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Sequential Urban Change

Photographic interpretation, analysis, and planning are also applicable to urban communities of 50,000 population and smaller.

ABSTRACT: *Urban planning has made use of aerial photography for several years, but the majority of communities under 50,000 population consider the cost beyond their budget allotment and the use of the photography too limited in nature. This study of such a typical urban community hopes to show that the cost factor is not as great as imagined and that much useful information can be derived from the aerial photographs for use in urban planning.*

INTRODUCTION

WITHIN THE PAST 20 years considerable change has taken place in urban planning techniques, both in gathering of the data and its ultimate use in the overall planning program. During the period 1950–1956 urban use of aerial photography began a rapid upward climb urged along by federal pilot projects and private urban research corporations. During this period Green, Pownall, Stone, Witenstein and Wray studied such diverse locations as Birmingham, Ala., Madison, Wis., Rockville, Md., and Peoria, Ill. in terms of urban keys to be developed (Pownall and Stone), socio-economic city structure (Green) and urban land use (Witenstein and Wray).

In most urban studies, including the majority of those mentioned, photomosaics are first used to obtain a broad, small-scale perspective of the urban area, where the second stage involves an intensive study of stereopairs at a scale of 1:20,000 or larger. These two initial stages open the way for delineation of general urban patterns such as transportation lines, various age classes of residential areas, the Central Business District and a variety of commercial and industrial features. If sequential photography is obtained, a changing pattern within the urban area can be mapped and utilized in projecting future growth and the course of action necessary to maintain orderly urban growth.

Although studies have been made in urban area planning utilizing aerial photography, many have not actually led to a continuing use of the aerial photography on a sequential basis due to several factors: some have been pilot projects developed to serve a research purpose and after the research agency, either the federal government or some private research agency completed the study, the use of the aerial photography technique of gathering data ceased to be used; many small communities under 50,000 population have not been convinced of the long-term benefits and multiple uses of the aerial photography; still other communities have not experienced the sudden urban growth in the early 1960's that has affected the planning methods of some urban areas. This study merely seeks to examine briefly the cost factor involved, the general technique involved, and the accuracy of using aerial photography compared to basic ground methods of obtaining similar urban information.

THE STUDY AREA AND SOURCE OF PHOTOGRAPHY

The urban area selected for the study was the city of Janesville, Wisconsin and environs, an area of approximately 36 square miles encompassing all the major annexation areas proposed to 1970 (Figure 1).

Aerial photography for the urban area was obtained from the ASCS Photo Laboratory in Asheville, North Carolina, and the Cartographic Services Branch of the National Archives in Washington, D. C. for the years

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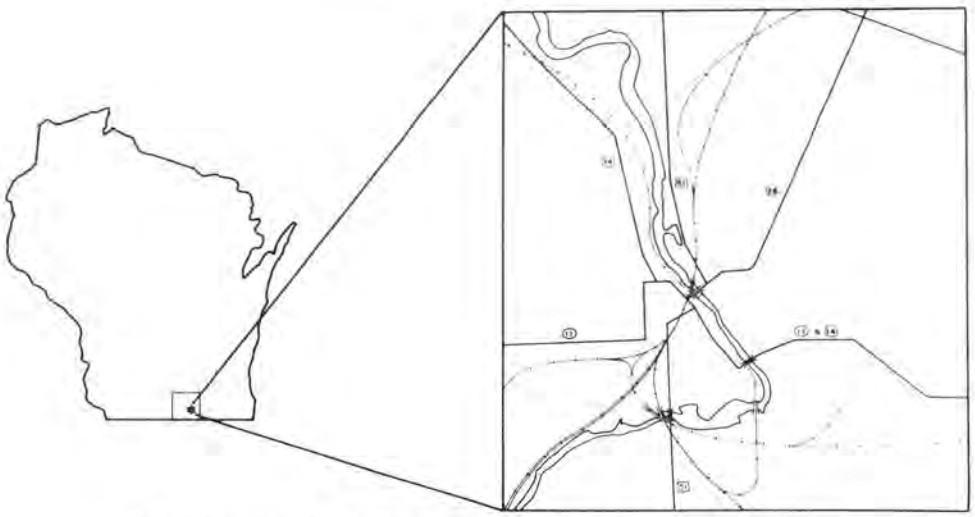


FIG. 1. Geographic location of the urban study of the city of Janesville, Rock County, Wisconsin.

1940, 1950, 1956 and 1963. Cost of the photography was $2.00 per sheet for the photo indexes with one sheet sufficing for each year's growth, $1.00 per glossy contact print at a scale of 1:20,000, with an average of 25 prints sufficing for each year depending on the location of the north-south flight lines, $2.75 per semi-matte print at an enlarged scale of 1:7,920 with an average of 12 prints sufficing for each year since stereo coverage is not possible at the size of the 1:7,920 enlargement. Whereas scale accuracy was somewhat limited near the edge of the prints, measurements in the inner half compared favorably with random ground checks and topographic map checks, primarily due to the fact that the local relief in the urban area, with the exception of bluff areas along the Rock River, were of a low order. This type of aerial photography is readily available for a town the size of Janesville which has witnessed a growth in population from 23,000 in 1940 to 40,000 in 1963, the period of time involved in this study. Although this type of photography could be used for a great many segments of urban planning, contract photography allows for greater scale accuracy and resultant increased utilization of the photos at a nominal increase in cost.

THE JANESVILLE, WISCONSIN URBAN STUDY

To increase the interpretative value of the aerial photographs, a sequence of urban growth maps were compiled to graphically show the developing pattern of urban-industrial development over the period 1940–1963. The general transportation grid of the urban area is shown in Figure 2 in conjunction with major large-scale land-use tracts for the year 1940. The street grid appears as a relatively regular pattern orientated north-south and east-west along the peripheral margins of the older pre-1940 core residential and Central Business District area, the older orientation being related to the channeling affect of the Rock River. In 1940 U. S. highways 14 and 51 and State highways 11 and 26 were major arteries of transportation, in addition to the Milwaukee, St. Paul and Pacific Railway and the Chicago, Northwestern Railway, with both modes of transportation affording a variety of compass-point transportation directions.

From Figure 2 it could be theorized that growth would proceed along major arteries of transportation in a type of ribbon pattern and along the Rock River at a moderate distance away from the immediate Central Business District warehouse and commercial area. This basic assumption would be further enhanced by the large sand and gravel ownership to the north and developed gold courses and cemeteries to the west which would generally preclude large-scale block building in these areas. At the same time a closer look at the photo mosaics revealed active farm land on relatively flat land to the east which would command high land values in this traditional farming area of the upper Midwest, and industrial development, railroad right of ways and some state owned land might tend to slow growth to the south.

It could also be projected that a green belt

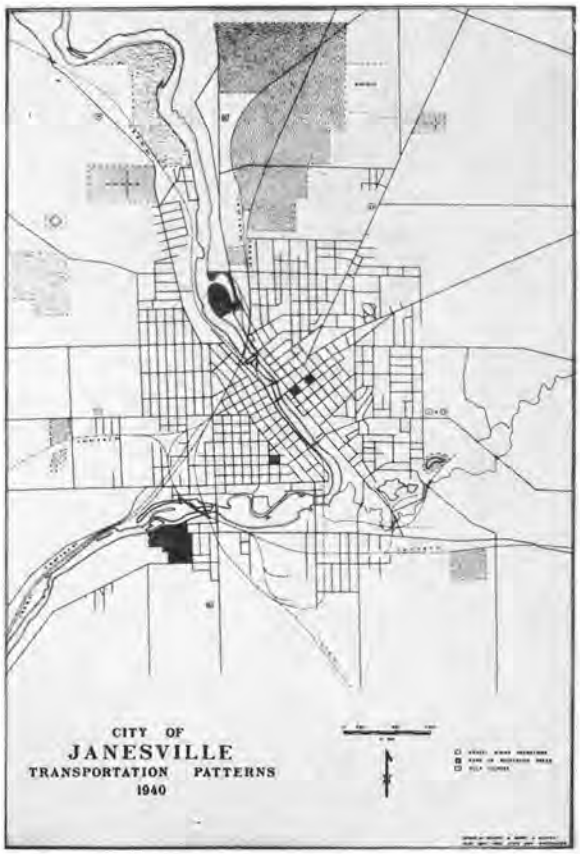


FIG. 2. General transportation grid and large scale land ownership tracts in 1940.

or parkway would be most desirable between the older residential core and the industrial area to the south stretching along the Rock River and the small creek entering from the east and including some mined-out gravel areas. This would, in effect, offer recreational facilities for the growing population, make use of otherwise non-usable gravel-pit areas, and create a screen between the industrial area and older residential core area in the big bend of the Rock River and any future growth to the east. Additional parkway along the northern reaches of the Rock River would also appear to be a desirable projection, but would appear to be somewhat hampered in development by major U. S. highways and railroad lines that have considerable right of ways, and by large tract ownership patterns.

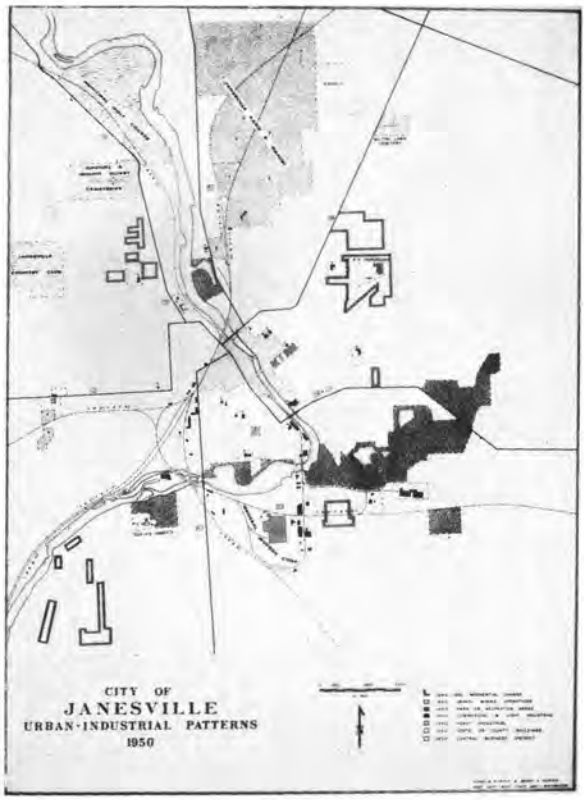
The complete urban-industrial patterns for 1940 shown in Figure 3 substantiate the presence of industrial establishments along the south edge of the city and the need for the greenbelt. The approximate limit of residential homesites for 1940 is indicated by the diagonal line border pattern indicating a slight majority of homesites, in terms of residential land area, are located on the east side of the Rock River. The big bend of the Rock River is part of the older residential portion of the city dating back to the early 1800's with pre-1940 growth having occurred along the river itself and to the east and west for short distances.

By 1950 (Figure 4) the green belt had been established separating the industrial district from the older residential homes, and actually incorporating the gravel pits along the small creek entering from the eastern farmland area which was more an intermittent than a permanent stream by 1950 due to land use practices and some farm use. Growth of the city was following the major highways from the northwest and northeast, with some limited growth along the southwestern edge of the city, the pattern of growth indicating a ribbon growth as had been predicted from the initial 1940 photos and maps.

The general expansion pattern continued through 1956 (Figure 5) although a change from the ribbon pattern was beginning to take place with some block building in the east and to the southwest as farmland was subdivided by either the owners or large scale land developers. The expansion at this time in terms of actual number of homesites was the greatest on the eastern side of the city, with apartments and many low-cost, single-family dwellings being erected corresponding to an expansion in the Chevrolet Division of General Motors Corp., and growth of the Parker Pen Company, both establishments being major employers in the city of Janesville.

At this point in the study, a system of land use categories was established as designed by Pownall and acreages of the seven categories computed from elementary planimeter methods based on the 1:7,920 enlarged aerial photographs for each of the study years. A comparison was then drawn between the photo measurements and the existing ground gathering methods as employed by the city of Janesville, which included general surveying at selected intervals, questionnaires to existing industry and commercial establishments and existing federal and state data. In addition to the area computations

FIG. 4. General urban-industrial patterns in 1950.



the population density, dwelling occupancy and other urban quantitative factors as developed by Green were applied to the Janesville area. This data was correlated to federal, state and city data available for the selected years of the study, as well as being used for projections to the year 1963, with an accuracy factor in the former well within anticipated margins and readily adaptable to the needs of the city in terms of general urban planning.

It should be noted that the city of Janesville has a relatively homogeneous population and little of what could be called *urban renewal land* in which the population density is very high and difficult to ascertain from aerial photography. The primary reason for the Pownall and Green urban research techniques at this point was due to the fact that aerial photography was used for the first time on a limited basis in the city of Janesville Planning Department in 1955. Comparisons to the city use of aerial photography for the period 1955–1963 was to be attempted within limits set by available materials and photogrammetric equipment available to the research study. The city of Janesville had contracted with Mark Hurd Corp. of Minneapolis, Minn. to fly coverage of the city in 1955 and had this photography updated in 1965, actually relying on aerial photography for the greater portion of its planning data than on any other single data gathering method in terms of scope and cost savings.

At a cost of $4.50 per acre flown, maps were produced by Mark Hurd, Corp. at a scale of 80 feet per inch for exceptionally detailed work and at a

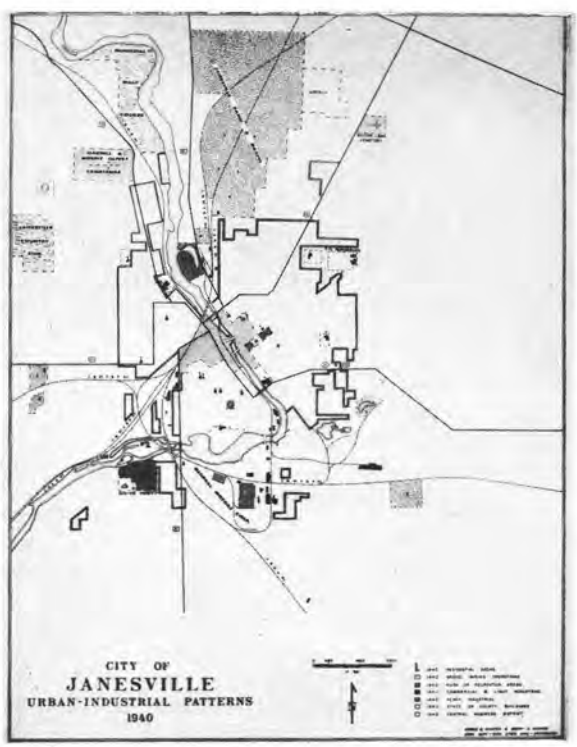


FIG. 3. General urban-industrial patterns in 1940.

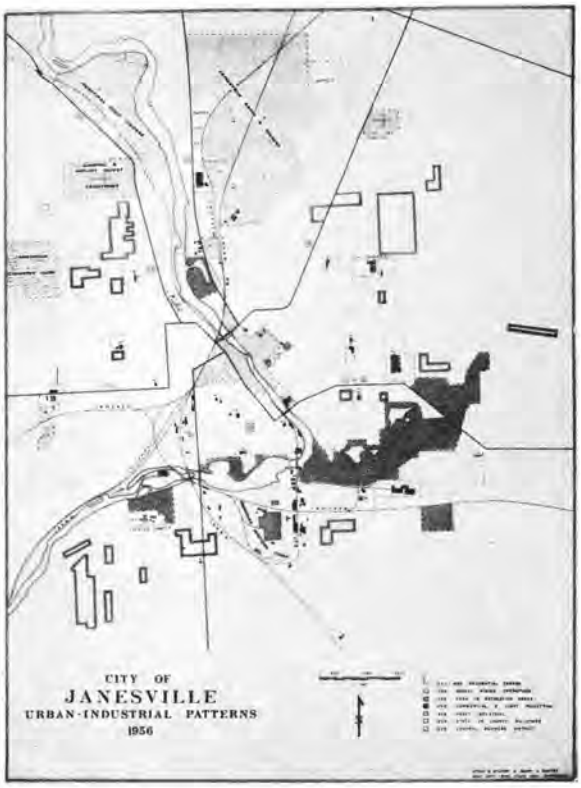


FIG. 5. General urban-industrial patterns in 1956.

scale of 200 feet per inch for the bulk of the city planning needs. The 200-feet-per-inch maps were on clear mylar film and included contours at 2 foot intervals, all existing roads added to major cultural features and vegetation plots. The 200-feet-per-inch maps are being used in all stages of the city planning including: placement of city streets in proposed subdivisions including the designation of major arterial streets and minor feeder streets; school and church site evaluation: sewer and water pipeline grade planning and designation of future parkway areas according to drainage patterns and slope of the terrain. This multiple usage of the aerial photography and the photo-compiled maps has allowed the city of Janesville to plan well ahead in relation to the rapid growth the city has experienced since the mid 1950's.

The controlled growth through careful planning is shown in Figure 6 where new street sites on a sequential basis have been indicated, although not necessarily new homesites as has been the case in the maps for 1950 and 1956. Several factors that have contributed to the more rapid urban growth on the eastern side of the city would include: cost of land, sewage disposal plant location, and the influence of large tract land ownerships of a relatively permanent nature. Although it was theorized from the 1940 maps and photos that the possibility of the land to the west developing before that on the east side of the city despite large tract ownerships in terms of the golf courses and cemeteries, this in fact has not been realized.

The active farmland in the eastern portion began to be sold as early as 1952 for subdivision purposes, with the land value in terms of farmland being exceeded by the value in respect to homesites development. Contributing to the sale of the farmland were several related factors such as age of the farmers, need for increased fertilization on the glacial till material, and the increased competition in the farming community with large-scale ownerships in the Midwest and western states. This relatively flat land lent itself well to road grading and sewer and water pipelines with a minimum of expenditures on behalf of the developer and the city, and continued to appeal to the developer despite changes in land values from $1,600 per acre in 1954 to $3,000 per acre in 1963. The construction of Interstate 94 on the east side of Janesville was at first envisioned as a barrier to further urban growth and in the initial plans allowed for fewer overpasses than would allow for expansion of arterial streets to the east out of Janesville.

Changes in state and federal overpass plans and the leapfrog effect of the urban growth westward has dispelled the blocking theory and in effect led to zoning rules concerning commercial and industrial development along the Interstate and associated major traffic—both road and rail—byways as determined from use of the aerial photography. The land to the west, although not particularly better farmland than that to the east, has not developed residentially as quickly with the major factors being cost of the land, nearness of bedrock to the surface and the presence of drainage areas that would create problems in sewage pipeline construction. The value of this rolling, wooded farmland has reached $4,000 per acre with lot sizes being larger and more desirable than the flat, monotonous land in the eastern part of the city, although this terrain

factor increases cost of road grading and sewer and water pipeline construction. From stereocomparagraph contouring, identification of rock outcrops and the tracing of drainage lines, the difficulty that the land presented to subdivision development could have been determined from the 1940 photographs, although merely to make the assumption that growth would then take place to the east in what was at that time active farmland would have been somewhat precarious in nature.

The areas to the southwest and southeast have encountered growth problems related to the slope of land and the location of the municipal sewage plant. Homes in these two areas have reached the approximate limit in southward growth without the city installing a sewage pumping system at select locations, as compared to the gravity flow system utilized in other parts of the city. The existing sewage conveyance system was designed with the local surface drainage system in mind and thus the conveyance system is capable of handling effluent from expansion of the city—although the sewage plant itself is at this time inadequate to treat the increased input, and a new plant is to be constructed by 1970 further downstream than the existing one, a factor which may increase growth to the southwest and southeast.

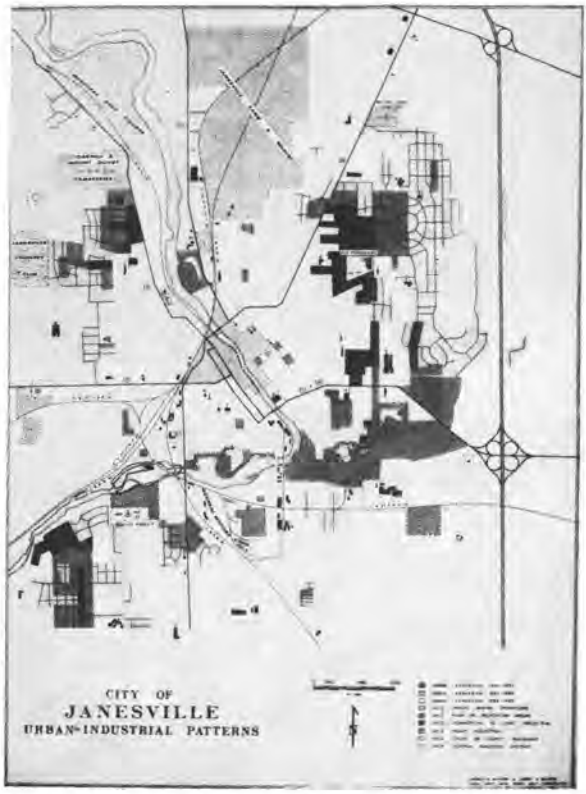


FIG. 6. Summary of urban land use changes 1940 to 1963, and 1963 industrial pattern.

The large tract land ownerships have primarily affected growth in the northern sections of the city, especially the Janesville Sand and Gravel ownership which dates its operation to before World War I. The golf courses and cemeteries on the west side have not hampered growth as much as might have been anticipated as this has almost guaranteed an almost country club-like atmosphere in the area. The major ownership tract in the south that has somewhat impeded urban growth are the Chevrolet Division of General Motors Corp. and satellite manufacturing and trucking establishments, in addition to the slope of the land previously mentioned.

These urban expansion problems might become evident to the urban planning group during the course of using standard ground methods of urban planning, but by using sequential aerial photography flown at convenient intervals, urban planning can—for a nominal cost—be updated by cities under 50,000 in population, few of which at this time actually make complete usage of aerial photography and the very valuable information that may be derived from the photos. The plotting of new residential, commercial and industrial areas on a zoning basis, contouring for road grading and sewer and water installation, the location of school sites and the taxation of property can all be facilitated by using aerial photography in conjunction with limited standard ground methods.

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New Publications

San Giovenale, Bertil Hallert, Lund Berlingska Boktryckeriet, Stockholm, Sweden, 1967. 26 pages, 9 by 11.5 inches.

Photogrammetry is applied exclusively to the archeological site San Geovenale in Italy, resulting in a 1:1,000-scale topographic, and a 1:500-scale relief model, compiled from aerial photographs at 1:5,000, which is also the scale of an anaglyph. The work was completed in Sweden supported by several foundations including the Swedish Institute of Classical Studies of Rome, and the Soprintendenza alle Antichita dell'Etruria Meridionale. The publication comprises a documentation of the procedure involved in the work including an explanation of the photogrammetric practices that were utilized.

Precision Measurement and Calibration—Statistical Concepts and Procedures. Edited by Harry H. Ku, National Bureau of Standards Special Publication 300—Volume 1; issued February 1969; 436 pages; $5.50. (Order from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402; the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151; or from local U. S. Department of Commerce Field Offices.)

Volume 1 of NBS Special Publication 300, just issued, deals with statistical concepts and procedures that are oriented specifically to the field of physical measurements and calibrations. It contains reprints of forty papers on various aspects of the subject, including pioneering contributions made by NBS staff members on the concept of statistical control of a measurement process, and the use of statistical design in physical experimentation (notably work by Churchill Eisenhart, W. J. Youden, and Joseph M. Cameron in these areas).

The material in Volume 1 is arranged in seven sections, the first five of which deal with the following: The measurement process, precision, systematic error, and accuracy; Design of experiments in calibration; Interlaboratory tests; Functional relationships; and Statistical treatment of measurement data. In the sixth section, miscellaneous topics are discussed, and there is included a list of selected references, each accompanied by brief descriptive comments. The last section consists of abstracts of some recent publications that were too long to include in full.

Two other volumes in the series have already appeared; 12 volumes in all are now planned.