, information consistency, data durability, reliability and scalable information distribution. With over 20 different quality-of-service Qos policies DDS provides ready-made configurable patterns that can be used to meet most of these use-cases. Learn to leverage DDS Qos and patterns to simplify your application code and increase the robustness of your system. Presented by Gerardo Pardo-Castellote, Ph. A Conversation with Dr. Ed Hammond and Ken Rubin Recorded: A Standards Story Recorded: Jun 20 31 mins Robert A. Considering the technological trends towards data-centricity and the rate of adoption, tomorrow, DDS will be at the heart of an incredible number of Industrial IoT IIoT systems. After attending this webcast you will know the fundamentals required to start using DDS in your next project. Presented by Angelo Corsaro, Ph. Challenges and the Need for Standards Recorded: Data residency issues result from the storage and movement of data and metadata across geographies and jurisdictions. Attend this webinar to learn more about data residency:

Chapter 3 : Future Directions for SysML v2

Future Directions for SysML v2 Since that time, much has been learned about applying MBSE with SysML. This presentation describes the directions and approach for the next generation of SysML (v2) to provide capabilities that address the limitations of SysML v1, and enable the evolving practice of MBSE.

Ozone, an allotropic form of oxygen possesses unique properties which are being defined and applied to biological systems as well as to clinical practice. As a molecule containing a large excess of energy, ozone, through incompletely understood mechanisms, manifests bactericidal, virucidal and fungicidal actions which may make it a treatment of choice in certain conditions and an adjunctive treatment in others. These first treatment attempts, however, were hampered by technological difficulties. Medical ozone generators have since been developed and refined. They differ from industrial generators in their capacity to deliver the purest ozone-oxygen mixtures in precise dosages. In the last few years ozone treatment has seen growing interest from diverse medical disciplines, and research is in progress to delineate its effects on biological systems and to define its clinical applications. Priestly and Cavendish noted that electrical sparks fired in a closed volume of air resulted in volume compression. In , Schonbein repeated these experiments, concluded that this odor was due to a gas which he named ozone, from the Greek ozein odorant , and described several of its properties. Still today, theoretical issues remain regarding its electron structure, the varieties of its molecular configurations and its kinetics. Mariniak and Delarive showed that it is an allotropic form of oxygen, and Mulliken and Dewar clarified its molecular architecture. Chemists made use of these properties to study complex molecules by cleaving them into smaller fragments. Harries, by such methods, discovered the structure of natural rubber. Wiesbaden, Germany became the first city to use ozonation for purification of its drinking water , followed by Zurich, Florence, Brussels, Marseille, Singapore and Moscow the largest installation in the world , among others. Kleinmann is said to have carried out the first bacteriological studies on pathogenic organisms using the Siemens tube, shortly after its invention. Hansler developed one of the first reliable models of medical ozone generators. It has a bond angle of [3], which resonates among several forms, is distinctly blue as a gas and dark blue as a solid; 4 O4 is a very unstable, rare, nonmagnetic pale blue gas which readily breaks down into two molecules of oxygen. Ozone is a powerful oxidant, surpassed in this regard only by fluorine. Shonbein,3 in , discovered that it reacts with ethelene. Exposing ozone to organic molecules containing double or triple bonds yields many complex and as yet incompletely configurated ephemeral transitional compounds zwitterions, molozonides, cyclic ozonides , which may be hydrolyzed, oxidized, reduced or thermally decomposed to a variety of substances, chiefly aldehydes, ketones, acids or alcohols. Ozone reacts with saturated hydrocarbons, amines, sulfhydryl groups and aromatic compounds. The most studied is lipid peroxidation although interactions have yet to be more fully investigated with complex carbohydrates, protein, glycoproteins and sphingolipids. These dynamics are especially relevant for medical applications because some of the most practiced methods in ozone therapy involve the mixing of a small volume of whole blood with a pure oxygen ozone mixture and subsequently returning it to the patient. In this manner, it is calculated that the dose of ozone administered will perform its therapeutic functions without disrupting blood constituents. Since there are a variety of lipid components in whole blood, it is of more than theoretical interest to determine the end products of ozone per oxidation and their effects, not only on physiological systems but on the integrity of ambient patholgenic organisms, since one of the mechanisms of viral inactivation is thought to be through this modality. Of these, lipid hydroperoxides, the most extensively studied, are known in sufficient concentrations to manifest their toxicity by altering cell membranes. Acted upon by glutathione peroxidase, they are reduced to their corresponding alcohols. Method of Manufacture and Precautions The production of ozone-oxygen mixtures for human and veterinary applications is subject to important technical consideration and standards. The purity of the oxygen source is especially emphasized since nitrogen, in the presence of high energy fields, forms toxic nitric oxides. Caution is needed not to appose ether and an ozone, an especially reactive mixture. Listed contraindications to ozone treatment[5] include acute alcohol intoxication, recent myocardial infarction, hemorrhage from any organ, pregnancy,

hyperthyroidism, thrombocytopenia and ozone allergy. Methods of Administration, Dosage, and Clinical Applications External Ozone Gas Application Historically, ozone was first administered by application to external body surfaces to determine its effects on a variety of lesions, A. Wolff,[13] in , is credited for using local ozone treatments for wounds, fistulas, decubitus ulcers and osteomyelitis. Like natural rubber which cracks and fritters when exposed to oxygen-ozone mixtures, early materials caused ozone to "bag" around skin surfaces and met with early oxidation disuse. Today, specially designed plastics Teflon enable extremities or portions of the head or torso to be comfortably encased in a space where a determined dosage ratio of oxygen to ozone is administered at a chosen flow rate. In this way, the walls of the transparent bags do not touch the patient, an important consideration in burn treatment. Indication for external ozone application include poorly healing wounds, burns,[14] staphylococcal infections, fungal and radiation lesions, herpes simplex and zoster, and gangrene diabetic or Clostridium. Dosage is adjusted to the condition treated. High ozone concentrations are used for disinfection and cleaning or debridement , while low concentrations promote epithelialization and healing. The list of indications has expanded to include proctitis and hemorrhoids. It is reported that in inflammatory diseases of the bowel, ozone promotes healing and restores the flora balance disturbed by pathogenic organisms. Microsporidia, a tiny, rarely detected parasite may be responsible for many cases of AIDS wasting illness,[17] and studies await determination of its susceptibility to ozone treatment. Major Autohemotherapy AHT Whereas it can be readily understood that external ozone applications produce local effects such as disinfection, wound healing or local circulatory enhancement, the technique of introducing ozone into the circulation poses more complex theoretical issues. In the technique of major autohemotherapy, 50 to ml of blood is drawn from the patient, mixed with a dose of ozone-oxygen of a predetermined concentration, then returned via the same intravenous catheter butterfly. Returned to the patient, the ozonated blood is rapidly distributed to all tissues. In the treatment aliquot of blood, it is gauged that the dose of ozone given not only will exert therapeutic actions locally virucidal activity, oxygenation, increased red cell fluidity , but will determine beneficial systemic actions. Clinically, some patients, upon receiving their own ozonated blood, report a faint background taste of ozone, which may be an indication of its survivability in solution for at least a few seconds. Major autohemotherapy has been applied to the treatment of several conditions, including acute and chronic viral infections hepatitis , some carcinomas, circulatory disturbances diabetes, arteriosclerosis , and hyperlipidemia. Of interest are the reports of some patients, who after receivng this treatment experience feelings of well-being lasting for a few minutes to several hours. Whether this represents a placebo effect, a metabolic alteration or possibly a neuro-psychiatric mechanism remains to be determined. Miscellaneous Applications Although the above techniques of ozone administration represent the majority of hospital or office-based procedures, others deserve mention. Minor Autohemotherapy In this technique, 10 ml of venous blood is drawn from the patient, mixed with ozone-oxygen, then injected intramuscularly. Listed indications include asthma, acne, some allergic conditions and some carcinomas. Up to 10 ml of pure ozone-oxygen may be slowly injected directly into the artery usually femoral , or into a vein, without incurring embolization since both gases are readily soluble in blood. Due to accidents produced by too rapid introduction of the gas mixture into the circulation, this technique is now rarely used. Intramuscular Injection Up to 10 ml of pure ozone-oxygen mixture is injected into the gluteus maximus muscle or the deltoid. This treatment along with major autohemotherapy is invoked as an adjunct to cancer therapy. Mixed into aqua bidestillata pyrogen free water, the half life of ozone is nine to ten hours at pH 7 and 20C ; and at 0C, it is doubled. Ozonated water finds applications in dental surgery where it is reported to promote hemostasis, enhance local oxygen supply and inhibit bacterial proliferation. Applied following tooth extraction or during dental surgery,[28] it may also be rinsed in conditions such as thrush and periodontal disease, swallowed in cases of gastritis or gastric carcinoma, or irrigated in chronic intestinal or bladder inflammation. Ozone Ointments Ozonated olive oil provides long term, low dose exposure of ozone and lipid peroxides to tissues. Decubitus ulcers and mycoses are indications for its use. One study [31] examined 10, samples and found no cases of hepatitis transmission. This technique may extend its efficacy to the HIV virus as one preliminary unpublished study indicates although once ensconced in the genetic cellular material, it is unclear how any agent could inactivate it without compromising cellular integrity. Produced as a result of interactions between

industrial gases, oxygen and ultraviolet rays, there is evidence of synergistic action on pulmonary compromise. The effects of pure ozone, however, need to be differentiated from those of smog. The majority of studies have been performed on animals who show great interspecies variability in their response to inhaled ozone. Extrapolation to humans is difficult due to differences in pulmonary anatomy and physiology. Mice[32] seem to be the most sensitive LD50, 22 ppm for 3 hrs and birds[33] the least turkeys survived ppm ozone for 3 hrs. While overdose is marked by pulmonary edema and hemorrhage, long term, low level exposure produces poorly understood, sometimes contradictory findings. Reported effects[34] include enhanced enzyme activity, as evidenced by increase in glucose utilization, lactate and CO2 formation and elevated glucosephosphate dehydrogenase; an increase in the NADPH-cytochrome P content in rat lung pointing to enhancement of metabolizing enzymes; increased lung fibroblast glucose uptake, and production of lactate and pyruvate. Humans exposed to ambient ozone 0. Large intersubject response differences are notable. The threshold for significant changes in respiratory compromise ranges from 0. Histological findings extrapolated from primate research points to ciliated cell inhibition and type 2 cell proliferation, increased membrane permeability and variable inflammatory response. Pulmonary effects from ozone in low doses appear to include metabolic activation of lung cells while higher doses produce evidence of cellular metabolic compromise. In the methodology of ozone treatment, care is given to avoid the escape of ozone into the treatment area and modern machines are equipped to catalytically convert excess ozone to oxygen during administration. Interestingly some studies point to possible beneficial effects of low dose ambient ozone. For the reason that below 0. Studies of human blood in young adult males exposed to 0. RBC membrane fragility, glucosephosphate dehydrogenase and lactate dehydrogenase enzyme activities were increased, while RBC acetyl cholinesterase and reduced glutathione reductase were not significantly changed. Serum vitamin E and lipid peroxidation levels were significantly increased. These findings indicate that ozone exposure increases metabolic activation parameters in red blood cells. According to other researchers,[20,24,43] the direct intravascular injection of pure oxygen-ozone mixtures results in the following responses: Further physiological effects include 3 an enhanced oxidative decarboxylation of pyruvate with the formation of Acetyl-CoA, and consequent citric acid cycle activation, 4 a direct influence on the mitochondrial transport system with reduction of NADH and oxidation of cytochromes, and 5 an increase in RBC pliability, blood fluidity, and arterial PO2. Mechanisms of Bactericidal, Virucidal and Fungicidal Action Although the inhibitory and lethal effects of ozone on pathogenic organisms have been observed since the latter part of the 19th century, the mechanisms for these actions have not yet been satisfactorily elucidated. Ozone is a strong germicide needing only a few micrograms per liter for measurable action. Viruses differ in their susceptibility to destruction by ozone. The resistance of polio virus type 2 was 40 times that of coxsackie AS,[46,47] and in an experiment using a continuous flow mixed reactor under controlled laboratory conditions, relative resistance in descending order was found to be: In pure water, at maximal solubility of ozone and room temperature, Echovirus type 29 is inactivated in one minute, polio virus type 1 in two, type 3 in three and type 2 in seven minutes. The cell envelope of Gram negative microorganisms such as E. Gram positive cells have a less complex, three layer envelope with a thick peptidoglycan middle layer. There is evidence for interaction with proteins as well. It is notable that higher organisms have enzymatic mechanisms to restabilize disrupted DNA and RNA, which could provide a partial explanation for why, in clinical treatment with ozone at doses prescribed, ozone appears to be toxic to infecting organisms and not to the patient. In one study, Candida utilis cell growth inhibition with ozone was greatly dependent on phases of their growth, budding cells exhibiting the most sensitivity to its presence. Viruses are parasites at the genetic level, separated into families based on their structure, type of nucleic genome and mode of replication. Many virions contain a phospholipid envelope with glycoprotein spikes, encasing the nucleocapsid which contains nucleic acids DNA or RNA , and structural proteins including enzymes. Lipid-containing viruses are sensitive to treatment with ether, assorted organic solvents, and ozone, indicating that disruption or loss of lipids results in impaired or destroyed infectivity. Viruses containing lipid envelopes include the Herpes viridae a large family grouping the Simplex, Varicella-Zoster, Cytomegalovirus and Epstein-Barr viruses; the Paramyxoviridae mumps, measles ; the Orthonyxoviridae influenza ; the Rhabdoviridae rabies ; and the Retroviridae HIV. The HIV virus has an outer

envelope made of a double layer of lipids penetrated by proteins of several types encasing two molecules of RNA.

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Chapter 4 : Digital Transformation in Health Care â€“ II â€“ IEEE Future Directions

This presentation describes the directions and approach for the next generation of SysML (v2) to provide capabilities that address the limitations of SysML v1, and enable the evolving practice of.

This is an open access article distributed under the Creative Commons Attribution License , which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. Abstract Most of the rural transportation system is composed of two-lane highways, and many of them serve as the primary means for rural access to urban areas and freeways. In some highways, traffic volumes can be not high enough to justify a four-lane highway but higher than can be served by isolated passing lanes, or can present high number of head-on collisions. This type of highway is used to provide high-performance highways as intermediate solution between the common two-lane highway and the freeway. Successful experiences reported in Germany, Sweden, Finland, Poland, or Texas US may suggest that they are potentially applicable in other countries. The significance of this paper is twofold: In two-lane highways, faster vehicles that want to travel at their desired speed face the on-coming traffic in the opposite lane and may suffer delays because of their inability to pass slow-moving vehicles. On the other hand, passes are conditioned by the opposing lane occupation, which generates a conflict area. In fact, even though passing is not one of the main causes of crashes in two-lane highways, its consequences are severe [6]. Therefore, the main objective was to separate physically both travel directions. Nevertheless, restricting passing opportunities in the whole segment could lead to risky maneuvers performed by the delayed vehicles, despite the quite low traffic demands in Sweden. The rural network had low level of service at medium traffic demands, where passing opportunities are restricted by the opposing traffic stream. Under those conditions, providing passing lanes increases the level of service compared to common two-lane highways. The separation between both travel directions is achieved through one median painted in green, between the side markings. The lack of physical carriers is due to a lower relative importance of head-on collisions. At traffic volumes close to capacity, vehicles on the passing lane face short gaps on the main lane while merging. They can contribute to head-on collision and provoke some drivers to continue passing at the transition zone or force vehicles on the base lane to brake. As a result, the number of conflicts in the merging area is increased and overall traffic efficiency is reduced. In this sense, merging areas act as bottlenecks that can reduce capacity and increase traffic conflicts at volumes close to capacity. Experimental studies have observed high speeds in passing lanes, in most of cases over the speed limit. Higher speed limits the capability of the driver to react under unexpected conditions, such as crossing fauna or slippery conditions. On the other hand, it can cause more conflicts with bicyclists or agricultural vehicles, which travel at a significantly lower speed. Special attention should also be drawn to single-lane sections. On those sections, drivers are not allowed to pass. In some cases, it can lead to illegal passing maneuvers or to very long queues that may not be dissolved on the downstream passing lane. Similar conditions apply to two-lane highways vi May require a separate network for slow-moving traffic, such as agricultural vehicles and cyclists vii High cost and land occupation to accommodate split level junctions Successful experiences reported in Germany, Ireland, Sweden, Finland, Denmark, Norway, Ireland, the US, Korea, and Japan may suggest that they are potentially applicable in other countries. The structure of the paper is as follows. Two opposite directionsâ€”elaboration or simplificationâ€”are reviewed. Finally, conclusions and remarks on future directions are presented in Section 5. This configuration leads to unique design aspects that must be considered before their implementation. They include, but are not limited to, recommended AADT range and speed limit, passing lane length, design of transition areas, cross section, intersection and access design, and markings and signing. Traffic Flow and Speed Limit Kirby et al. Passing lane closures are implemented in Finland and Sweden at peak traffic conditions, such as weekend peaks [10 , 27] Table 1. Another traffic variable to consider is the percentage or share of heavy vehicles. On the one hand, heavy vehicles have a lower desired speed and vehicle capabilities, thereby decreasing overall average travel speed [29 , 34] and increasing the number of desired passes, having a direct impact on the expected traffic performance and safety. It is important that designers provide land widths, turning radii, and other features,

such as pavement, to accommodate trucks without impeding their access and ability to maneuver. Similarly, additional lengths may be required to accommodate passing convoys of heavy vehicles [35 , 36]. For example, in the Utah DOT decision-making process for implementing passing lanes at US route , the freight corridor is worth 20 points out of a maximum of points, compared to the scores for passing lanes that total between 35 and 66 points [37]. Initial applications in Sweden were based on restripping existing 13 to 14 m wide pavements, while in Germany only one-third have been reconverted through stripping [2]. Table 2 summarizes the cross sections that are reported in international studies. There is a high variation in the carriageway width provision. The paved widths vary between 11 and 15 m. Generally, cross sections with cable barriers are wider than cross sections with painted median. Narrow traffic lanes have two objectives: The total width of the single-lane section is 5. Barriers include wide ropes, centerline rumble strips, or median barriers. Cable barriers are decided over paved median because they had the highest reduction on the number of fatalities in Sweden in the 90s: Given the scarce motorcycle traffic, cable barriers are not considered a safety issue. The total width of pavement is It also provides additional 1. Shoulders are narrower to avoid slower vehicles to move to the right side of their lane to allow illegal passing maneuvers in the left side of the lane. As discussed earlier, painted medians are preferred over cable barriers because of safety concerns. Desirable minimum stopping sight distance must be provided, although full overtaking sight distance is not required because the passes are only performed in the passing lane [32]. Therefore, the alignment is usually less generous. As they may include sections with two-lane highways, overtaking sight distance is usually required along the entire facility. Passing Lane Length Passing lane length affects both the two-lane subsection and the single-lane subsections of the highway. On the one hand, the longer the passing lane section, the higher the number of passes and higher reduction in platooning, although the effectiveness rate typically drops off with distance. On the other hand, the longer the single-lane section, the higher the increase in platooning due to passing restriction. Therefore, the passing lane length should be an equilibrium between the benefits to the two-lane section traffic and the disadvantages to the single-lane section traffic, as well as a function of topography and location of junctions [32]. In Germany, typical lengths of passing lanes are between 1. He found a strong correlation between the length of passing section, directional traffic volume, and share of incomplete dissolving processes. Specifically, the shorter the passing lane, the higher is the likelihood of having platoons dissolved at the transition. The maximum recommended length of 1, m was defined based on the percentage of followers on the single lane, which should not exceed On a follow-up project, Lippold et al. Medium length passing lanes â€” m presented the highest speeds, compared to shorter or longer passing lanes, because drivers continued accelerating at the second half of the passing lane. Additionally, increasing the length of the prohibition for overtaking reduced average speeds. Average speed was governed by the slowest vehicle when the prohibition to overtake was longer than 2. A summary comparing international passing lane lengths is provided in Table 3. In other countries, practice has shown that passing lane lengths between 1. This range agrees with the TWOPAS simulation results of Szagala [43], who concluded that passing lanes between and 2, m did not provide differences in PTSF combined for the whole range of traffic volumes. Based on the Aimsun simulation results, she recommended passing zone lengths between 1, and 3, m, depending on the directional traffic volume. Based on simulations, Cafiso et al. A critical transition is located immediately downstream of a lane drop, while a noncritical transition is located immediately upstream of a lane addition Figure 3. At the critical transition, vehicles in the passing lane are merging to the single lane and can head toward the opposing traffic. At the noncritical transition, vehicles are diverging to the passing lane and head away from each other. Based on observations in Germany, only about 1. The percentage can increase as the percentage of trucks increases. Therefore, a substantial buffer between the vehicles traveling in opposite directions is needed [2]. Existing passing lane standards may lead to large transition zones and therefore shorter two-lane subsections. Table 4 summarizes the international design criteria for transition zones. The main differences are observed at the critical transition, ranging between m in Germany and m in Finland. They usually include two tapers and a buffer section, while the noncritical transition only uses tapers. The range for noncritical transitions is narrower and varies from 50 to m. Comparison of international transition zone design. In some design guidelines [8 , 32], it is stated that the design must minimize the number of intersections in

order to avoid standing vehicles and concentrate turning movements. Major intersections should generally be located in the buffer areas between passing lanes in opposing directions of travel and should have left-turn lanes provided [1 , 26 , 32 , 34]. The intersections vary from priority intersections, U-turn facilities with left turn, at-grade roundabouts, or compact grade separation [8]. Left turns off the major road are only permitted at priority junctions located at single-lane sections, while left turns onto the major road are not permitted [8]. U-turn provisions are ideally provided at junction locations, and one of the easiest ways is a roundabout [20 , 23]. When the number of heavy vehicles is significant, at-grade roundabouts shall be avoided to minimize the impact on traffic performance, given that capacity of a roundabout is significantly decreased when the share of heavy vehicles increased [33]. In this sense, it must be indicated: For example, in Sweden, the end of the passing lane is indicated m before the start of the taper from the critical transition and at the start of the taper from the critical transition [10]. In Germany, the same sign is indicated and m before the start of the taper [1], while in Finland it is located in the beginning, in the midpoint, and m before the end of the passing lane [30]. One of the most important additional sign is the advance information on when the passing lane starts and how long it is. This sign is used to reduce frustration due to passing prohibition and encourage drivers to delay passing until the passing lane is approached [14 , 23 , 30 , 32]. Other additional signs can be located at the end of the passing lane to indicate the length of the prohibition to overtake. Based on field observations of passing times, Kaistinen et al. Marking of rural highways is enforced at the German Design Guideline [1]. Standardized cross sections and markings help the driver to identify which type of highway they are driving at without depending on road signs.

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